Model Remedies for Cleanup of Inactive and Abandoned Mine Lands in Washington

Sampling and Cleaning Up Mine-Waste-Contaminated Soils

For the

Toxics Cleanup Program

Washington State Department of Ecology
Union Gap, Washington

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Publication Information

This document is available on the Department of Ecology's website at:
https://apps.ecology.wa.gov/publications/summarypages/2409024.html

Related Information

Inactive and Abandoned Mine Lands. Most metal mining was concentrated in the north Cascade Range and in the Okanogan geologic province.

For an interactive map, visit Ecology's Dirt Alert Map.[1]

Contact Information

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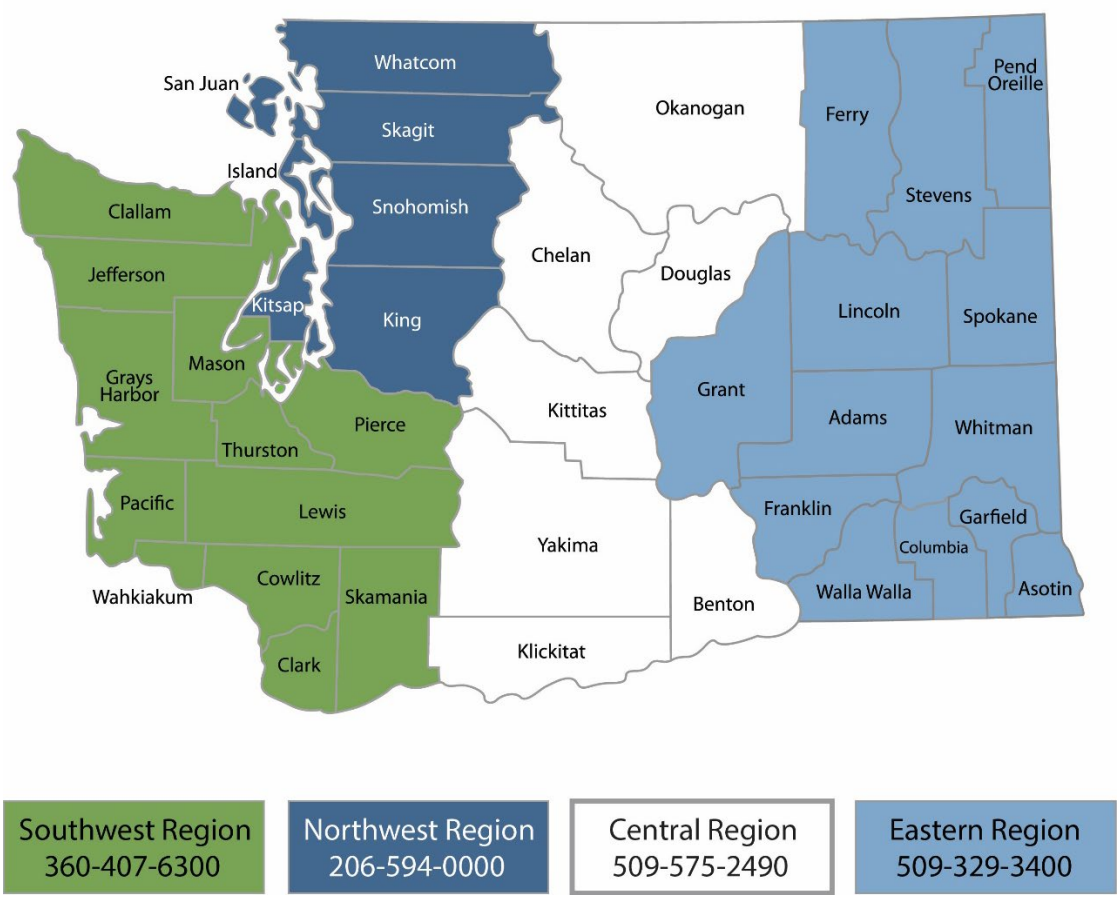
[1] https://apps.ecology.wa.gov/dirtalert/
[2] www.ecology.wa.gov/contact

Department of Ecology's Regional Offices

Map of Counties Served



Region	Counties served	Mailing Address	Phone
Southwest	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, Wahkiakum	P.O. Box 47775 Olympia, WA 98504	360-407-6300
Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	P.O. Box 330316 Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 West Alder Street Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 North Monroe Spokane, WA 99205	509-329-3400
Headquarters	Statewide	P.O. Box 46700 Olympia, WA 98504	360-407-6000

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DEPARTMENT OF
ECOLOGY
State of Washington

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Executive Summary

You can use this document if:

- You have knowledge that your property includes inactive or abandoned mine lands;
- Each individual mine waste (waste rock or tailings) pile contains 2,000 cubic yards or less of material;
- Metals are the only suspected contaminants on your property; and
- Sediment, surface water, and groundwater are not contaminated.

If all the criteria listed above apply, you can meet state cleanup requirements without doing your own feasibility study by carefully following the steps in this model remedy.

I need a No Further Action determination from Ecology

You might not need a formal evaluation from Ecology if your cleanup is being conducted in cooperation with a local government; however, if a local government permit office or lender requires Ecology's formal written concurrence of your cleanup, you can enter the Voluntary Cleanup Program (VCP) to pursue a No Further Action (NFA) determination. Also, a future buyer might want to see Ecology's written concurrence of your cleanup, so a NFA determination issued by opinion letter through VCP might be valuable to you. The VCP provides non-binding, informal advice and technical assistance in the form of a written opinion. Additional information is in Chapter 2: Planning for Cleanup – Option to pursue a No Further Action (NFA) determination.

More information is available on Ecology's VCP web pages.[3]

Or you can call 509-575-2490 or email justin.rice@ecy.wa.gov to speak with Ecology's Abandoned Mine Land Program.

[3] https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Voluntary-Cleanup-Program

Introduction

Washington has a legacy of mining activity, and that history has led to thousands of inactive and abandoned mines across the state. Many of these inactive and abandoned mines are ongoing sources of contamination that include high concentrations of metals in soil. The term metals is used in this document to describe both metals and metalloids.

Cleaning up inactive and abandoned mine lands (IAMLs) presents unique challenges and opportunities. While there are some common characteristics (remote locations, heavy metals contamination, surface water pollution, etc.), the scope and scale of individual cleanups can vary drastically. This guidance addresses IAMLs that:

- Are contaminated by waste rock (rock containing target minerals in concentrations too low for economic recovery) or tailings (mined material remaining after processing removed the valuable minerals), herein referred to as mine waste piles.
- Consist of individual mine waste piles that each contain 2,000 cubic yards or less of material.
- Sediment, surface water, and groundwater are not contaminated by mine waste piles.

Goals of this guidance are to:

- Provide simple sampling and cleanup guidance to remediate mine waste piles,
- Encourage independent cleanup of IAML properties, and
- Provide consistency and clarity for property owners.

This guidance focuses on mine waste piles at inactive and abandoned mining sites, but it does not address chemical releases not associated with mine waste (for example, wastes from other commercial or industrial activities or illegally dumped hazardous waste). At many sites, physical hazards, such as open shafts, adits, unstable buildings, and unstable slopes, present a safety hazard. These safety hazards are not considered in this document.

Overview of mining operations

Since at least the early 1800s, miners have explored, mined, and processed valuable minerals in Washington. Traditional metals mining usually involves digging tunnels and pits to reach deposits of mineral-rich ore. Ore is removed from the ground and processed to extract the desired minerals. When the ore is exhausted, miners move on leaving behind finely-ground tailings and waste rock piles

Figure 1. Mine waste pile, Kaaba Texas Mine, Okanogan County

above ground and in underground tunnels. Many of the environmental concerns about mine waste piles depend on the type of mining and ore-processing techniques that were used. The metals-rich material that make up the mine waste piles, which were once underground, are now concentrated into piles that are exposed on the surface.

Health effects of mine wastes

Abandoned mines can cause environmental degradation and hazardous conditions that pose risks to human health and the environment. Mine wastes potentially contain metals in toxic concentrations. Typical contaminants found in mine wastes include the following Priority Pollutant Metals:

- Antimony
- Arsenic
- Beryllium
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Selenium
- Silver
- Thallium
- Zinc

Exposure to these metals can increase the risk of certain health problems for humans and wildlife. Scientists have linked long-term exposure to these metals to a variety of health problems, including cancer of the bladder, lung, skin, kidney, liver, and prostate; heart disease; diabetes; and behavioral problems.

Whether someone is impacted depends on the amount of metal contaminants taken into their body over time (EPA 2021). People exposed to contaminated soil on a regular basis may be affected.

Who is at highest risk?

Mine waste contaminants can pose a risk to people's health, particularly to young children and pregnant women. Because many IAML sites are in remote locations, you are most likely to encounter mine waste contaminants while recreating in natural areas. Although these contaminants are not easily absorbed through the skin, exposure to mine waste will likely result in ingestion of contaminated soil and inhalation of dust.

Children are also more likely to be exposed because they typically play on the ground and tend to put their hands in their mouth. The small amount of metal contaminants they might swallow is more harmful because they are still growing.

Development in historic mining areas creates additional exposure scenarios that could include residential contact, groundwater, or surface water contamination. Construction workers, gardeners, and landscapers can also be exposed to contaminated soil at a work site by accidentally ingesting soil or inhaling dust. Employers are responsible for meeting health and safety requirements at work sites to limit worker exposure. Employers should contact the

Washington Department of Labor and Industries (L&I)[4] for more information on exposure limits and other safety requirements at work sites.

As a result of the tendency of IAMLs to be in remote locations, wildlife and terrestrial and aquatic organisms are considered at high risk from mine waste exposure.

Why sample?

Ecology requires initial determination sampling when mine waste is suspected to be on a property. At some sites, the extent of mining and mine waste might not be visually apparent, and it would be necessary to consult published reference material. Useful publicly available data sources on IAMLs include the following:

- State of Washington, Department of Natural Resources, Inactive and Abandoned Mine Land Reports Index.[5]
- State of Washington, Department of Natural Resources, Washington Geologic Information Portal.[6]
- State of Washington, Department of Ecology, What's in My Neighborhood[7] map-based search tool of Washington cleanup sites.

Ecology requires sampling because there is a very strong correlation between elevated metal concentrations and mine waste. As a result, properties containing mine waste are suspected to be contaminated, and sampling is required by state law.

Even if your property is a former mine land, you might not have elevated levels of metal in your soil. Metal concentrations depend on several factors, including local geology and past mining processes, and are highly variable from property to property. Initial determination sampling verifies whether your property contains concentrations of metals above state cleanup levels. Once you know if contamination is present and where contamination is located, you can take actions to manage potential exposure on your property.

Estimate mine waste volume

Mine waste pile dimensions can be estimated using field measurements, approximations, and GPS data. Estimated depth of material can be made through visual observation.

Mine waste pile dimensions can generally be characterized as uniform in depth, cone shape, or pyramid shape. Mine waste volume for these configurations can be calculated using the following general formulas.

- **Uniform Depth**: Volume (cubic feet) = Surface Area (square feet) x Depth (feet)
- **Cone**: Volume (cubic feet) = 1/3 x π x (Radius of Base [feet])^2 x Depth (feet)

[4] https://www.lni.wa.gov/
[5] https://file.dnr.wa.gov/publications/ger_iaml_reports.pdf
[6] https://geologyportal.dnr.wa.gov/
[7] https://apps.ecology.wa.gov/neighborhood/

- **Pyramid**: Volume (cubic feet) = 1/3 x Surface Area of Base (square feet) x Depth (feet)
- **Conversion Factor**: 1 cubic yard = 27 cubic feet

The volume of mine waste piles can also be calculated with great accuracy using remote sensing and surveying techniques. Ecology recommends hiring an experienced surveyor for more accurate mine waste pile measurements.

Soil cleanup levels

When defining cleanup levels at sites contaminated with several hazardous substances, Ecology can eliminate contaminants contributing a small percentage of the overall threat to human health and the environment. WAC 173-340-703[8] provides the criteria by which a substance can be eliminated from further consideration.

Ecology reviewed chemical analytical data from IAMLs in Washington to identify indicator hazardous substances for mine waste piles, as described in Appendix A. Past studies found other elements, but mostly in trace amounts. They include antimony, beryllium, chromium, copper, mercury, nickel, selenium, silver, and thallium. If other metals did exceed cleanup levels, arsenic, cadmium, lead, or zinc would too. Cleanups driven by arsenic, cadmium, lead, and zinc will address all other hazardous substances from mine waste piles.

Cleanup levels for IAML indicator hazardous substances are available in Table 1. Cleanup levels for the IAML indicator hazardous substances meet Model Toxics Control Act (MTCA) requirements for human health and upland ecological receptors. See Appendix A for a discussion about developing IAML cleanup levels.

Table 1: State cleanup levels for IAML indicator hazardous substances

Contaminant	Cleanup Level in milligram per kilogram (mg/kg)
Arsenic	20
Cadmium	4
Lead	250
Zinc	86

Background levels

At certain sites, background sampling can provide a useful tool to determine whether contamination represents conditions caused by past mining activities. Natural background is defined as the concentration of a hazardous substance consistently present in the environment that has not been influenced by localized human activities (WAC 173-340-200).[9] Often, mining activities occur in areas of naturally occurring elevated metal concentrations. In these

[8] https://app.leg.wa.gov/WAC/default.aspx?cite=173-340-703&pdf=true
[9] https://app.leg.wa.gov/WAC/default.aspx?cite=173-340-200

instances, an investigation of the natural background condition can assist to determine site-specific cleanup levels.

Contact Ecology if you suspect metals contaminants naturally occur at concentrations greater than cleanup levels at your property.

Dangerous waste

Washington State Dangerous Waste Regulations (DWRs) (WAC 173-303)[10] govern the generation, management, and disposal of dangerous waste. Highly contaminated mine waste might designate as dangerous waste if the waste exhibits the characteristics of toxicity, using the *Toxicity Characteristic Leaching Procedure* (TCLP) laboratory method. Soil samples may need to undergo a TCLP analysis to determine if they designate as dangerous waste. Table 2 lists soil concentrations requiring TCLP analysis.

Table 2: Dangerous waste concentration levels

Contaminant	Soil concentration requiring TCLP analysis (mg/kg)
Arsenic	≥ 100
Cadmium	≥ 20
Lead	≥ 100

mg/kg = milligrams per kilogram
TCLP = Toxicity Characteristic Leaching Procedure

Model remedies

The purpose of model remedies is to streamline and accelerate the selection of cleanup actions that protect human health and the environment, with a preference for permanent solutions to the maximum extent practicable. This document provides information to establish model remedies for cleanup of mining waste at IAMLs. Appendix A discusses the eligibility criteria each project must meet, and a discussion of how the model remedies comply with MTCA requirements.

Model remedies are most appropriate for routine cleanup projects at lower risk sites and are generally more applicable to independent cleanups. This includes those seeking an NFA determination via opinion letter under the Voluntary Cleanup Program (VCP) or situations where the potentially liable person (PLP) is implementing the cleanup with no Ecology oversight. These model remedies can also apply to Ecology-supervised cleanups.

[10] https://app.leg.wa.gov/wac/default.aspx?cite=173-303

Table 3 contains the three model remedy options found in this document. The best option will depend on the specific conditions and proposed land use for your property. A combination of these options is acceptable if all contaminated areas are addressed.

Table 3: Model remedy options

Model Remedy	Action	Considerations
Excavate and Remove (Chapter 3)	Excavate contaminated soils and properly dispose of them.	Compliance sampling of excavated areas required. Careful sampling in advance provides understanding of how much soil must be removed.
Cap in Place (Chapter 4)	Cover contaminated soils with a geotextile fabric and soil cap or hard cap.	Requires long-term monitoring and maintenance. Institutional controls required.
Consolidate and Cap (Chapter 6)	Excavate and consolidate contaminated soils into an area of the property and place under a cap (see above).	Compliance sampling of excavated areas required. Requires long-term monitoring and maintenance. Institutional controls required.

Capping presented in the model remedies provides protection from direct exposure to contaminated material; however, it would not stop precipitation from infiltrating the contaminated material and potentially reaching groundwater. Based on this, capping not an approved model remedy for sites with dangerous waste.

The premise of the model remedies presented in this document is the remedial action would be implemented as a final cleanup action, in accordance with WAC 173-340-390.[11] However, some or all the components of a model remedy could be implemented as an interim action under WAC 173-340-430.[12]

[11] https://app.leg.wa.gov/WAC/default.aspx?cite=173-340-390&pdf=true
[12] https://app.leg.wa.gov/WAC/default.aspx?cite=173-340-430&pdf=true

Chapter 1: Soil sampling

This chapter describes the steps in sampling mine waste on your property. There are three stages of mine waste sampling that might be required during the cleanup process. They include:

1. Initial determination sampling
2. Site characterization sampling
3. Compliance sampling

Initial determination sampling will show whether a property or a portion of it is clean or contaminated. Ecology requires initial determination sampling on properties that contain mine waste. If the property is identified as clean during initial determination sampling, no other action is required.

Ecology will conduct initial determination sampling at your property at no cost. This sampling event will be used to determine whether your property is impacted and whether additional sampling and mitigation are required. If indicator hazardous substances (Table 1) are detected at concentrations above state cleanup levels, site characterization sampling might be required to determine which remedy is appropriate for your property.

Site characterization sampling might be required if initial determination sampling shows the property is contaminated. Site characterization sampling will determine the extent and magnitude of contamination, and determine what remedial options are appropriate.

Compliance sampling is required if you use a remedy that includes excavation. Compliance sampling will demonstrate whether you have successfully excavated all contaminated soil. Compliance sampling is discussed further with the excavation model remedy (Chapter 3) and the consolidate and cap model remedy (Chapter 5). Additional details are provided in Chapter 6.

Decision units

You will need to prepare an existing site condition map illustrating relevant current site features such as property boundaries, extent of mine waste and impacted soils, process-related operation areas, haul routes surface topography, surface water, well locations, and other pertinent information.

Individual mine waste piles distributed throughout the property should be identified as separate decision units.

Initial determination sampling

As stated in the introduction, Ecology *requires* initial determination sampling when mine waste is on a property. Initial determination sampling will follow the procedure described in "Sampling Strategy for the Rapid Screening Assessment of Mine-Waste Dumps on Abandoned Mine Lands" (Smith et. al., 2000) developed by the United States Geological Survey (USGS). This

procedure consists of collecting 30 subsamples within a targeted mine waste pile and then combining the subsamples into one composite sample for chemical analysis.

Site characterization sampling

Site characterization sampling is used to understand how metal contaminants are distributed throughout your property, and to help you select the best model remedy. Site characterization must be completed in accordance with WAC 173-340-350.[13] Appendix B (Form 1: Characterization Sampling) will help you document your planning for this process.

Sampling for a capping remedy

Use Table 4 to find the number of sample locations you need for a capping remedy. Fewer samples are required for capping remedies because a cap is protective of the range of metal contamination found at IAML sites. The specific contaminant concentrations are not critical if the property is properly capped. Take a sample from each location from the top 0–6 inches of soil after clearing away large rocks, grass, leaves, twigs, or other debris from the surface.

Table 4: Minimum number of soil sample locations per decision unit for a capping remedy

Cubic yards of mine waste	Number of samples for chemical analysis
0–100	4
101–500	6
501–1,000	8
1,001–2,000	10

Sampling for an excavation remedy

For an excavation remedy, site characterization requires taking samples at multiple depths to identify the maximum depth of contaminated soil. Collecting characterization samples from multiple depths might require the use of mechanical equipment such as a backhoe or drill rig. The sample locations selected for depth profile samples should be equally distributed across the decision unit. This information is critical to understand the quantity of soil that will be excavated. For sample locations selected for depth analysis, samples should be taken at 1-foot depth intervals until clean soil is encountered. This process is much quicker when using an X-ray fluorescence (XRF) detector rather than laboratory analysis. See discussion of XRF use later in this chapter. Use Table 5 to find the number of sample locations you need for an excavation remedy.

[13] https://app.leg.wa.gov/WAC/default.aspx?cite=173-340-350

Table 5: Minimum number of soil sample locations per decision unit for an excavation remedy

Cubic yards of mine waste	Number of samples for chemical analysis	Number of sample locations with depth profile samples
0–100	4	2
101–500	6	3
501–1,000	8	4
1,001–2,000	10	5

Additional factors

Other factors might influence the number of samples required. Please contact Ecology to discuss potential needs to modify the number of required samples. Additional factors might include the following:

1. Presumptions – Do you plan to use a capping remedy and presume the entire decision unit is contaminated and the entire area will be capped to save sampling costs? In this case, contact Ecology as a minimal number of samples might be required to characterize what will remain beneath the cap.
2. Land use – What is the intended land use? Will the land be inaccessible to the public? A higher level of land use residential or public recreational use typically requires a greater degree of data confidence to ensure protectiveness.

Where to sample

You will be required to attach a site cleanup map to your final cleanup report showing the property dimensions and decision units. For each decision unit, lay out sampling points in an evenly spaced grid.

Initial determination samples are composite samples, which means the soils from multiple locations are combined into a single sample. When conducting initial determination sampling, lay out 30 sampling points to collect subsamples for compositing.

All characterization samples are discrete, which means the soils for one sample come from a single sample location. Use the number of locations from tables 4 or 5, for site characterization sampling. Grid points should cover as much area as possible. Adjust the grid or add locations to make it fit.

Collecting samples

At a minimum, you will need the following equipment to collect soil samples for laboratory analysis:

- Stainless-steel tools to dig holes and remove soil (trowel and small shovel),
- Stainless-steel bowl to mix (composite) samples, if performing initial determination sampling,

- Lab-provided glass sample containers,
- Permanent marker to record sample locations on the container labels,
- Wash bucket, non-phosphate detergent, scrub brush, and rinse water (tap water and distilled or deionized water),
- Nitrile gloves,
- Property diagrams with sampling grids,
- Map or aerial photo of decision unit,
- Cooler with ice to keep the samples cool, and
- Chain-of-custody forms.

Sample collection steps

Before taking any samples, contact an Ecology accredited lab (see Help Desk). The lab might have special instructions about labeling and delivering the samples.

The following sections describe procedures to collect samples for laboratory analysis.

Initial determination procedure

1. Remove any large debris at each subsample location. This includes rocks, pebbles, leaves, vegetation, and roots. For each decision unit, there will be 30 subsample locations.
2. Excavate a 2- by 2-inch square to a depth of about 6 inches with a clean (see Decontamination section below) spade or trowel.
3. Screen material to remove any pebbles, gravel, roots, or other debris.
4. Place excavated soil into a clean, stainless-steel bowl for compositing.
5. Repeat steps 1 through 4 at each subsample location. There will be a total of 30 subsample locations.

Figure 2: Collecting mine waste subsamples for compositing.

6. Mix the soil subsamples to obtain a homogenized sample.
7. Using a permanent marker, label your lab-provided glass sample containers with:
    a. A unique identifier for the sampling location,
    b. Your name, and

c. The date and time the sample is being collected.

8. Fill up the glass sample containers with the mixed soil and seal it securely. Discard any extra soil back onto the mine waste pile.
9. Place the samples in an iced cooler and fill out laboratory-provided chain-of-custody form to accompany the samples to the laboratory with the required information.

Site characterization procedure

1. Remove any large or nonrepresentative debris from the sample location before analysis. This includes rocks, pebbles, leaves, vegetation, and roots.
2. Use a clean (see Decontamination section below) stainless-steel trowel or shovel to dig an eight- to twelve-inch hole making an exposed vertical soil face to sample from.
3. Using a clean trowel or spoon, scrape soil from the side of the hole at the depth interval you are sampling and put the soil in the clean, stainless-steel mixing bowl. Avoid or discard pebbles, rocks, roots, or other debris. Collect soil evenly from the desired sampling depth of the hole. It is important to mix the soil well in the stainless-steel bowl.
4. Using a permanent marker, label your lab-provided glass sample containers with:
    a. A unique identifier for the sampling location,
    b. Your name, and
    c. The date and time the sample is being collected.
5. Fill up the glass sample containers with the mixed soil and seal it securely. Discard any extra soil back onto the hole. Do not composite (mix) samples from different locations.
6. Place the samples in an iced cooler and fill out laboratory-provided chain-of-custody form to accompany the samples to the laboratory with the required information.
7. Between each sample, scrub and wash the sampling tool and mixing bowl clean using the decontamination procedures listed below.
8. For deeper samples, to identify maximum extent of contamination, continue digging at the same location to reach the desired sample depth. Depending on the depth, you might need to excavate using mechanical equipment such as a backhoe or a drill rig. Collect deeper samples using the techniques described above by collecting the sample either from a drill rig core sampler, or by scraping the sidewall of the excavation at the desired depth using the bucket of the excavation equipment. Do not enter deeper excavations.

X-ray fluorescence detector analysis

Ecology encourages the use of XRF technology for analyzing properties for metals contaminants. XRF analysis provides real-time data and makes sampling and analysis highly efficient. With real-time data, changes to your sampling plan can be made in the field based on analytical results. This can avoid multiple return sampling events that might be required when

relying on delayed laboratory results. There are many brands and models of XRF. Ecology will accept data from any XRF that has detection limits below the cleanup levels presented in Table 1. Prior to taking the instrument into the field, calibrate the instrument according to the manufacturer's instructions. Include calibration results with the final cleanup reportsubmitted to Ecology (see the Reporting to Ecology section).

Figure 3: Conducting XRF analysis on composite sample.

The same tools and techniques described above in "Sample Collection Steps" should be used for XRF analysis, except that the sample material can be placed in a XRF sample cup (if available) or a small plastic bag. Analyze the sample through the plastic bag or sample cup according to the XRF user's manual. Conduct calibration and calibration checks of the XRF instrument as required by the equipment manufacturer.

Initial determination sampling conducted with XRF does not require laboratory analysis results for comparison. Site characterization and compliance sampling conducted by XRF require that at least 10% of samples are submitted for laboratory analysis.

Note: Proper training for the safe operation of the instrument and radiation training should be completed by the analyst prior to analysis. Ecology recommends that an experienced environmental consultant be hired to do soil sampling as well as reporting of sampling methods and results (see the Help Desk section). If you choose to do such sampling yourself, Ecology expects documentation to be thorough and complete, and sampling procedures followed strictly to prevent potential cross-contamination and ensure high-quality data.

Decontamination

The objective of the decontamination procedure is to minimize the potential for cross-contamination between sample locations. Sampling equipment should be decontaminated using the following procedures immediately before each sampling event.

1. Put on a clean pair of nitrile gloves.
2. Brush equipment with a nylon brush to remove large particulate matter.
3. Wash equipment with non-phosphate detergent and water solution.
4. Rinse with distilled water, ensuring that all soap from the previous step has been removed.
5. Air dry equipment.

Laboratory analysis

If you elect to use a laboratory for analysis, see the Help Desk section of this guidance to select a lab.

Samples must be immediately placed in a cooler packed with enough ice to maintain a temperature between 2 and 8 degrees Celsius until receipt at the laboratory facility. Make sure the sample containers and forms remain dry by sealing them in plastic bags inside the cooler. Bring the samples to the lab or follow its instructions for shipping. Include a copy of the sample inventory sheet (Form 2) and the chain-of-custody form provided by the lab. Keep copies for yourself.

The lab report should include a list or separate pages of results for each sampling location. It should have results for quality-control samples done at the lab. This is standard practice for all metals analysis. You will also see the chain-of-custody form signed by the laboratory. Keep everything you receive from the lab.

If you anticipate pursuing an NFA determination from Ecology, you will have to submit laboratory data to Ecology's Electronic Information Management system (EIM). To facilitate this process, you should request that the laboratory provide your data in an electronic deliverable format that is compatible with EIM. Most laboratories can produce this format.

Soil: Understanding your characterization results

Use the sample results to plan your next steps. If indicator hazardous substance (arsenic, cadmium, lead, and zinc) concentrations are "elevated" for any decision unit on the property, it needs cleanup. Elevated means one or more of the following criteria are met:

- Average indicator hazardous substance (arsenic, cadmium, lead, and zinc) concentrations are greater than cleanup levels provided in Table 1.
- Maximum (any one sample) indicator hazardous substance is two-times greater than cleanup levels provided in Table 1.

Use Appendix B (Form 2: Characterization Sampling Results) to calculate average and maximum indicator hazardous substance concentrations for each decision unit. Mark which decision units exceed cleanup levels.

For assistance with interpreting your results and deciding on cleanup options, please contact Ecology.

What to do next

If none of your decision units have elevated indicator hazardous substance concentrations, stop here. If one or more decision units have elevated concentrations, select one or more cleanup options from Chapter 2.

Ecology also recommends:

- Entering Ecology's VCP to obtain an official opinion letter such as an NFA determination, if needed.
- Taking healthy actions like handwashing and taking shoes off at the door if you contact mine waste materials.
- Notify property users of healthy actions and why to use them.

Chapter 2: Planning for Cleanup

Table 3 summarizes model remedies for mine-waste piles. Any combination of these remedies is acceptable. Excavation is a permanent remedy, whereas capping needs ongoing monitoring, maintenance, and property restrictions. Permanent solutions should be used to the maximum extent practicable.

Remedy selection

It is up to you to select the best remedy for your property. Below are general considerations for each model remedy. Each remedy is discussed in more detail in its respective chapter.
The property location, accessibility, and features can make certain options less expensive.

Excavation and disposal

Excavation and disposal is often the most expensive option. It requires excavation of all contaminated soil from your property, and it requires disposal of this soil at a certified landfill. If contamination extends deep into the soil, as is typical, a large amount of soil must be excavated from your property. The benefit to excavation and disposal is that the remedy is permanent. No other actions are required.

Capping

Capping is often the least costly remedy, but also requires the greatest amount of long-term maintenance and monitoring. Capping requires the least amount of sampling because a cap is protective of the range of metals found in mine-waste piles. The specific metal concentrations are not critical if the property is properly capped. The depth of the extent of contamination is also irrelevant for the capping remedy. Capping does require a significant source of clean soil; however, other remedies typically require the import of topsoil, as well. Institutional controls are required as part of this remedy.

Consolidation and capping

Consolidation and capping can be an excellent option for sites with multiple mine-waste piles. If your property has room to designate an area specifically for consolidation and capping, contaminated soil from across the property can be placed in that area. The remainder of the property would be clean and would not require any additional work. The consolidation area is the only area requiring capping. This is a particularly effective remedy when waste-rock piles are relatively small and numerous, and large amounts of excavation are not required. Institutional controls are required as part of this remedy for the portion of the property where you have capped contaminated soil.

Model remedy options can be combined, as appropriate.

Additional options

Contact Ecology to discuss other site-specific mitigation options. Other options will be considered that are equally protective of human health and the environment but would not qualify as a model remedy. When using an option that is not a specified model remedy, you will be required to submit your cleanup documentation to Ecology through the VCP if you want to obtain an NFA determination for your property.

Natural areas

In some cases, preserving a natural area is more valuable than destroying habitat just to clean up the soil. Contact Ecology to discuss approval to leave contamination in place to preserve natural areas.

Additional sampling requirements

Model remedies 1 and 3, excavation and removal and consolidation and capping, require compliance sampling (Chapter 6) to show the cleanup is complete in the excavated areas. Soil disposal might also require stockpile sampling (Chapter 7).

When importing soils, request sample results from the soil provider, or complete soil sampling yourself prior to accepting the imported soil or obtain approval from Ecology that the source of the fill should be sufficient to be considered clean fill (Chapter 8).

Follow other government requirements for your project

Model remedies are not exempt from local, state, or federal laws. Therefore, implementation must comply with all applicable procedural and substantive requirements, including any necessary permits. The information in this chapter involving government requirements serves as general guidelines but is by no means comprehensive. Additional information can be found at the Governor's Office for Regulatory Innovation and Assistance.[14]

The information below is provided for example purposes only. Some provisions might not apply to your cleanup action, while additional requirements to those below might apply. Therefore, anyone considering one of the model remedies in this document should consult Ecology and other government entities (city or county authorities) to ensure compliance with all required permits, notifications, and other requirements.

State Environmental Policy Act (SEPA)

SEPA (RCW 43.21C, Chapter 197-11 WAC,[15] and the SEPA procedures found in Chapter 173-802 WAC[16]) are intended to ensure that state and local government officials consider

[14] https://apps.oria.wa.gov/opas/
[15] https://apps.leg.wa.gov/wac/default.aspx?cite=197-11
[16] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-802&full=true

environmental values when making decisions. The SEPA process is triggered whenever a local or state permit is required to conduct the cleanup. It begins by completing a SEPA Environmental Checklist and submitting it to the "lead agency" (usually the county or city where the property is located). The lead agency will use the checklist to decide whether the cleanup action is likely to cause a significant adverse impact to the environment. The SEPA Environmental Checklist form can be found in WAC 197-11-960.[17] Information on how to use the checklist can be found in WAC 197-11-315[18] and 330.[19]

Grade and fill permit

Most local governments require a grade and fill permit for larger excavations. Prior to conducting a cleanup, contact the city or county development permitting department with jurisdiction for the area to determine if a permit is required.

Demolition permit

If the cleanup requires demolishing a building or other structure, a permit will likely be needed from the local government. Contact the city or county development permitting department for additional information.

Construction stormwater general permit (CSWGP)

Construction site operators are required to obtain a CSWGP (also known as a general permit) if:

1. Clearing, grading, and excavating activities are disturbing one or more acres; and
2. Stormwater will or may be discharged to surface waters of the state.

Construction activity Ecology determines to be a significant contributor of pollutants to waters of the state and construction activity that has a reasonable expectation to cause a violation of any water quality standard also require a CSWGP. CSWGPs typically apply only to situations where runoff does not contact contaminated soil or groundwater. Further information on the CSWGP can be found on Ecology's Construction Stormwater General Permit[20] web pages.

Contaminated sites might not be eligible for a CSWGP if the stormwater or dewatering discharge from the construction site might violate water quality standards. In these situations, contact Ecology's Water Quality Program[21] for direction on the applicable permit submittal requirements and permitting options.

Air emissions

Excavation activities might trigger regulatory requirements related to equipment emissions and dust. Although using local construction equipment and dust controls (such as wetting or

[17] https://app.leg.wa.gov/WAC/default.aspx?cite=197-11-960&pdf=true
[18] https://app.leg.wa.gov/WAC/default.aspx?cite=197-11-315&pdf=true
[19] https://app.leg.wa.gov/WAC/default.aspx?cite=197-11-330&pdf=true
[20] https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Construction-stormwater-permit
[21] https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Construction-stormwater-permit#contact

covering exposed soils during construction) should limit equipment emissions and airborne particulates, contact the local authority to determine if any additional requirements apply.

Dust control must take place during remedial activities that could result in soils with elevated metal concentrations being suspended in the air as dust.

Noise ordinance requirements

Construction activities must comply with the local and state environmental noise standards (Chapter 173-60 WAC).[22] Contact the city or county development permitting department for additional information.

Minimum standards for constructing and maintaining wells

Groundwater monitoring wells that will be installed or removed as part of excavation activities must be constructed or decommissioned in accordance with Chapter 173-160 WAC.[23]

Location of Underground Utilities

Increasingly, many of the utility services provided to homeowners and businesses are buried underground. Damaging these utilities can result in fines and large damage claims. Under Washington State law (Chapter 19.122 RCW),[24] anyone who digs more than 12 inches below the ground surface is required to call to locate utilities two business days before digging. In general, you only have to make one call. Most owners of underground utilities, such as telephone, cable, water, sewer, electricity, and natural gas have cooperated in providing a one-call utility locate service. Simply call 811 or 1-800-424-555 two business days before you plan on digging.

Reporting to Ecology

Under MTCA, when contamination is discovered, it must be reported to Ecology within 90 days of discovery. MTCA allows for independent cleanup of contaminated sites; however, Ecology should be notified when site characterization and cleanup work is done.

Once remedial work has been completed, compile the site characterization results, describe the cleanup work in a final cleanup report, and submit it to Ecology. This report must provide adequate information to document that the selected model remedy meets the applicable cleanup standards.

For sites enrolled in the VCP, the final cleanup report needs to follow the format and requirements in Chapter 5 of *Guidelines for Property Cleanups under the Voluntary Cleanup Program*[25] (Ecology 2015). In addition, electronic data must be submitted compatible with Ecology's EIM data management system. Indicate in the cover letter transmitting a cleanup

[22] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-60
[23] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-160
[24] https://app.leg.wa.gov/rcw/default.aspx?cite=19.122
[25] https://apps.ecology.wa.gov/publications/summarypages/0809044.html

report that an Ecology-approved model remedy was used so it is clear a feasibility study and disproportionate cost analysis are not required.

Based on the selected model remedy, environmental covenants or other institutional controls might be necessary to help ensure the remedy remains protective of human health and the environment over the long-term. If an environmental covenant is used, it must be approved by Ecology, then filed with the Register of Deeds in the county where the site is located. The environmental covenant must meet all applicable requirements in WAC 173-340-440,[26] and a copy of the draft restriction must be included in the final remedial action report. *Procedure 440A: Establishing Environmental Covenants under the Model Toxics Control Act*[27] (Ecology 2016) describes how to establish an environmental covenant at a site cleaned up under MTCA authority. Document the impediments encountered and estimate the amount of contaminated soil remaining in the final remedial action report. Institutional controls are discussed further in Chapter 9.

For more information, visit Ecology's Toxics Cleanup Program (TCP) Policies and guidance for site cleanups web page.[28]

Option to pursue a No Further Action (NFA) determination

Property owners following the independent cleanup process who are interested in pursuing a NFA determination have two options.

NFA through initial investigation

If you can complete your cleanup within 90 days of initially sampling your property, you may be eligible for an NFA determination through Ecology's initial investigation process. Final cleanup documents must be submitted to Ecology within this timeframe. If the cleanup is conducted in accordance with a model remedy, no additional action may be required.

NFA through VCP review

You must apply to enter the VCP, including completing the application form and agreement. Indicate in Part 1 of the application form that you are requesting a NFA determination. While you are not required to request a NFA for independent cleanups, the fees are waived when a model remedy is the remedial option. Therefore, Ecology encourages you to request a NFA after completing work. The procedures for submitting a NFA request are in Chapter 5 of *Guidelines for Property Cleanups under the Voluntary Cleanup Program*.[29] Ecology has checklists to help identify the information to provide when requesting our opinion. These documents are available on Ecology's Working with the Voluntary Cleanup Program webpage.[30]

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[26] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-440
[27] https://apps.ecology.wa.gov/publications/SummaryPages/1509054.html
[28] https://ecology.wa.gov/Regulations-Permits/Plans-policies/Toxics-cleanup-policies
[29] https://apps.ecology.wa.gov/publications/summarypages/0809044.html
[30] https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Voluntary-Cleanup-Program/Working-with-VCP#RequestingOpinions

Chapter 3: Model Remedy 1 – Excavation and Removal

The purpose of Model Remedy 1 is to permanently clean up any mine-waste piles on your property by excavating contaminated waste rock, tailings, and soils; properly disposing of them at a landfill; and backfilling with uncontaminated soils if necessary. Following excavation, confirmation testing must be performed to document the applicable soil cleanup levels, determined using the provisions contained in WAC 173-340-740(3),[31] have been met at the limits of the excavation, such that no environmental covenants are necessary.

Excavation and removal is a permanent remedy. Permanent remedies should be used to the maximum extent practicable. It does not require institutional controls or long-term monitoring and maintenance.

Considerations

The up-front costs are higher for removal and proper landfill disposal. However, there are not long-term costs for maintenance and monitoring because the remedy is permanent.

Excavation and disposal process

A worksheet to help plan the excavation and removal process is in Appendix C (Worksheet 1: Planning for Excavation and Removal) and a form to document the excavation and removal process is in Appendix B (Form 3: Excavation and Removal). The general steps are as follows:

1. Develop a site-specific cleanup design that includes delineating your excavation area. Make sure you have sufficiently narrowed down your decision units. Ample sampling can help you eliminate areas that already meet state cleanup levels for IAML indicator hazardous substances contamination.
2. Prevent contaminated soils and dust from leaving the site. Control dust on the worksite during dry months by watering down the soil.

   If you are storing soil until it can be disposed, cover it to prevent runoff. Install proper erosion-control devices to prevent contaminated soil from leaving the project area.

   a) You will need to apply for coverage under the Construction Stormwater General Permit[32] if you disturb one or more acres. There may be additional local stormwater control requirements.
   b) If possible, trucks should avoid driving through contaminated soils. Tightly cover truck beds transporting contaminated soil and rinse their wheels to prevent contaminated soil from leaving the worksite. Use quarry spall at entrance.

[31] https://app.leg.wa.gov/WAC/default.aspx?cite=173-340-740&pdf=true
[32] https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Construction-stormwater-permit

3. Plan to protect workers. L&I regulates health and safety at worksites. Employers must comply with all workplace safety rules on toxic exposures, including:
    - Arsenic, WAC 296-848.[33]
    - General Occupational Health Standards, WAC 296-62.[34]
    - Hazardous Waste Operations, WAC 296-843.[35]
4. Excavate and test soils before disposal. For properties or decision units with IAML indicator hazardous substances contamination above MTCA cleanup levels, all mine waste must be disposed at a permitted landfill.
    a) Use stockpile sampling (Chapter 8) to determine your contaminant levels. This information or a TCLP may be required for a Waste Disposal Authorization or to dispose of soils in a private landfill.
    b) If you are loading material directly into transport for disposal, you may also be able to use characterization sampling results. The highest sample concentrations from the area to be excavated should be used for disposal determination.
    c) For more information about waste disposal, contact your local health authority.
5. Take compliance samples after excavation is complete. Soils from 0–6 inches below the excavated surface should have IAML indicator hazardous substances concentrations at or below site-specific cleanup levels. If not, excavate further. Chapter 7 describes how to take compliance samples.
6. Backfill the excavated areas with clean soil if needed. Before you purchase soil, check with the supplier to ensure the soil does not contain contaminants at concentrations greater than MTCA cleanup levels.

    Some questions to ask your supplier include:

    a) Where does this soil come from?
    b) Is it blended with compost or additives? If so, where do they come from?
    c) Has it been tested for chemical contamination?
    d) Will the soil support sod, vegetation, etc.?
    e) If you are unsure of whether these soils meet MTCA cleanup levels, use imported soils sampling (Chapter 8) or ask the supplier to sample. If you are planning to use onsite soils to backfill, do stockpile sampling (Chapter 7) to make sure they won't contaminate the excavated area.

[33] https://app.leg.wa.gov/wac/default.aspx?cite=296-848
[34] https://app.leg.wa.gov/WAC/default.aspx?cite=296-62
[35] https://app.leg.wa.gov/WAC/default.aspx?cite=296-843

Chapter 4: Model Remedy 2 – Capping in Place

The purpose of Model Remedy 2 is to cover mine waste piles in place with a soil or hard cap, if a more permanent remedy is not practicable. The cap prevents exposure to contaminated soils on the property.

A hard cap may be a building, parking lot, pavement, or driveway. A soil cap is a minimum depth of clean soil over a geotextile. Part of the soil cap can be landscaping material.

Remember to follow proper engineering practices and local, state, and federal regulations when installing soil and hard caps.

Considerations

Caps are effective if they are maintained. The up-front costs of capping in place can be lower. However, there might be long-term monitoring and maintenance costs.

A soil cover only provides protection from direct exposure to contaminated material; however, it would not mitigate the potential infiltration of precipitation through the contaminated material and potentially to groundwater. Based on this, soil-only covers are not an approved remedy for sites with dangerous waste.

Soil caps

Soil caps must be a minimum settled thickness of 12 inches and include:

- Geotextile;
- Eight inches of mechanically compacted clean soil;
- Four inches of loose topsoil; and
- Seeding to establish native vegetation or landscaping material to mitigate surface erosion.

Soil cap materials must meet MTCA cleanup levels for metal contaminants. Otherwise, you could re-contaminate the property. Review imported soils sampling (Chapter 8) or ask the supplier to sample. Meaningful questions should include inquiring where the soil came from, if it has additives, and if it will support vegetation.

A geotextile is necessary to indicate soil beneath it is still contaminated and it needs maintenance when it becomes exposed. Use a bright color to warn future property users. The marker also reduces the chance of animals bringing capped soils to the surface. Check with your supplier to make sure the marker material is not bio-degradable and durable enough to last underground. Consult with Ecology to confirm your choice of material is acceptable.

Hard caps

Hard caps are most cost-effective when they are part of the original development plan, such as a building or driveway. Hard caps include building footprints, asphalt, or any other permanent surface Ecology approves. Hard caps must have a minimum thickness of three inches.

Remember to follow proper engineering practices and local, state, and federal regulations when installing both soft and hard caps.

Capping process

A worksheet to help plan the capping-in-place process is in Appendix C (Worksheet 2: Planning for Capping in Place), and a form to document the capping-in-place process can be found in Appendix B (Form 4: Capping in Place). These are the general steps:

1. Determine the capping area. Use more sampling to narrow down the area.
2. Pick a cap type.
3. Prevent contaminated soils and dust from leaving the site. Control dust on the worksite during dry months by watering down the soil during construction. Install proper erosion-control devices to prevent dirty water from leaving the project area.

   You will need to apply for coverage under the Construction Stormwater General Permit[36] if you disturb one or more acres. There might also be additional local stormwater control requirements.

4. Plan to protect workers. L&I regulates health and safety at worksites. For guidance, visit their Safety and Health web page.[37]
5. Regrade mine waste as necessary. Soil caps should have a maximum slope of 2 feet horizontal to 1 foot vertical except where steeper slopes are necessary to control drainage.
6. Build the cap. Use enough materials to create the necessary cap depth. Make sure it covers the contaminated area.
7. Revegetate soil caps. Revegetation involves promoting plant growth, performing grading activities, and adding soil amendments and nutrients to promote vegetative growth.
8. File an Ecology-approved environmental covenant documenting any institutional or engineered controls with the appropriate county recording office. This warns future property owners contamination remains on the property. It also restricts uses that would damage the cap and sets an inspection schedule and cap maintenance instructions. See Chapter 9 for more information.

[36] https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Construction-stormwater-permit
[37] https://lni.wa.gov/

Chapter 5: Model Remedy 3 – Consolidation and Capping

The purpose of Model Remedy 3 is to excavate mine-waste piles, consolidate them in one place, and cover them with a soil or hard cap (if a more permanent remedy is not practicable). Detailed capping information is available in Chapter 4.

Consolidation reduces the footprint of contamination on the property, and the cap prevents exposure.

Considerations

The up-front costs of consolidation and capping might be lower than excavation and removal; however, there are long-term monitoring and maintenance costs. Consolidating mine waste confines contamination to a smaller footprint on your property and requires an environmental covenant.

A soil cover only provides protection from direct exposure to contaminated material; however, it would not mitigate the potential infiltration of precipitation through the contaminated material and potentially to groundwater. Based on this, soil only covers are not an approved remedy for sites with dangerous waste.

Process for consolidation and capping

A worksheet to help plan the consolidation and capping process is in Appendix C (Worksheet 3: Planning for Consolidation and Capping), and a form to document the consolidation and capping process is in Appendix B (Form 5: Consolidation and Capping). These are the general steps:

1. Determine the capping area. Use additional sampling to narrow down the area that needs to be capped. The consolidation area should be located as far upland from any water body as feasible. Contaminated soil cannot be consolidated where concentrated stormwater infiltration will occur.
2. Pick a cap type.
3. Prevent contaminated soils and dust from leaving the site. Control dust on the worksite during dry months by watering down the soil during construction. Install proper erosion-control devices to prevent dirty water from leaving the project area.

   You will need to apply for coverage under the Construction Stormwater General Permit[38] if you disturb one or more acres. There might also be additional local stormwater control requirements.

[38] https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Construction-stormwater-permit

4. Plan to protect workers. L&I regulates health and safety at worksites. For guidance, visit their Safety and Health web page.[39]
5. Remove contaminated soils from removal areas. Use the worksheet in this chapter to help determine your excavation depth.
6. Take compliance samples after excavation is complete. Soils from 0–6 inches below the excavated surface should have IAML indicator hazardous substances concentrations at levels less than MTCA cleanup levels. Chapter 6 describes how to take compliance samples.
7. Consolidate the mine waste. Carefully transport excavated soils to the area where they will be capped. These soils can contaminate other parts of the property if they escape during transport.
8. Regrade mine waste as necessary. Soil caps should have a maximum slope of 2 feet horizontal to 1 foot vertical except where steeper slopes are necessary to control drainage.
9. Build the cap. Use enough materials to create the required 12-inch cap depth as described in Chapter 4. Make sure it covers the contaminated area. Sample any imported soils as described in Chapter 8, to make sure the cap material is not contaminated.
10. File an Ecology-approved environmental covenant documenting any institutional or engineered controls with the appropriate county recording office. This warns future property owners contamination remains on the property. It also restricts uses that would damage the cap and sets an inspection schedule and cap maintenance instructions. See Chapter 9 for more information.

[39] https://lni.wa.gov/

Chapter 6: Performance Compliance Sampling

Performance compliance sampling determines if excavation was successful. Samples must meet cleanup levels for IAML indicator hazardous substances except where residual contamination is contained under a cap.

When to do compliance sampling

Compliance sampling is required if using Model Remedy 1, Excavation and Removal, or Model Remedy 3, Consolidation and Capping. Compliance sampling is performed after excavating material, at the base of the excavation, and before placing backfill.

Sampling area

Use Appendix B (Form 6: Compliance Sampling) to record the sampling area, sample numbers, and locations. Table 6 describes the minimum number of compliance sample locations per decision units.

Table 6: Minimum number of compliance sample locations per decision unit

Sampling area in acres	Number of samples
Less than or equal to 0.25	4
0.25 to 1	8
1 to 5	15
5 to 10	20
Greater than 10	20 + 2 per 5 acres

For each decision unit, lay out sample points in an evenly spaced grid. Grid points should cover as much area as possible. Adjust the grid or add locations to make it fit. All samples are discrete, which means the soils for one sample come from a single sampling location.

Sample depth

Take compliance samples from the remaining soil surface after excavating contaminated soil. Do this for every sample location.

Sampling by X-ray fluorescence detector

Compliance sampling can be conducted by XRF, however, at least 10% of samples must be submitted for laboratory analysis. XRF analysis should only be performed by someone trained in the safe operation and data extraction techniques of this equipment. As described earlier, XRF analysis can be conducted without disturbing the soil to be analyzed.

Sampling process

The compliance sampling process should be completed using the same process as characterization sampling for both XRF and laboratory samples (see Chapter 1).

Understanding compliance results

Evaluate the compliance sample results to confirm that each decision unit meets MTCA cleanup levels. If IAML indicator hazardous substances concentrations do not meet the MTCA cleanup levels for any decision unit, you will have to take further action to clean up the soils, such as excavating at least six inches deeper and doing compliance sampling again.

When am I done?

Cleanup is complete when all excavated areas meet MTCA cleanup levels for soil. Make sure you have a complete packet for Ecology, future property owners, and your own records. This packet should include:

- Characterization sampling results, lab report, and chain-of-custody
- Forms 1 and 2 (characterization sampling)
- Form 6 (compliance sampling)
- Compliance sampling lab report and chain-of-custody
- One completed form for each cleanup method used for all decision units
- Maps documenting characterization and compliance sample locations and cleanup work
- For capping or consolidation and capping, include a description of institutional controls used.

Next steps

Keep a copy of the forms you filled out to pass on to future property owners, so they know cleanup was done and how to maintain any non-permanent remedies.

Chapter 7: Stockpile Sampling

You will save time and money by segregating clean soil and contaminated soil. When possible, soil should be sampled prior to excavation. For soil leaving your property for disposal, it must be sampled prior to transport.

When to do stockpile sampling

Sample stockpiles before transporting offsite. It might be required for a Waste Disposal Authorization; however, they might be able to use results from characterization samples instead of re-sampling stockpiles. Ask the permitted landfill where you will dispose of the contaminated soil whether they will accept characterization sampling results.

Stockpile sampling is different from characterization sampling. You will be taking your samples from a pile of soil you excavated and plan to dispose or reuse onsite as clean. The samples are "composite," meaning you are taking several subsamples and mixing them together for analysis. Use Appendix B (Form 7: Stockpile Sampling) to track your sampling.

Planning for sampling

Use the same equipment as in Chapter 1.

- Stainless-steel tools for digging sampling holes and removing soil.
- Stainless-steel mixing bowl and spoon for compositing.
- Clean glass containers from the analytical lab.
- Permanent marking pen to record sample locations on the jar.
- Wash bucket, soap, scrub brush, and rinse water (distilled or deionized).
- Nitrile gloves.

Number of samples

Take composite samples from each stockpile. Table 7 shows how many samples you need to collect for a certain size stockpile. Each composite should contain six subsamples that you mix into a single sample.

Table 7: Number of composite samples per stockpile

Stockpile volume (cubic yards)	Number of composites
0–500	2
501–1000	4
1,001–5000	6
5,001–10,000	10
10,001–20,000	14
>20,000	14 + 1 per 5,000 cubic yards

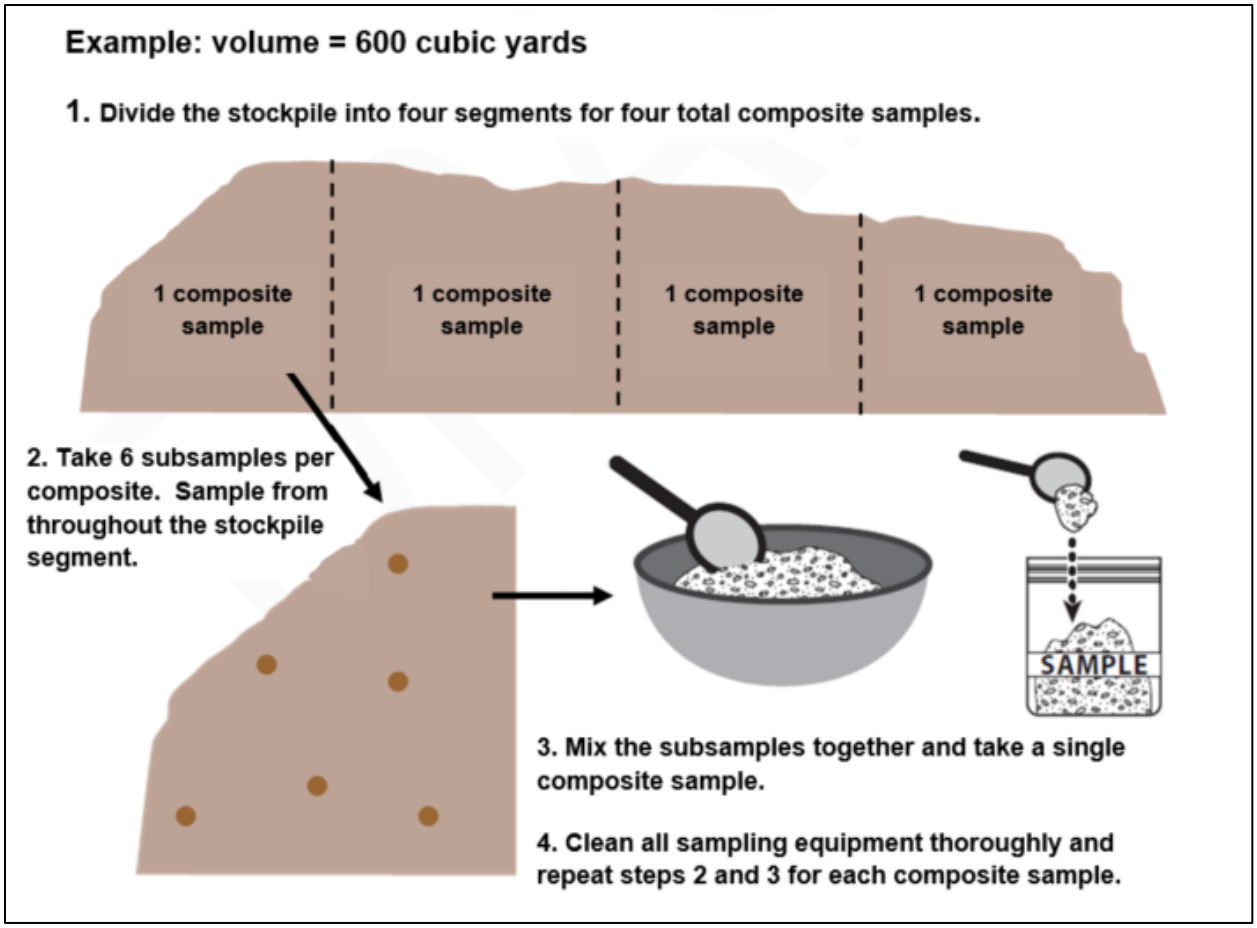

Figure 4: Stockpile sampling process

Sampling process

Before taking any samples, contact an Ecology-accredited lab. For more information, see the Help Desk section of this guidance. The lab might have special instructions about labeling and delivering the samples to their labs.

1. Check the number of composites needed and divide your stockpile into that many sections. Plan to take one composite per segment to have a good distribution throughout the stockpile.
2. Using a permanent marker, label the glass jar with:
    a. The stockpile identifier.
    b. Composite number (you will take multiple composites per stockpile).
    c. Your name.
    d. The date and time the sample is being collected.

3. For each composite sample, from each stockpile segment:
    a. Divide your six subsamples evenly among surface samples, mid-depth samples, and deep samples. Make sure to collect samples from several different parts of the pile. Make sure to collect about the same volume of material from each subsample location. Clean sample equipment in the wash bucket and change the dirty water between samples.
    b. Place all subsamples for a single composite into the stainless-steel bowl. It is important to mix the soil well. All subsamples should be the same size. Mix thoroughly with the stainless-steel spoon, fill up the sample jar with the mixture, and seal it securely. This is your composite sample for an individual segment.
    c. Repeat the sampling process for each segment.
    d. Between individual composite samples, scrub the bowl and spoon clean in the wash bucket, rinse, and pour the dirty water on the property where the sample was collected where it can soak into the ground. Do not pour dirty water down the storm drain.
    e. List all the composite soil samples in the sample inventory on Form 8.
    f. Place the samples in an iced cooler and fill out laboratory-provided chain-of-custody form to accompany the samples to the laboratory with the required information.

Understanding your results

If any composite result is greater than cleanup levels for IAML indicator hazardous substances, that segment must be properly disposed. If you want to reuse it on the property, you must cap it to meet model remedy requirements.

Disposal

If you plan to dispose of these soils, check with your local health department's solid waste division about their requirements. A waste disposal authorization form might be needed.

Reusing soils on site as "clean" soils

For any stockpiles that do not exceed MTCA cleanup levels, you may reuse the soil on the property.

Important: Transporting stockpiled soils offsite for use on another property, even if sampling shows they meet MTCA cleanup levels, is not a model remedy and not advised, as it might violate local anti-degradation policies.

Chapter 8: Imported Soils Sampling

Imported soils should meet MTCA cleanup levels for potential contaminants. This includes imported soils that are used on a site to backfill an excavation, create a soil cap, or for construction and landscaping projects.

What contaminants to test for in imported soils

The potential contaminants in your import soil are dependent on the source. You might choose to purchase soil from a commercial supplier, or you might have your own source. If you purchase, ask your supplier:

- Does the soil contain metal concentrations above MTCA cleanup levels?
- Where does the soil come from?
- Is it blended with compost or additives? If so, where do they come from?
- Has it been tested for chemical contamination?
- Will the soil support sod, vegetation, etc.?

If the supplier cannot answer these questions, you should strongly consider another source.

If you have found your own source of soil, consider its location carefully. Steps to evaluate this source may include:

- Is this soil from an IAML site? If so, you should test this soil for IAML indicator hazardous substances identified in this document.
- Does the source location fall within the historic orchard footprint found on the Dirt Alert map on Ecology's website? If so, you should test this soil for arsenic and lead at a minimum. There is a high probability that this soil contains elevated concentrations of arsenic and lead, and you should likely find another source. The map is available here: Dirt Alert Map.[40]
- Is this soil from a native, undisturbed location? If that is the case, the likelihood of contamination is low. You might still wish to collect one composite sample and analyze for Priority Pollutant Metals. Native, undisturbed soils sources are the ideal choice.
- Is this soil from a quarry? Soil is often supplied from the fine material collected at a rock quarry. This material is not likely to contain contaminants but is also not likely to contain the nutrients required to support vegetation.
- Is this soil from a commercial or industrial location? Consider the activities conducted at the source location and analyze soil samples accordingly. For example, if there were storage tanks or other types of chemical storage near your source, consider sampling for petroleum and other specific chemicals found at the site.

[40] https://apps.ecology.wa.gov/dirtalert/

As with stockpile sampling, composite samples are allowed when evaluating import soils. Use Chapter 7 to determine the appropriate number of composite samples to collect from each stockpile of the imported soil source.

Chapter 9: Environmental Covenants and Institutional Controls

Institutional controls are required if contaminated soils remain on the property as part of the remedy. Institutional controls are required for capping in place and consolidation and capping model remedies (Model Remedies 2 and 3). Institutional controls are also required for any portion of your property that is not being cleaned up to preserve natural areas.

Institutional controls limit or prohibit activities in areas with remaining contamination and they inform future property owners about contamination left on the property. They may also provide direction for regular maintenance and inspection of capped areas. The traditional form of institutional control is an environmental covenant, but they can include any instrument that effectively limits disturbing capped areas and notifies all future landowners of the conditions found on your property.

Types of institutional controls

For this model remedy, there are several types of institutional controls that are acceptable. The best option could be a combination of those listed below. Institutional controls include:

- **Physical measures,** such as fences.
- **Use restrictions,** such as limitations on the use of property or resources; or requirements that cleanup action occur if existing structures or pavement are disturbed or removed.
- **Educational programs**, such as signs, postings, public notices, health advisories, mailings, and similar measures that educate the public and/or employees about site contamination and ways to limit exposure.

What to include in your institutional controls

The following information should be included in your institutional control:

- Location of remaining contamination, including maps.
- Nature of remaining contamination, including sample results.
- How and when lessees, users, and future property owners will be notified.
- Cap locations and dimensions.
- Cap depth and materials used.
- Inspection schedule and cap maintenance.

How to prepare an environmental covenant

An environmental covenant is a legal document that is recorded with your county. It is discovered during any property transaction during title searches, and therefore is very effective at communicating property conditions to future owners. It also prevents activities or land uses that could make the cleanup less effective, such as removing or digging through a cap.

Prepare the environmental covenant using Ecology's procedure and template. Download the procedure by visiting the Publication Summary web page for "Toxics Cleanup Program Procedure 440A: Establishing Environmental Covenants under the Model Toxics Control Act[41]" (Publication 15-09-054). Download the template by clicking Microsoft Word format in the View Now field.

[41] https://apps.ecology.wa.gov/publications/SummaryPages/1509054.html

Help Desk

Selecting an analytical lab

Ecology's Laboratory Accreditation[42] website lists state-accredited labs that analyze soil. The lab must be accredited for a metals analysis method in the 'solid and chemical materials' matrix. You do not have to use a local lab, since many labs can work with you through the mail. Most labs should be able to provide results within three to four weeks. Costs vary.

When you talk to the lab, ask them the following questions:

- Can they screen the soil sample to 2 millimeters?
- Can they report the results on a dry-weight basis?
- Will they provide a quality review of the data and a summary of the quality control results?
- How long will it take to get results?
- How much will it cost?

Hiring and working with a consultant

Ecology has a guide for finding and hiring a consultant, *Hazardous Waste Cleanups: Selecting an Environmental Consulting Firm.*[43]

You may want to start the search by asking other companies in your industry (if applicable), environmental professional organizations, and banks for recommendations. Follow up with your own research. Ask questions and get at least three different proposals and cost estimates.

Questions you might want to ask include:

- What is your firm's experience with soil sampling and related cleanup work? Request a list of completed projects and references.
- What work might be subcontracted? Request the names of their subcontractors and check their experience.
- What is your firm's experience with regulatory requirements?
- Which staff members will be assigned to my project? Ask for resumes, roles, and the project manager.
- Is your field staff trained in safety procedures required by the Washington Industrial Safety and Health Act (WISHA)?

[42] https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Laboratory-Accreditation
[43] https://apps.ecology.wa.gov/publications/SummaryPages/FTCP92116.html

- Does your firm and their subcontractors have environmental liability insurance?
- How will you plan to be cost-effective?

Ask each firm to prepare a proposal for the sampling work. The proposal should include a detailed approach and cost estimate by specific task. It may be difficult to provide specific estimates for future work because they will depend on the characterization sampling results.

Other situations

For all projects, check if federal, state, or local land-use permits are needed. For situations not covered by this guidance, please call 509-575-2490 for Ecology's Abandoned Mine Lands Program.

Healthy actions to reduce exposure to contaminated soils

Anyone working or playing in potentially contaminated soils, should follow a few simple actions:

- Wash hands after working or playing outside, and before eating.
- Take off shoes at the door or use a doormat.
- Damp dust, damp mop, and vacuum with a HEPA filter regularly.
- Wear gloves when working in soil.
- Wash home-grown fruits and vegetables well, peeling or scrubbing root vegetables.
- Keep pets clean.

For a full list of healthy actions, visit Healthy Actions - protect yourself from arsenic and lead in dirt.[44]

[44] https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Dirt-Alert-program/Healthy-actions

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Appendix A: Model Remedies

MTCA regulations (WAC 173-340-390) specify that Ecology must identify the circumstances under which application of a model remedy meets the requirements for selection of cleanup actions established under WAC 173-340-360. If a site meets the requirements for using a model remedy, it is not necessary to conduct a feasibility study (WAC 173-340-350(8)) or a disproportionate cost analysis (WAC 173-340-360(3)).

A feasibility study evaluates technologies that may be appropriate for addressing contamination at a site. A disproportionate cost analysis compares the cost of remedial actions against the most practical permanent remedy to determine whether the increased costs are warranted. If the cost to implement the more aggressive remedy is significantly higher than the incremental increase in benefits achieved, then selecting the more costly remedy is not required.

Additionally, Ecology has the option to waive fees for the time spent reviewing NFA requests at cleanups that qualify for and appropriately use a model remedy. As a matter of policy, Ecology will not require a fee to review NFA requests for sites in the VCP if the selected remedy meets the specified criteria and implementation follows the provisions in this document.

Developing a model remedy includes the following elements:

- Requirements for characterizing a site;
- A description of how the model remedy meets the cleanup standards and remedy selection provisions in MTCA;
- Monitoring requirements; and
- Public notice and the opportunity to comment on the proposed model remedy and the conditions under which it may be used.

Purpose of a model remedy

The purpose of model remedies is to streamline and accelerate the selection of cleanup actions that protect human health and the environment, with a preference for permanent solutions to the maximum extent practicable.

This document provides information to establish model remedies for cleanup at sites with metals contamination due to historic mining activities, including: a) the eligibility criteria each project must meet, and b) a discussion of how the model remedies comply with the requirements of MTCA.

Before considering a model remedy, the following steps in the remedial process must have already been completed:

- A release to the environment has been confirmed;
- Ecology has been notified of the release;

- Emergency/interim actions have been implemented (if appropriate); and
- An adequate site characterization has been completed.

Model remedies are most appropriate for routine cleanup projects at lower risk sites and are generally more applicable to independent cleanups. This includes those seeking an NFA letter under the VCP or situations where the potentially liable person is implementing the cleanup with no Ecology oversight. However, these models can also apply to Ecology-supervised cleanups.

Eligibility criteria for this model remedy

The following criteria apply to all model remedies identified in this document unless otherwise noted.

Geographic area

The model remedies in this document are applicable to IAML sites in Washington.

Release confirmation and Ecology notification

Metals contamination due to historic mining processes has been confirmed, and Ecology notification of the release has been completed.

Affected media

These model remedies do not apply to properties with sediment, surface water, and groundwater contaminated by mine-waste piles. Soil cleanup levels are intended to address the soil direct-contact exposure pathway. These model remedies are applicable to mine-waste piles containing 2,000 cubic yards or less of material. These model remedies do not apply to sites with contaminated soil below the water table.

Given the importance of conducting an adequate site characterization, Ecology strongly recommends selecting a consultant who has significant experience performing this type of work and is very familiar with the information in Chapter 1, "Soil Sampling" of this document.

Emergency/interim actions

These model remedies can be used if emergency or interim actions are not required due to the lower risk nature of the site, or if the necessary emergency/interim action required by WAC 173-340-430[45] have already been implemented.

Terrestrial Ecological Evaluation

WAC 173-340-7490 through 173-340-7493 establish the process and procedures for completing a Terrestrial Ecological Evaluation (TEE). WAC 173-340-7491[46] establishes criteria for deciding whether a particular site can be excluded from the requirements for preparing a simplified or site-specific TEE. Most IAML sites will not qualify for exclusion and require a site-specific TEE.

[45] https://app.leg.wa.gov/wac/default.aspx?cite=173-340-430
[46] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-7491

How model remedies meet MTCA remedy selection and compliance monitoring requirements

The model remedies in this document provide for removing the contaminant source as well as the impacted soil to the maximum extent practicable so that:

1. The remaining soil meets the cleanup levels established in accordance with MTCA through excavation and removal; or
2. When hazardous substances remain on-site at concentrations exceeding cleanup levels, those hazardous substances will be capped in place or consolidated and capped to the maximum extent practicable where needed to minimize the potential for direct contact and migration of hazardous substances using engineered controls (such as containment).

In cases with engineered controls (such as containment), contaminated soil must be removed to the greatest extent practicable. In these situations, institutional controls (typically environmental covenants) that meet the provisions in WAC 173-340-440[47] must be implemented to ensure the remedy remains protective.

The two primary components of cleanup standards are cleanup levels and points of compliance. Cleanup levels determine the concentration at which a substance does not threaten human health or the environment. A cleanup remedy addresses all media exceeding a cleanup level to prevent exposure to the contaminated material. Points of compliance represent the locations on the site where cleanup levels must be met.

Soil cleanup levels

The process for establishing soil cleanup levels involves the following:

- Confirm lack of impacts to sediment, surface water, and groundwater;
- Develop cleanup levels for individual contaminants in each media; and
- Determine which contaminants contribute the majority of the overall risk in each media (indicator hazardous substances).

Note: Method A cleanup levels may be used to establish cleanup levels at sites that have few hazardous substances and are undergoing a routine cleanup action. Method B is the standard method for establishing cleanup levels and can be used at any site.

Contaminants of concern and model remedy abandoned mine sites

For the model remedies presented in this document, cleanup level development centers on metal contaminants in soil. Based on previous IAML investigation work completed in

[47] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-440

Washington, arsenic, cadmium, lead, and zinc are identified as indicator hazardous substances for IAML sites.

Soil cleanup levels based on protection of human health and upland ecological risk

When determining soil cleanup levels based on protection of human health and upland ecological risk, Ecology evaluated the following pathways:

- Human health:
    - Direct-contact non-cancer
    - Direct-contact cancer
- Terrestrial Ecological Evaluation (site-specific evaluation)
    - Protection of plants
    - Protection of soil biota
    - Protection of wildlife
        - Mammalian predator
        - Mammalian herbivore
        - Avian predator

The following provides the cleanup levels developed for this model remedy. Cleanup levels were developed for typical metal contaminants found in mine wastes and meet the requirements of MTCA for both human health and ecological receptors.

Antimony:

- Human health = 32 milligrams per kilogram (mg/kg) – Based on soil Method B (direct-contact non-cancer)
- Upland ecological risk = 5 mg/kg – Based on site-specific evaluation (protection of plants)
- Final value = 5 mg/kg

Arsenic:

- Human health = 20 mg/kg – Based on soil Method A (IAML sites approved under the model remedies qualify for Method A because they are considered routine with few hazardous substances)
- Upland ecological risk = 7 mg/kg – Based on site-specific evaluation (protection of wildlife). **Note:** Upland ecological risk is based on arsenite (As III)
- Final value = 20 mg/kg (based on MTCA Method A cleanup level,)

Beryllium:

- Human health = 160 mg/kg – Based on soil Method B (direct-contact non-cancer)
- Upland ecological risk = 10 mg/kg – Based on site-specific evaluation (protection of plants)
- Final value = 10 mg/kg

Cadmium:

- Human health = 80 mg/kg – Based on soil Method B (direct-contact non-cancer)
- Upland ecological risk = 4 mg/kg – Based on site-specific evaluation (protection of plants)
- Final value = 4 mg/kg

Chromium:

- Human health = 1.20E+05 mg/kg – Based on soil Method B (direct-contact cancer).
- Upland ecological risk = 42 mg/kg (based on adjustment to natural background)
- Final value = 42 mg/kg

Copper:

- Human health = 3,200 mg/kg – Based on soil Method B (direct-contact non-cancer)
- Upland ecological risk = 50 mg/kg – Based on site specific evaluation (protection of soil biota)
- Final value = 50 mg/kg

Lead:

- Human health = 250 mg/kg – Based on preventing unacceptable blood screening levels
- Upland ecological risk = 250 mg/kg – Based on Tacoma Smelter Plume Protection (Ecology 2012).[48]
- Final value = 250 mg/kg

Mercury:

- Human health = 24 mg/kg – Based on mercuric chloride soil Method B (direct-contact non-cancer)
- Upland ecological risk = 5.5 mg/kg – Based on site specific evaluation (protection of wildlife). **Note:** Although little information is available on the toxicity of mercury to plants or soil biota, the available data suggest that the soil concentration on wildlife protection should also be adequately protective of plants and soil biota.[49]
- Final value = 5.5 mg/kg

[48] Ecology, 2012. Asarco Tacoma Smelter Site. Final Interim Action Plan for the Tacoma Smelter Plume.
[49] Ecology, 2000. Attachment V. WAC 173-340 Table 749-2. Chemical-specific Technical Support Documents.

Nickel:

- Human health = 1,600 mg/kg – Based on soil Method B (direct-contact non-cancer)
- Upland ecological risk = 30 mg/kg – Based on site specific evaluation (protection of plants
- Final value = 38 mg/kg (based on an upward adjustment of protection to natural background)

Selenium:

- Human health = 400 mg/kg – Based on soil Method B (direct-contact non-cancer)
- Upland ecological risk = 0.3 mg/kg – Based on site-specific evaluation (protection of wildlife)
- Final value = 0.78 (based on an upward adjustment of protection to natural background)

Silver:

- Human health = 400 mg/kg – Based on soil Method B (direct-contact non-cancer)
- Upland ecological risk = 2 mg/kg – Based on site-specific evaluation (protection of plants)
- Final value = 2 mg/kg

Thallium:

- Human health = 0.8 mg/kg – Based on soil Method B (direct-contact non-cancer)
- Upland ecological risk = 1 mg/kg – Based on site-specific evaluation (protection of plants)
- Final value = 0.8 mg/kg

Zinc:

- Human health = 24,000 mg/kg – Based on soil Method B (direct-contact non-cancer)
- Upland ecological risk = 86 mg/kg – Based on site-specific evaluation (protection of plants)
- Final value = 86 mg/kg (based on an upward adjustment of protection to natural background)

MTCA defines the factors used to determine whether a substance should be retained as an indicator hazardous substance for a site. When defining a cleanup level at a site contaminated with several hazardous substances, Ecology may eliminate those contaminants contributing a small percentage of the overall threat to human health and the environment from further consideration. WAC 173-340-703[50] provides the following factors to consider when eliminating individual hazardous substances from further consideration:

- The toxicological characteristics of the substance which govern its ability to adversely affect human health or the environment relative to the concentration of the substance.

[50] https://app.leg.wa.gov/WAC/default.aspx?cite=173-340-703

- The chemical and physical characteristics of the substance which govern its tendency to persist in the environment.
- The chemical and physical characteristics of the substance which govern its tendency to move into and through the environment.
- The natural background concentration of the substance.
- The thoroughness of testing for the substance.
- The frequency of detection.
- The degradation of by-products of the substance.

Cleanup requirements under MTCA

The following discussion documents how the model remedies meet the minimum requirements found in WAC 173-340-360 and WAC 173-340-390.

1. **Threshold Requirements:**
    a. *Protect human health and the environment.* Removal and capping remedies will reduce potential human and ecological receptors by reducing the exposure pathways.
    b. *Comply with cleanup standards.* The model remedies identified in this document require compliance with the soil standards in MTCA. Adequate characterization must be completed to document that the site has not impacted groundwater, surface water, or sediment.
        i. Model Remedy 1 is excavation and removal of the contamination (see Chapter 3). This remedy removes contaminated soil so cleanup standards are met at the point of compliance.
        ii. Model Remedy 2 is capping in place (see Chapter 4). In this remedy, soils with hazardous substances above cleanup levels are contained. The cleanup action may be determined to comply with cleanup standards, provided the compliance monitoring program ensures the long-term integrity of the containment system, and other requirements for containment are met. This remedy requires an environmental covenant (see Chapter 9).
        iii. Model Remedy 3 is consolidation and capping (see Chapter 5). In this remedy, contaminated soils are excavated, consolidated in one place, and covered with a soil or hard cap. The cleanup action may be determined to comply with cleanup standards, provided the compliance monitoring program is designed to ensure the long-term integrity of the containment system, and other requirements for containment are met. This remedy requires an environmental covenant (see Chapter 9).
    c. *Comply with state and federal laws*. Due to the lower risk nature of sites eligible to use model remedies, many state or federal laws will not be applicable. For example, releases from the site cannot have impacted sediments; therefore,

requirements found in the Sediment Management Standards (Chapter 173-204 WAC[51]) will not be applicable. Although implementing any of these model remedies is unlikely to trigger compliance with a large number of state or federal laws, several laws will apply (for example, transporting and managing contaminated soil in accordance with the state's solid waste management rules). Conduct an evaluation to determine compliance with applicable state and federal laws.

d. *Provisions for compliance monitoring*. There are three types of compliance monitoring: 1) protection, 2) performance, and 3) confirmational monitoring. Protection monitoring includes preparing a health and safety plan, which should be completed before implementing any model remedy. Performance and confirmational monitoring can likely be combined and are necessary to document that the applicable cleanup standards have been met, or to estimate the amount of contaminant mass that remains.

2. Other Requirements:

a. *Use a preference for permanent solutions to the maximum extent practicable*. A disproportionate cost analysis determines whether the selected remedy used permanent solutions to the maximum extent practicable. If the incremental increase in costs for an alternative remedy is disproportionate to the benefits achieved, then selection of the more costly remedy is not warranted. Model remedies are, by definition, exempt from the requirement to evaluate cleanup action alternatives by preparing a feasibility study and a disproportionate cost analysis. If a structural impediment precludes complete removal of all contaminated soil or a containment remedy (capping) is used, an environmental covenant must be used with the remedy to reduce the overall risk and help ensure that the site remains protective over the long term. If a covenant is accepted, it will then be subject to the requirements of a periodic review under WAC 173-340-420.[52]

b. *Provide for a reasonable restoration time frame*. The model remedies are based on soil being the only media impacted by the release. Implementation of a capping or soil removal remedy will limit the time frame needed to achieve compliance to the greatest degree practicable.

c. *Consideration of public concerns*. A draft of this guidance document will be available for public comment and may be changed in response to comments.

[51] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-204
[52] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-420

Alternatives considered but not selected

Ecology looked at the following alternative remedial actions but did not select them:

- Soil mixing,
- Soil amendments, and
- In-situ treatment technologies.

Soil mixing

Mixing contaminated soils with clean imported soils or clean soils underneath the contaminated surface soils was considered as a cleanup alternative. However, mixing effectiveness depends on several measures including how deep you mix, how deep contamination goes, and the efficiency of mixing equipment. Based on the typical dimensions of mine-waste piles including depth, Ecology determined soil mixing is not an effective technique in remediating mine-waste piles.

Soil amendments

Soil amendments, such as mulch, biosolids, and biochar, are techniques used to potentially bind metals contamination in soil and promote vegetation growth. The use of soil amendments is effective as part of a capping remedy; however, this technique was not selected as a standalone treatment alternative. These methods require rigorous characterization and monitoring activities.

In-situ treatment technologies

In-situ treatment technologies, such as electrokinetics, phytoremediation, soil flushing, and solidification, were considered as a cleanup alternative. However, experience with these technologies to treat mine waste is limited to bench and pilot-scale studies. Ecology determined these technologies are not appropriate as model remedies because they are not easily implemented or require rigorous characterization and monitoring activities.

Appendix B: Forms

Form 1: Characterization Sampling

Reminder: Keep a copy of the completed forms to pass on to future property owners.

Part 1: Determine your decision units

1. Total property size: _____ acres
2. Check all that apply and identify decision units in any of these cases:
   - ☐ Mine waste pile volumes are less than 2,001 cubic yards.
   - ☐ Mine structures such as former mill buildings are on your property.
   - ☐ Mine features such as adits or shafts are on your property.
   - ☐ Property has geographic features, such as steep slopes or other unusable areas.
   - ☐ More than one type of land use is planned for the development of the property.
   - ☐ Parts of the property will be play-areas, gardens, or other high-use areas.
3. On the next page in Table 8, list the decision units on your property and their size. Use Table 9 or Table 10 to determine the number of samples needed for each decision unit.

Part 2: Soil sample depth

4. Complete Table 1 on the next page with the sample depths.
   - **At every location:** Take samples from the top 0–6 inches of soil after clearing away grass, leaves, gravel, or debris on the surface.
   - **If using excavation as a remedy:** At every other location (50% of the samples) take one soil sample from depths immediately below the bottom of the waste-rock pile based on visual observations.
   - **Areas where fill dirt or topsoil was added in the past:** Take samples from the top 0–6 inches of the original land surface.

Part 3: Overlay a sampling grid for each decision unit

5. Attach a diagram showing property dimensions and decision unit locations.
6. Attach a separate diagram for each decision unit, including dimensions, existing structures, and which features will remain after development.

Table 8: Characterization sampling plan

Decision unit description (past use, planned use)	Cubic yards (cy)	# of samples	Sample depth

Table 9: Minimum number of soil sample locations per decision unit for a capping remedy

Cubic yards of mine waste	Number of samples for chemical analysis
0–100	4
101–500	6
501–1,000	8
1,001–2,000	10

Table 10: Minimum number of soil sample locations per decision unit for an excavation remedy

Cubic yards of mine waste	Number of samples for chemical analysis	Number of sample locations with depth profile samples
0–100	4	2
101–500	6	3
501–1,000	8	4
1,001–2,000	10	5

Form 2: Characterization Sampling Results

Reminder: Keep a copy of the completed forms to pass on to future property owners.

Completing the sample inventory

1. List the samples by decision unit in the inventory on the back of this page. Enter the depth of each sample. When sampling multiple depths at a single location, mark each depth as a separate sample number.
2. Record the date and time.
3. Complete the rest of the columns when you get the sampling results.

Determining if indicator hazardous substance concentrations are elevated

4. Calculate average contaminant (arsenic, cadmium, lead, and zinc) levels **for each sampling depth** and **each decision unit** and enter them on the inventory sheet. For each decision unit, circle the average concentrations that are greater than or equal to the following values:

Contaminant	**Cleanup Level in milligram per kilogram (mg/kg)**
Arsenic	20
Cadmium	4
Lead	250
Zinc	86

* Milligrams per kilogram is equivalent to parts per million (ppm).

5. Attach a copy of your lab results and chain-of-custody.
6. For decision units with a circled value (maximum or average), note in the Comments column that cleanup is needed for that entire decision unit. See Chapter 2 to review options for cleaning up those decision units.

   If no decision units have elevated contaminant concentrations, no cleanup is necessary. Because no cleanup is being done, you do not need to take any compliance samples. The characterization samples demonstrate your soils meet state standards. Treat these results as compliance sampling results and read Chapter 7 for next steps.

Soil Characterization Sampling Inventory Sheet

Property address: Phone: Sampled by:					Testing parameters (ppm)			
DU no.	Sample no.	Sample depth	Date	Time	Arsenic	Cadmium	Lead	Zinc

Notes: DU = decision unit

Form 3: Excavation and Removal

Reminder: Keep a copy of the completed forms to pass on to future property owners.

1. **List decision units being excavated:** **Depth**

   _____ _____

   _____ _____

   _____ _____

2. **Prevent soils from escaping the site and plan for worker safety:**
   - ☐ Make a water source available for dust control
   - ☐ Install erosion-control devices
   - ☐ Cover trucks carrying contaminated soil
   - ☐ Set up rinsing area for truck wheels and quarry spall at the entrance
   - ☐ Follow Department of Labor & Industries worker safety regulations

3. **Record soil disposal information:**

Name of landfill facility: _____

Contact name and phone: _____

- ☐ Attached a copy of the Waste Disposal Authorization form

4. **Record the clean fill soil source:**
   - ☐ Off-site soils —Supplier: _____

     Supplier phone: _____
   - ☐ On-site soils

5. **Conduct stockpile sampling or imported soil sampling:**
   - ☐ Completed stockpile sampling for onsite soils and filled out Form 7.
   - ☐ Completed imported soil sampling and filled out Form 8, or soils were certified to be clean by the supplier.

6. **Conduct compliance sampling:**
   - ☐ Filled out Form 6.
   - ☐ Attached a map showing areas excavated and the depth of excavation and performance sampling locations.

Form 4: Capping in Place

Reminder: Keep a copy of the completed forms to pass on to future property owners.

1. List the decision units and cap information for each one.

Decision unit	Type of cap	Cap depth	Geotextile used?

2. Prevent soils from escaping the site and plan for worker safety:

- ☐ Follow dust- and erosion-control practices
- ☐ Follow Department of Labor & Industries worker safety regulations

3. Record the soil source:

- ☐ Off-site soils —Supplier: _____

  Supplier phone: _____
- ☐ On-site soils

4. File the Ecology-approved environmental covenant:

- ☐ Filed a deed notice with: _____ County

Recording number: _____

5. Compile the following attachments:

- ☐ Map showing areas with results above cleanup levels capped and any additional details about the cap a future property owner would need to know
- ☐ Maintenance and monitoring plan
- ☐ A copy of the environmental covenant

Form 5: Consolidation and Capping

Reminder: Keep a copy of the completed forms to pass on to future property owners.

1. List the decision units and excavation and consolidation information for each one.

Decision unit	Excavation depth

2. Conduct compliance sampling after excavation.

☐ Filled out Form 6

3. Prevent soils from escaping the site and plan for worker safety:

☐ Follow dust- and erosion-control practices

☐ Follow Department of Labor & Industries worker safety regulations

4. Record cap information:

Cap type: _____ Cap depth: _____

☐ Used a geotextile barrier

☐ Attached a map showing both excavated and consolidated capped areas and included details about the cap a future property owner would need to know

5. Record the soil source:

☐ Off-site soils —Supplier: _____

Supplier phone: _____

☐ On-site soils

6. File the Ecology-approved environmental covenant:

☐ Filed a deed notice with: _____ County

Recording number: _____

7. Compile the following attachments:

☐ Map showing areas with results above cleanup levels capped and any additional details about the cap a future property owner would need to know

☐ Maintenance and monitoring plan

☐ A copy of the environmental covenant

Form 6: Compliance sampling

Reminder: Keep a copy of the completed forms to pass on to future property owners.

1. **Record the total volume for excavated areas:**

- Decision Unit: _____Excavated: _____cubic yards
- Decision Unit: _____Excavated: _____cubic yards
- Decision Unit: _____Excavated: _____cubic yards
- Decision Unit: _____Excavated: _____cubic yards

2. **Calculate the number of samples needed using Table 12.**

Table 11: Minimum number of compliance sample locations per decision unit

Sampling area in acres*	Number of samples
Less than or equal to 0.25	4
0.25 to 1	8
1 to 5	15
5 to 10	20
Greater than 10	20 + 2 per 5 acres

* 1 acre = 43,560 square feet

3. **Attach a property diagram with compliance sampling grid overlaid (see Chapter 6), showing which areas were cleaned up and the locations of paved or built areas.**

4. **Complete the sample inventory.**
   a) List the samples by decision unit on the Compliance Sampling Inventory sheet. Enter the depth of each sample. When sampling multiple depths at a single location, mark each depth as a separate sample number.
   b) Fill in the date and time.
   c) Complete the rest of the columns when you get the sampling results.

5. **Determine if indicator hazardous substances (arsenic, cadmium, lead, and zinc) concentrations are elevated.**
   a) Calculate average concentrations for the area sampled and enter them on the inventory sheet. For each decision unit where average concentrations exceed Table 13, circle the average.

Table 12: State cleanup levels for inactive and abandoned mine lands indicator hazardous substances

Contaminant	**Cleanup Level in milligram per kilogram (mg/kg)**
Arsenic	20
Cadmium	4
Lead	250
Zinc	86

b) Circle every value where concentrations are two-times greater than cleanup value in Table 12.

c) Attach a copy of the lab results and chain-of-custody.

d) For each sampled area with a circled value (maximum or average), note in the Comments column that more cleanup is needed for that area. Return to Chapter 3 to review options for cleaning up those decision units. If no decision units have elevated arsenic or lead, read Chapter 6 for next steps.

Compliance Sampling Inventory

Property address: Phone: Sampled by:					Testing parameters (ppm)			
DU no.	Sample no.	Sample depth	Date	Time	Arsenic	Cadmium	Lead	Zinc

Notes: DU = decision unit

Form 7: Stockpile sampling

Reminder: Keep a copy of the completed forms to pass on to future property owners.

Each composite should contain six subsamples mixed together. In Table 13, fill in the number of composite samples needed for each stockpile, based on its size (Table 14).

Table 13: Planning for stockpile sampling

Stockpile identifier	Stockpile volume	# of subsamples	# of composites
		6	
		6	
		6	
		6	

Table 14: Number of composite samples per stockpile

Stockpile volume (cubic yards)	Number of composites
0 - 500	2
501–999	4
1,001–5,000	6
5,001–10,000	10
10,001–20,000	14
> 20,000	14 +1 per 5,000 cubic yards

1. **Complete the sample inventory.**
   a) List the composite samples by stockpile in the inventory on the next page.
   b) Fill in the date and time.
   c) Note any unusual observations in the Comments column.
   d) Complete the rest of the columns when you get the sampling results.

2. **Determine if indicator hazardous substances are elevated.**
   a) Mark each composite sample that exceeds cleanup levels for indicator hazardous substances. These segments cannot be reused on the property. See Chapter 7 for next steps.
   b) Attach a copy of the lab results and chain-of-custody.

Stockpile Sampling Inventory

Property address: Phone: Sampled by:				Testing parameters (ppm)			
Stockpile no.	Sample depth	Date	Time	Arsenic	Cadmium	Lead	Zinc

Sampling and Cleanup Checklist

Characterization sampling

Form 1: Characterization Sampling

- ☐ Appropriate number of samples per decision unit (0–6 inch depth)
- ☐ 50% of samples collected from bottom of mine waste pile, if applicable

Form 2: Characterization Sampling Results

- ☐ Maximum indicator hazardous substance concentrations are less than 2 times cleanup values and average concentrations are less than cleanup values (stop here)
- ☐ Maximum indicator hazardous substance concentrations are greater than or equal to 2 times cleanup values or average concentrations are greater than cleanup values (continue below)

Cleanup and compliance sampling

Compliance sample depth should be at least 6 inches.

To be protective, cap depth should meet the guidelines in Chapters 4 or 5. Ensure future owners know to maintain the remedy by providing them with the sample results and cleanup information.

1. Excavation and removal
   - ☐ **Form 3** with cleanup map
   - ☐ **Form 6** with sampling grid map
   - ☐ **Form 7** stockpile sampling (if applicable)
2. Capping in place
   - ☐ **Form 4**
   - ☐ Environmental covenant*
3. Consolidation and capping
   - ☐ **Form 5**
   - ☐ Environmental covenant*

**The environmental covenant should describe remaining contamination and how to inspect and maintain the remedy.*

Appendix C: Worksheets

Worksheet 1: Planning for excavation and removal

1. Calculate soil removal depth by decision unit.

Remove enough soil to reach soils meeting state cleanup levels below the contaminated surface soils (Figure 6).

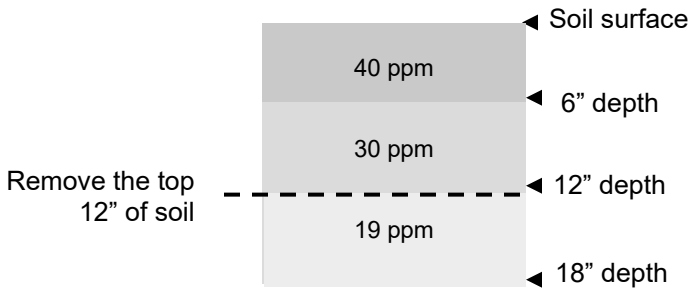

Figure 6. Example soil profile for arsenic

2. Calculate the volume of soil to be removed in cubic yards (yds^3) by decision unit (DU).

DU1 area _____ sq ft **x** removal depth _____ ft**/**27 **=** _____ yds^3

DU2 area _____ sq ft **x** removal depth _____ ft**/**27 **=** _____ yds^3

DU3 area _____ sq ft **x** removal depth _____ ft**/**27 **=** _____ yds^3

DU4 area _____ sq ft **x** removal depth _____ ft**/**27 **=** _____ yds^3

3. Calculate soil transport cost by volume.

_____ yds^3 (from step 1) x 1.5 tons/yds^3 x $_____ /ton = $_____

4. Select a municipal or private permitted landfill and call for waste disposal authorization fee information.

Landfill name: _____

Phone: (____) _____ Fee: $_____

5. Ask the permitted landfill or your local health department what type of sampling is required for soil disposal. It may require stockpile sampling (Chapter 7) or toxicity characteristic leaching procedure (TCLP) testing. This test determines if soil is safe for landfill disposal. Ask your lab if they can do TCLP, which typically costs $75–100.

Sampling or TCLP: $ _____

6. Calculate the soil disposal cost by volume.

_____tons of soil x $_____ /ton= $_____

7. Calculate the fill cost by volume: Use the excavated soil volume from step 1 as your backfill volume. To ensure you are not re-contaminating the property, check the soil quality with your supplier. Ask if they have any data on metals in their soils. If not, ask if they can sample for you (see Chapter 9).

_____ yds^3 fill x $_____ /cubic yd = $_____

8. Other costs: Estimate the labor and equipment costs of soil removal and backfilling. Also, think about the cost of compliance sampling (Chapter 6) and possible imported soil sampling (Chapter 8).

$_____

9. Total the costs:

3	Soil transport	$ _____
6	Soil disposal	+ $ _____
7	Backfill	+ $ _____
8	Other costs	+ $ _____
		= $ _____

Worksheet 2: Planning for capping in place

Hard cap—There should be no extra cost to your project if the building or pavement area was part of the original plan.

Soil cap—There should be little additional cost for areas where landscaping was part of the original plan.

1. Calculate soil cap cost.

a. Calculate the volume of soil by decision unit (DU):

DU area _____ft^2 x _____ft depth of cap / 27 = _____ yd^3

b. Request a cost estimate for the new soil and delivery.

$ _____/yd^3 x _____yd^3 = $_____

c. Calculate the cost of the geotextile:

DU area _____ ft^2 / 9 x $ _____/yd^2 material = $ _____

d. Labor cost of installing the cap = $_____

2. Estimate monitoring and maintenance costs.

Inspect caps at least once every year. Factor in the cost of regular inspections and repairs. Maintenance may include replenishing soil or landscaping materials.

3. Total estimated costs:

1b	Soil cap	$ _____
1c	Geotextile	+ $ _____
1d	Labor	+ $ _____
2	Monitoring and maintenance	+ $ _____
	Total	= $ _____

Worksheet 3: Planning for consolidation and capping

1. **Calculate consolidation costs**—Labor and equipment costs may vary depending on the volume of contaminated soil and how far it is being moved.

Hard cap—There should be no additional cost to your project if the building or pavement area was part of the original plan.

2. **Calculate the soil cap cost**—There should be little extra cost for areas where landscaping was part of the original development plan.

   a. Calculate the volume of soil:

Consolidated area _____ft^2 x ____ft depth of soil cap / 27 = _____ yd^3

   b. Request a cost estimate for the soil:

$ _____/yd^3 x _____yd^3 = $_____

   c. Calculate the cost of the geotextile:

DU area _____ ft^2 / 9 x $ _____/yd^2 material = $ _____

   d. Labor cost of installing the cap = $_____

3. Estimate the monitoring and maintenance costs.

Inspect caps at least once every year. Factor in the cost of regular inspections and repairs. Maintenance may include replenishing soil or landscaping materials.

4. Total estimated costs:

1	Consolidation	$ _____
2b	Soil cap	+ $ _____
2c	Geotextile	+ $ _____
2d	Labor	+ $ _____
3	Monitoring and maintenance	+ $ _____
	Total	= $ _____