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Please contact Tony Allen at 360-705-5450 or allent@wsdot.wa.gov with comments, questions, or suggestions for improvement to the manual.

For updating printed manuals, page numbers indicating portions of the manual that are to be removed and replaced are shown below.

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Chapter 3 Field Investigation	3-1 – 3-C-8	3-1 – 3-E-8

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Washington State Department of Transportation
Environmental and Regional Operations
Construction Office
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Signature

Washington State
Department of Transportation

Geotechnical Design Manual

M 46-03.10

August 2014

Environmental and Regional Operations
Construction Division
Geotechnical Office

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Chapter 3 Field Investigation

3.1 Overview

This section addresses subsurface investigation that includes drilling and excavation of test pits as part of a geotechnical field investigation. It is organized by activities and policies involved prior to, during, and after exploration.

3.2 Activities and Policies – Before Exploration

A geotechnical field exploration plan should be formulated as described in Chapter 2. The geotechnical designer assigned to the project is responsible to coordinate with the Region or Washington State Ferries (WSF) Project Office (project Office) to prepare the way for the field exploration crews to implement the field exploration program. The geotechnical designer also functions as the primary liaison between the region or WSF and the Field Exploration Manager (FEM), to keep the FEM informed as the region or WSF completes the necessary preparations to begin implementation of the field exploration plan.

Specifically, the geotechnical designer should do the following before submitting the final field exploration request to the FEM:

1. Make sure senior Geotechnical Division management agrees with the proposed exploration plan (see Section 1.4).
2. Make sure that the project office has provided adequate site data to locate test holes and key project features on paper and in the field.
3. Make sure that the project office has asked for (preferably obtained) an environmental assessment of the site to determine whether or not there is potential to encounter hazardous subsurface materials. The geotechnical designer is responsible to have a basic knowledge of previous site use as well.
4. Make sure that the project office has asked for (preferably obtained) an archeological assessment of the site to determine if there is potential to encounter Native American or other artifacts.
5. Coordinate with the project office to make sure any right-of-entry's needed are obtained for the proposed drilling.
6. Coordinate with the project office to make sure the necessary permits are obtained (especially with regard to wetlands and other environmentally sensitive areas).
7. Coordinate with the Field Exploration Supervisor (FES) who will be assigned to the project, and the project office, to conduct a joint field review to evaluate access and other issues related to setting up and finalizing the field exploration program.
8. Act as the liaison between the Field Exploration Manager (FEM) and the project office to make sure the FEM knows when all the tasks have been completed and to inform the FEM of the results so that the exploration program can be properly estimated.

Note that to obtain permits and right-of-entry, a preliminary field exploration plan will likely be needed by the region (or WSF) before the final exploration plan is completed and turned in. Therefore, the development of the field exploration plan may require a somewhat iterative process. Once enough field exploration plan details have been developed, the geotechnical designer should request that those who will be directly negotiating with local owners to obtain right-of entry (if needed) invite the FEM or FES to assist in those negotiations. This generally makes the negotiations go much smoother.

If the geotechnical designer recognizes, either through an environmental assessment or through general knowledge of the previous site use, that there is a potential to encounter hazardous materials during the geotechnical field exploration, it is important that the geotechnical designer make the FEM aware of this as soon as possible in the development of the exploration plan. The potential to encounter hazardous subsurface materials can completely change the approach, cost, and scheduling for the site exploration activities.

A preliminary field exploration plan is also needed for use as the basis for conducting the joint field review mentioned above. This field review should be used to determine how each individual exploration site will be accessed, the type of drill equipment best suited for the site, areas for utility locates, required traffic control, and to identify any permit, right-of-entry, and environmental issues. Adjustments to the specific locations of exploration points can be made as needed during the field review to address the above issues.

During the field review, the FES will stake the borings if they have not already been located and if right-of-entry (if needed) has been obtained. The FES should also assess the traffic control needs for the exploration work at this time. The FES will coordinate directly with the Maintenance Office for traffic control. After staking borings, the FES is responsible for calling all utility locates a minimum of 48 hours prior to the start of explorations.

Once the final field exploration plan has been completed, the FEM will provide a cost estimate to the geotechnical designer to complete the field exploration plan. Once the expenditure for the field exploration has been authorized, the geotechnical designer must then notify the FEM to commence with the field exploration. Once the exploration plan has been executed, any subsequent requests to modify the plan should be provided in writing by the geotechnical designer to the FES. The FES will respond with an updated estimate and schedule for requested plan change.

If the geotechnical design is to be conducted by a geotechnical consultant, the WSDOT geotechnical designer who is overseeing the consultant task assignment or agreement is responsible to make sure that the consultant accomplishes the tasks described above and to assist in the coordination between the consultant and the FEM. If the consultant needs changes to the field exploration plan, the geotechnical designer is responsible to provide input to the FES or FEM as to the acceptability of the changes. The FES or FEM is not to act on the requested changes to the field exploration plan without input from the geotechnical designer.

While the geotechnical designer is responsible to coordinate between the project office and the FEM or FES regarding permits, right-of-entry, hazardous materials assessment and archeological evaluation for the site, and adequate site data to locate the exploration points for exploration plan development and for location in the field, the project office is ultimately responsible to perform these tasks or see to it that they are performed.

Currently, WSDOT has a five-year blanket Hydraulic Project Approval (HPA) for both marine and fresh waters statewide. Once again the FEM or FES should be involved early in the process to define all technical questions for each project. For all barge projects, the drilling shall be in compliance with the provisions described in the general HPA from the Washington Department of Fish and Wildlife (WDF&WL).

The FEM (or as delegated to a FES) will assign the project to a drill inspector(s) and a drill crew. The drill inspector will then initiate a meeting with the geotechnical designer to discuss the objectives and any particulars of the exploration plan. Either the FES or the drill inspector should notify the geotechnical designer of the anticipated start date of the requested work.

3.3 Activities and Policies – During Exploration

The drill inspector will maintain regular contact with the geotechnical designer, especially when unanticipated conditions or difficulties are encountered, significant schedule delays are anticipated, and prior to terminating the exploration and installing instrumentation. The driller is required to complete a daily drill report at the end of each workday. This is also required of any contract driller working for WSDOT. The drilling inspector is also required to complete a daily inspector's report at the end of each workday. At the completion of each workweek these reports shall be turned in to the FES and put in the project file. Examples for both the daily drill and inspector reports that show the minimum required documentation are included in Appendix 3-A.

Exploration activities during drilling must adhere to the Geotechnical Division's Best Management Practices to mitigate for sediment/erosion control and spill prevention (see Appendix 3-B).

Methods for advancing geotechnical borings should be in accordance with the following ASTM standards:

- D6151-97(2003) Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling
- D5876-95(2000) Standard Guide for Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices
- D2113-99 Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation

Hollow-stem augers are not to be used for assessment of liquefaction potential; wet rotary methods should be used. Further, care must be exercised during drilling with hollow-stem augers to mitigate for heave and loosening of saturated, liquefiable soils.

Sampling of subsurface materials should be in accordance with the following ASTM standards:

- D1586-99 Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils
- D3550-01 Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils
- D1587-00 Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
- D4823-95(2003)e1 Standard Guide for Core Sampling Submerged, Unconsolidated Sediments

In addition to the methods described above for sampling for soft, fine-grained sediments, WSDOT utilizes a thick-walled sampler referred to as the Washington undisturbed sampler. This sampler is lined with 2-inch (I.D.) extrudible brass tubes. The sampler is intended for stiffer fine-grained deposits than what would be suitable for Shelby tubes.

Down-the-hole hammers are not allowed for use in performing Standard Penetration Tests.

Samples should be handled in accordance with the following ASTM standards:

- D4220-95(2000) Standard Practices for Preserving and Transporting Soil Samples
- D5079-02 Standard Practices for Preserving and Transporting Rock Core Samples

Disturbed soil samples should be placed in watertight plastic bags. For moisture-critical geotechnical issues, a portion of the sample should be placed in a moisture tin and sealed with tape. Extreme care must be exercised when handling and transporting undisturbed samples of soft/loose soil; undisturbed samples must also be kept from freezing. Rock cores of soft/weak rock should be wrapped in plastic to preserve in situ moisture conditions. Rock cores should be placed in core boxes from highest to lowest elevation and from left to right. Coring intervals should be clearly labeled and separated. Core breaks made to fit the core in the box must be clearly marked on the core. All soil and rock samples should be removed from the drill site at the end each day of drilling and transported to the laboratory as soon as possible.

In situ testing methods commonly employed in geotechnical investigations should be in accordance with the following ASTM standards:

- D2573-01 Standard Test Method for Field Vane Shear Test in Cohesive Soil
- D5778-95(2000) Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils

Groundwater monitoring and in situ characterization methods commonly employed in geotechnical investigations should be in accordance with the following ASTM standards:

- D5092-02 Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers
- D4750-87(2001) Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)
- D4044-96(2002) Standard Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers

Additional information on ground water investigation and monitoring is provided in Mayne, et al. (2002).

As a minimum, groundwater levels should be measured/recorded prior to the daily commencement of drilling activities and upon completion of piezometer installation. Subsequent monitoring is at the discretion of the geotechnical designer. Prior to constructing a piezometer, the boring should be thoroughly purged of drill fluids using clean, potable water. The geotechnical designer should provide design input on the construction of the piezometer, specifically regarding the screened interval and seals. Piezometers shall be constructed in accordance with Washington Department of Ecology (DOE) regulations (RCW 18.104 /WAC 173.160) governing water wells. Following completion of the piezometer, the piezometer should be repeatedly surged or bailed to develop the well screen and optimize hydraulic connectivity with the formation. Furthermore, the piezometer should be sealed within the aquifer of interest, not hydraulically linking multiple aquifers.

Slope inclinometers are routinely employed for slope stability investigations. The installation and monitoring of slope inclinometers should be in accordance with the following ASTM Standard:

- D6230-98 Standard Test Method for Monitoring Ground Movement Using Probe-Type Inclinometers

Explorations using hand equipment such as augers and drive probes may also be useful for some geotechnical investigations, such as to define lateral and vertical extent of soft/loose, near-surface deposits. The WSDOT portable penetrometer consists of 1.75 inch diameter rod which tapers to a rounded 0.5 inch tip over a 4.5 inch length, and which is driven in the ground with a 35 lb weight dropped from a 25.5 inch height. Detailed procedures for portable penetrometer testing are provided in Appendix 3-C. Standard Penetration Test correlations for the WSDOT portable penetrometer (PP) are approximated as follows:

Soil Type	SPT Correlation
Clay	# PP blows/4
Silt	# PP blows/3
Sand/Gravel	# PP blows/2

The excavation of test pits can provide valuable subsurface information not determinable or well characterized by test borings. Extreme care should be exercised around open excavations, and access within them should adhere to Washington Administrative Code (WAC) sections 296-155-655 and 296-155-657.Prior to de-mobilizing, the drill inspector should ensure location information (e.g., station, offset, elevation and/or state plane coordinates) of all the explorations are recorded on the field logs. If exact location information is unavailable upon completion of field activities, a sketch of each exploration location should be made indicating relationship to observable features (i.e., bridge/structure, mile post, etc.). This information should be provided with the field logs to the geotechnical designer. In addition to providing field logs for all explorations, required documentation for test pits should include a scale drawing of the excavation and photographs of the excavated faces. Sampling methods and in situ measurement devices such as pocket penetrometers should also be documented. Detailed requirements for boring logs are provided in Chapter 4.

3.4 Activities and Policies – After Exploration

Upon completion of subsurface explorations, a finished log for each exploration is to be sent to the Department of Ecology (DOE) by the FES. In addition to subsurface conditions encountered, the log must include location (address, county, and ¼ - ¼ Section/Township/Range) and installation information (well #, type of instrumentation, seals, and screened interval).

Unless otherwise requested by the geotechnical designer, all explorations and resource protection wells (piezometers and inclinometers) shall be properly decommissioned prior to construction as per DOE requirements (WAC 173-160-381,500 and RCW 18.104.048). The construction Project Engineer is responsible for notifying the FEM at least 72 hours prior to required time for decommissioning.

Upon completion, the drilling inspector shall transmit recovered samples to the Geotechnical Division lab and provide both the original copy of the field notes and a finished log for all explorations to the geotechnical designer.

3.5 Standard Penetration Test (SPT) Calibration

Calibration to determine specific hammer system efficiencies shall be developed in general accordance with ASTM D4633 for dynamic analysis of driven piles or other accepted procedure. Measured hammer efficiencies for WSDOT drilling equipment are summarized at a link found at the following web address: www.wsdot.wa.gov/biz/mats/Geotech/default.htm.

3.6 References

Mayne, P. W., Christopher, B.R., and DeJong, J., 2002, *Subsurface Investigations – Geotechnical Site Characterization*, Publication No. FHWA NHI-01-031, National Highway Institute, Federal Highway Administration, Washington, DC, 300 pp.

Washington State Department of Transportation

Daily Drill Report

SR	CS	Date
Project		Project No.
Drill		Drill No.

☐ Structure ☐ Line ☐ Landslide ☐ Materials Source

Hole No	Size	Angle	From	To	Soil	Rock	Total

Item	Hours	Item	Hours
Mobilization and Demobilization		Water Haul: Mileage	
On Site Moving/Rigging		Equipment Downtime	
Drill Site Preparation		Explain:	
Soil Drilling		Standby for Hole Survey and Other Delays	
Rock Drilling		Explain:	
Reaming Hole		Installation of Instrumentation	
Placing and Removing Casing		Type:	
Hole Stabilization		Special Testing	
Install and Maintain Water System		Type:	
Water Delay		Travel Time	

Expendables

Core Boxes	Piezo Pipe	Slope Incl	Cement	Bentonite	Additives

Other

Support Equipment	No.	Job	Yard	O Serv.

Remarks

	Reg.	OT	Comp	Total
Inspector				
Driller				
Helper				

Shift Start	Shift Finish	Service Codes

DOT Form 350-152 EF
Revised 7/2007

Appendix 3-B Portable Penetrometer Test Procedures

Background

The WSDOT portable penetrometer (PP) is a field test used in highway and small foundation design. The test may be used in both cohesive (clay) and cohesionless (sands & gravels) soils. The test values (i.e., blow count per foot of penetration) are dependent upon the effective overburden pressure of granular soils and shear strength of cohesionless soils. However, since all equations and correlations related to use of blow count values are approximate, sound engineering judgment is necessary for accurate interpretation of the test results.

The PP test is a derivative of the Standard Penetration Test (SPT), the most widely used method for determining soil conditions in the world. The SPT is both a dynamic penetration test and a method of obtaining disturbed samples. For the SPT test, a split-spoon sampler attached to drill steel is driven downward by the impact of a falling weight on the steel. In the SPT test, a 140 lb. weight falls a distance of 30 inches per blow. In the PP test method, a 35 lb weight falls an approximate distance of 25.5 inches. In the SPT test, as a split-spoon sampler is driven downward, it fills with disturbed soil. In the PP test, no sample is obtained as a solid, cone-shaped tip is driven downward by a falling weight. However, the PP method requires excavation of a test hole, and samples should be obtained with each change in soil strata.

Equipment

Performance of portable penetrometer testing requires two groups of equipment. The first group is associated with preparation of a drilled borehole, backhoe test pit, or hand-excavated test hole. This group includes the tools used to dig the hole, with a hand auger employed most frequently in a PP test application. A list of equipment used for excavation of a test hole with a hand auger follows:

- Shovel with pointed end for breaking up turf and vegetation at the surface.
- Posthole digger for assistance in establishing the test hole excavated using the hand auger.
- Hand auger to include: auger, pipe extensions (± 3 feet lengths), and handle.
- Steel bar to loosen up hard pack soil and assist in the removal of rock or gravel from the test hole.
- Tarp for collecting representative samples of soil strata.
- Field notebook and pencil for recording location of test holes, numbers and descriptions of distinct soil layers encountered, and other information relative to a review of site characteristics and conditions.
- Sample bags with ties for preservation of samples of material encountered with changes of soil strata.
- Marker for writing on sample bags or tags to delineate test hole and depth of sample collection.
- Pocket or rag tape to be used to locate the test hole relative to some reference point, grid, or proposed alignment and for measurement of depth below surface of distinct soil strata and depth of exploration.

The PP device and accessories form the second group of equipment required for geotechnical investigation of proposed highway or small foundation designs. A list of the equipment necessary for this group follows:

- Portable penetrometer to include cone-shaped tip; drill rod sections (A-rod - 1.75 in. pipe OD & 22.5 in. lengths); falling weight section (length of bar for sliding weight up and down); the 35-lb weight; and the coupling devices used for connecting the tip – drill rod sections – falling weight section – falling weight stop.
- Pipe wrenches (2) used to loosen connections when breaking down the portable penetrometer.
- Lathe or another "straight-edge" useful for establishing a surface reference elevation.
- Construction crayon or marker used for marking three 6 inch intervals on the penetrometer in order to clearly delineate displacement as the penetrometer is driven into the ground.
- Rags to wipe down equipment, removing moisture and dirt, prior to packing away equipment.

Test Procedure

1. Using a shovel or other hand tool, strip away sod or surface vegetation and set aside for future restoration of the location. Using a posthole digger or a 6 in diameter or greater hand auger, dig down approximately 2 feet, noting the depth of topsoil, subsoil, and other changes in soil strata. Describe soil conditions such as color, texture, and moisture content of the soils encountered in the bore log. Collect samples for lab soil classification, grain size determination, or Atterberg limits determination.
2. Assemble the PP device for evaluation of soils near the surface. Use threaded coupling devices to connect the cone-shaped tip, drill rod sections, and falling weight slide section.
3. Measure the distance from the bottom of the test hole to the surface and record. From the tip of the penetrometer, measure this distance on the body of the testing device and annotate a reference line on the body of the device. From this line measure and mark three intervals, each 6 inches in length.
4. Lift up the PP device and place the tip at the bottom of the test hole. Insure that the bottom or base line mark lines up with the approximate ground surface. Place a lathe or other straight edge on the ground surface so that any downward displacement of the PP device may be measured accurately.
5. Lift the 35 lb weight up and lower it down on to the upper, slide portion of the testing device. Screw on the threaded stop at the upper end of the slide section.

6. Performance of PP testing requires a minimum of two people. One person should be responsible for steadying the PP device in the test hole, counting the number of times the weight drops, and watching the reference line in order to stop the process every time the device is displaced downward a total of 6 inches. The second person is responsible for raising and dropping the weight in as smooth and controlled manner as possible. Raising the weight upward of fifty times per 6 inch interval can prove to be a workout. Additional personnel can be employed to relieve the person responsible for lifting the weight and assist in the manual work requirements of test hole excavation.
7. For each "blow", the 35 lb weight drops a distance of approximately 25.5 in. The number of blows required to drive the cone penetrometer through three 6 inch intervals is recorded. The count for the initial 6 inch interval is noted but isn't used to compute a test value because it reflects the seating of the PP device. The sum of the blows for the last two 6 inch intervals is recorded. This sum of the blows represents the blow count for that 1 foot interval below the surface.
8. Upon completion of PP testing at a specific depth, the device is unseated by thrusting the weight against the stop at the end of the slide. Repeating this action should loosen the tip and permit removal of the device from the test hole.
9. Employ the hand auger to remove material "disturbed" by the action of the PP. Place this affected material on the tarp and obtain a sample for lab testing. Associate PP test results with material sampled from the proper test hole and elevation.
10. Continue advancing the auger into the soil, emptying soil and repeating the procedure until the desired depth is reached. Advances from one PP test to the next lower level test are usually in 2 feet increments. Monitor the condition and properties of the soil, noting any changes in strata. Obtain samples as necessary.
11. To prepare the PP device for the next test at a lower test hole level, remove the weight stop, 35 1b weight, and slide section to permit the attachment of additional drill rod sections. Re-attach the slide section to the penetrometer. Measure the distance from the bottom of the test hole to the surface. Mark this distance on the body of the testing device by measuring from the tip and annotating a base line corresponding to the distance on the PP device.
12. With assistance, lift the PP into the test hole, properly seat it in the center of the hole, and insure that the base line corresponds with the ground surface.
13. Lift the weight up and onto the slide section and screw in the threaded stop at the top end of the slide.
14. Perform PP test procedure and sampling as described previously.
15. Monitor changes in soil strata as the hand auger advances downward in the test hole. In general, sample only when there are obvious changes in soil strata. Use engineering judgment to guide whether additional sampling and testing are warranted. As the degree of geologic complexity increases, the degree of sampling and testing increases as well.

Figures 3-C-1 through 3-C-8 illustrate the equipment and procedures used for conducting the Portable Penetrometer test.

Perform a field reconnaissance of the site of the geotechnical investigation. Insure that the proposed design is tied to an established coordinate system, datum, or permanent monument.

Figure 3-C-1

Hand augers used in conjunction with the PP test.

Figure 3-C-2

Porta-Pen equipment. Clockwise from the top left: tape measure above cone-shaped tips (2); 22.5-inch lengths (9); threaded coupling devices used to connect PP components (10); threaded coupler used to stop weight (1); falling-weight slide section above pipe wrenches (2); 35 lb. weight; and threaded coupling devices used with small cone tips (not shown).

Figure 3-C-3

The vicinity of the test hole is cleared of vegetation using a shovel or posthole digger. Left photo shows using the auger to advance the hole to the desired depth. Right photo shows placing soil on the tarp prior to sampling.

Figure 3-C-4

Photo of PP device in the process of being assembled. The threaded coupling devices on the left side of the box are used to connect the cone-shaped tip to lengths forming the body of the penetrometer. The lengths forming the body of the penetrometer are then connected to the section on which the weight slides.

Figure 3-C-5

Marking a base line on the body of the penetrometer. This will line up with the top of the test hole. In addition, also mark three 6 inch intervals, measured from this base line, to track the downward displacement when the falling weight is applied.

Figure 3-C-6

PP testing in progress. Lathe is used to mark the surface of the test hole excavation. In this instance, one person is steadying the equipment, another is lifting and dropping the 35 lb weight, and a third is observing downward displacement and counting blows.

Figure 3-C-7

This PP testing can be tiring. Photo shows another person providing relief for the falling weight task.

Figure 3-C-8

Appendix 3-C Field Investigation Best Management Practices for Erosion and Spill Prevention

The Washington State Department of Transportation (WSDOT) is dedicated to protecting the environment when conducting field exploration projects. This memo outlines the erosion/sediment control and spill prevention best management practices (BMPs) that will be followed for all drilling activities.

The two distinct scenarios for drilling include pavement and vegetated areas. The variety of erosion and sediment control BMPs may vary between the two scenarios, but the philosophy of minimizing site disturbance, reducing waste materials, trapping sediment, and stabilizing the site, remains the same.

Disturbance Minimizing BMPs:

- Select the smallest rig capable for the job
- Use elevated scaffolding for driller and assistant when necessary

Waste Reduction BMPs:

- Re-circulate drilling slurry
- Minimize volume of water for drilling

Sediment Trapping BMPs:

- Baffled mud tub (sealed with bentonite to prevent fluid loss)
- Polyacrylamide (PAM) for flocculation (must meet ANSI/NSF Standard 60)
- Silt fence (trenched, below drill, and on contour)
- Sand bag barrier (washed gravel, below drill, two rows high, and on contour)
- Straw bale barrier (trenched, staked, below drill, and on contour)
- Catch basin insert (pre-fabricated type, above or below grate)
- Storage of slurry in locked drums

Site Stabilization BMPs:

- Seed with pasture grass
- Straw mulch (2” maximum for seeded areas)

All BMPs will be installed and a thorough inspection for sensitive areas (wetlands, streams, aquifer recharge, etc.) and stormwater conveyances will be conducted, prior to starting drilling activities. At no time shall drilling slurry or cuttings be allowed to enter Water Bodies of the State of Washington.

When sensitive resources or conveyances to these areas exist, all slurry and cuttings will be stored in lockable drums and disposed of off-site. If not, the slurry will slowly be infiltrated into the ground using surrounding vegetated areas and the cuttings will be stored and disposed of off-site.

Removal of sediment control BMPs will be performed immediately after drilling is completed. Place trapped sediment with cuttings in drums. If significant soil disturbance occurs during drilling, the BMPs will be left in place until the site is stabilized with grass or mulch.

The drill crew will have a copy of the Hydraulic Project Approval (HPA), issued by the Washington State Department of Fish and Wildlife (WDFW) on-site for all work adjacent to or over water. The Supervisor will discuss the requirements of this permit with the crew prior to each project. All of the provisions in each HPA will be strictly followed until the completion of said project. The previously defined erosion/ sediment control philosophy and BMPs will be implemented in these conditions

The approach to protecting surface and ground water is focused on prevention. The drill shaft will be filled with bentonite clay to prevent mixing of aquifers and eliminating the route for surface contaminants. In addition, the following Spill Prevention Control & Countermeasures (SPCC) BMPs will be used when applicable:

Minimize Risk:

- Visually inspect equipment for leaks or worn hoses on a daily basis
- Fix equipment leaks as soon as possible to minimize cleanup
- Use proper equipment to transfer materials
- Reduce the overall volume of fuel and chemicals on site
- Remove as many sources of spills as possible from the site when not working (evenings/weekends)
- Use environmentally-friendly chemicals whenever possible
- Store all chemicals with lids closed and keep containers under cover
- Have secondary containment devices underneath potential spill sources when applicable (e.g. 5 gallon bucket)

Maximize Response:

- Each drilling operation will have at least one emergency spill response kit on site at all times
- Know who to call in case of emergency spill

If an incidental spill (less than 1 gallon/small equipment leak) occurs, immediately collect contaminated soil and store it in label storage drum. Do not mix soils with different contaminants together. Report spill to your supervisor, as they are aware of reporting requirements.

If a major spill (more than 1 gallon) to water occurs, control the source of the leak if possible and contact the Washington State Emergency Management Division (800-258-5990) and the National Response Center (800-424-8802). If a major spill to soil occurs and there is immediate risk to human health and/or the environment, control the source of the leak if possible and contact the Washington State Department of Ecology (800-407-7170). Then contact your supervisor, as they are aware of reporting requirements.

Appendix 3-D Department of Natural Resources Memorandum of Understanding: Drilling Operations – State Owned Aquatic Lands

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES
PETER GOLDMARK, Commissioner of Public Lands

MEMORANDUM OF UNDERSTANDING

MOU No. 92-091209

This Memorandum of Understanding (MOU) is between the State of Washington, acting through its Department of Natural Resources, referred to as DNR, and the State of Washington, acting through its Department of Transportation, referred to as WSDOT.

The DNR is entering into this Agreement under authority of Chapter 39.34 RCW of Washington State, Interlocal Cooperation Act.

The DNR is the steward of 2.6 million acres of state-owned aquatic lands. DNR manages the aquatic lands beneath Puget Sound, the coast, navigable rivers and lakes to encourage direct public use and access, foster water dependent uses, ensure environmental protection, and to utilize renewable resources.

The WSDOT is responsible to keep people and business moving by operating and improving the state's transportation system vital to our taxpayers and communities. A key institutional linkage between DNR and WSDOT is a mandate to ensure environmental protection.

This MOU formally recognizes the connection between marine and freshwater sediment test drilling and State Owned Aquatic Lands habitat function, and it increases coordination between the DNR aquatic lands leasing and WSDOT Geotechnical Services Division programs. This MOU defines a streamlined process for DNR to authorize WSDOT access to state-owned aquatic land for the purposes of temporarily installing test drilling equipment and collecting geotechnical survey data. This increased coordination and streamlined process will result in better environmental protection of State Owned Aquatic Lands at a cost savings to the state.

We agree to the provisions and statements outlined below.

1.01 Definitions.

DNR – an agency of the state of Washington

WSDOT – an agency of the state of Washington

Memorandum of Understanding - The DNR and WSDOT enter into this memorandum of understanding, in good faith, to collaborate on and/or coordinate programs, and to define institutional linkages along broad areas of concern. Memoranda of understanding are not legal contracts and do not strictly obligate the resources of the Department.

Drilling operations may consist of several different types of drilling methods and equipment such as portable aluminum pontoon barge with a skid mounted drill. The ultimate goal is to collect geotechnical data necessary to determine the sub-surface composition for the purpose of structure and roadway design. This memorandum of understanding applies only to work that is conducted consistent with the activities described in Exhibit A. Any work proposed to be conducted on State Owned Aquatic Lands that is outside of the activities described in Exhibit A will require the submission of a completed application for use authorization and possibly a separate use authorization before access to State Owned Aquatic Lands is granted.

Access to State Owned Aquatic Lands – After satisfying all the procedural requirements triggered by this type of work and securing all other applicable federal, state and local permits, and receiving written confirmation that no conflicts exist with aquatic habitats, sediment contamination, navigation and public access, or any prior rights granted on State Owned Aquatic Lands at a proposed drilling site, WSDOT is granted access to State Owned Aquatic Lands for the purpose of temporarily installing marine and freshwater sediment test drilling equipment to collect geotechnical data. In authorizing access to WSDOT for this specific purpose, DNR conveys no rights in property. Access to State Owned Aquatic Lands may be revoked by DNR with thirty (30) day notice to WSDOT.

2.01 Objectives.

- Create a formal cooperative agreement between DNR and WSDOT that encourages joint planning and operations in support of the WSDOT's Field Exploration Unit.
- Create a streamlined process to grant WSDOT access to State Owned Aquatic Lands for the purpose of installing marine or freshwater sediment test drilling equipment and collecting geotechnical data while ensuring environmental protection of State Owned Aquatic Lands.
- Build collaboration between DNR and WSDOT that will establish a forum for communication regarding geotechnical surveys.

3.01 Work Activities.

See Attachment A

4.01 Functions/Roles/Tasks of Agencies/Parties.

DNR shall:

- Review WSDOT proposed sediment test drilling work descriptions and locations for potential conflicts on State Owned Aquatic Lands and consistency with activities described in Exhibit A.

- Provide written notification to WSDOT granting or denying access to State Owned Aquatic Lands for temporarily installing marine and freshwater sediment test drilling equipment to collect geotechnical. Written notification will be provided to WSDOT via email or fax, within fifteen (15) working days of receipt of notice of any proposed work. Written DNR approval does not exempt WSDOT from regulatory permits.

- Maintain communication with WSDOT regarding marine and freshwater sediment test drilling results on State Owned Aquatic Lands.

WSDOT shall:

- Contact DNR at least thirty (30) days before installing drilling devices with a description and anticipated duration of the proposed work and a description of the location in the form of a vicinity map depicting Section, Township, Range and accompanying GPS coordinates. WSDOT will not proceed with the proposed work until receiving written confirmation from the DNR project coordinator that there are no conflicts after and obtaining and fulfilling all other local, state, and federal permits and permit requirements.

- Maintain communication with DNR regarding marine and freshwater sediment test drilling results and implications to potential management activities on State Owned Aquatic Lands.

- Upon request, provide to DNR all sediment quality results and any other data, results, conclusions or findings WSDOT obtains from any of the work completed under this MOU.

5.01 Terms and Conditions.

(1) Effective Dates. This MOU is effective between May 1, 2014 and May 1, 2019. This agreement will be reviewed every two years.

(2) Amendments. This MOU shall be amended only by written mutual consent of the

(2) Amendments. This MOU shall be amended only by written mutual consent of the parties.

(3) Termination. Either party may terminate this MOU by notifying the other party, at the addresses given, of the termination and specifying the termination date. The terminating party shall deliver the notice at least fifteen (15) days prior to the termination date.

6.01 Project Coordinators.

(1) The Project Coordinator for the DNR is Linda Farr, Telephone Number (360) 902-1065.

(2) The Project Manager for the WSDOT is Cyndi Booze, Property & Acquisition Specialist, Telephone Number (360) 705-7377.

STATE OF WASHINGTON
DEPARTMENT OF TRANSPORTATION

Dated: 5-19, 2014

By: [signature]

Title: Acquisition Prog. Mgr

Address: PO Box 47338, Olympia WA 98504

Phone: 360-705-7312

STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES

Dated: 5/21, 2014

By: [signature]

Title: AQR Division Manager

Address: PO Box 47027, Olympia WA 98504-7027

Attachment A

WORK ACTIVITIES

Habitat Stewardship Measures and Best Management Practices:

(1) Species work windows will be used for the timing of any in-water construction and operational activities. This includes protection of forage fish, forage fish spawn, and associated spawning areas, as applicable.

(2) Avoid impacts to aquatic vegetation and fish spawning habitat/vulnerable life history stages. WSDOT will avoid drilling in Puget Sound eelgrass beds.

  (i) Fuels and other toxic materials must be stored in a location where they do not pose a risk of contaminating intertidal or nearshore areas.

    1. Maintaining pumps, boat motors, and other equipment in good condition, without leaks.
    2. Storing equipment free of fuel or in secure containment areas where any accidental leaks will be contained.
    3. Containing and cleaning up spills of fuels or other fluids without delay. Absorbent materials must be available onsite for this purpose.
    4. Removing broken-down vehicles promptly from beaches and intertidal areas.

(3) Floating structures and boats must not rest on the substrate. Boat moorage systems must be deployed in a manner that prevents dragging of the vessel or line. NOTE: When drilling location is in a confirmed forage fish spawning beach area, either use of the portable or large barge method is required for sediment test drilling and geotechnical surveys. However, deployment needs to be from a designated boat launch or beach void of suitable forage fish spawning habitat. Only in areas where successful avoidance of forage fish, their spawn and associated spawning areas is achieved, can other methods be deployed (i.e., truck or track mounted drill).

After satisfying all requirements triggered by this type of work, the WSDOT project coordinator will provide a description and anticipated duration of the proposed work and a description of the location in the form of a vicinity map depicting Section, Township, Range and accompanying GPS coordinates to the DNR project coordinator. The DNR project coordinator will review these proposals for potential conflicts on State Owned Aquatic Lands and provide written notification to the WSDOT project coordinator within 15 days granting access to State Owned Aquatic Lands for the sole purpose of conducting marine and freshwater sediment testing activities. WSDOT projects the length of time at each location to be approximately 1-60 days.

Marine and freshwater sediment test drilling and geotechnical surveys are necessary to determine the sub-surface composition for the purpose of structure and roadway design, hazardous materials detection, and other information necessary in the design roadway structures such as bridges.

WSDOT sampling procedure is as follows:

A 4 inch casing is sealed into the lake or river bottom. The test boring is advanced through that casing with a 3 inch casing. At every 5 foot interval a split spoon sampler is lowered on a 2 1/4 inch rod through the 3 inch casing to the bottom of the hole for taking soil samples. This process is repeated to the required depth of the soil investigation.

TRUCK MOUNTED DRILL
The truck mounted drill will access boring locations that are on relatively flat, easy to access sites. Each drill will have a support truck for water, tooling, and other required supplies.

TRACK MOUNTED DRILL
The track mounted drill is a low ground pressure (2.5 pounds per square inch rubber and steel track vehicle). It is used to access soft ground areas and sites with uneven or rough terrain. Each drill will have a support truck for water, tooling, and other required supplies.

PORTABLE BARGE
The Portable Barge is used when access is needed to an area within the waterbody where none of the above methods will work. It consists of hauling transportable pontoons to the vicinity by trailer and setting them into the water with a boom truck for assembly into a barge. Drills and support equipment are placed on the barge on moved into position for the drilling operation. The barge is held in place by four anchors.

For operations in deep water, a truck mounted drill is placed on a large barge rented. Tug boats are used to maneuver the barge.

CONE PENETROMETER TEST TRUCK
The Cone Penetrometer test truck is used to send sound waves into the ground to determine the density of material underground. It use an electronic instrumented cone assembly, hollow core sounding rods, a 20 ton hydraulic thrust frame, and a computer data acquisition/processing system to perform the analysis. This is a self-contained unit mounted on a truck. The system can be used from a barge for testing when there is deep soft sediment.

Appendix 3-E Geotechnical Field Investigation and Contaminated Drilling Waste Management Procedures

Requirements for handling, storage, and disposal of hazardous materials encountered during geotechnical drilling are provided at the following website:
www.wsdot.wa.gov/Environment/HazMat/Investigations.htm#Geotech

For convenience, the documents located at that website are provided below:

WSDOT GEOTECHNICAL FIELD INVESTIGATION AND CONTAMINATED DRILLING WASTE MANAGEMENT PROCEDURES

INTRODUCTION

This document has been produced as a guide for Washington State Department of Transportation (WSDOT) personnel involved in geotechnical exploration drilling where potential environmental contamination may be encountered. This guide provides simple procedures to support WSDOT personnel in planning for, storing, and disposing of potentially contaminated material generated during drilling activities. Information in this document will be incorporated into WSDOT manuals, such as the Design Manual (M 21-02), Geotechnical Design Manual (M 46-03), and the Environmental Manual (31-11) as appropriate.

A decision tree included below as Figure 1, illustrates a simplified step by step process to follow in preparing for and dealing with geotechnical drilling waste. The following sections will provide further explanation of the decisions associated with each step in the process.

SUSPECTED CONTAMINATION

As described in the WSDOT Geotechnical Design Manual (GDM), a geotechnical field exploration plan and an environmental assessment (per GDM, Chapter 3) is done prior to drilling activities. As part of this environmental assessment the WSDOT project engineer (PE) assigned to the project will:

- Review NEPA/SEPA environmental documentation prepared for the project, such as the Hazardous Materials Analysis, Technical Memorandums, or NEPA/SEPA checklists (i.e., Environmental Classification Summary). For more information regarding these reports, read Chapter 447 of the Environmental Manual and/or contact the Regional Environmental Office.

- If environmental documentation does not yet exist, the project PE shall coordinate with the WSDOT Regional Environmental Office to review environmental information on the Department of Ecology's (Ecology) Facility Site Atlas Database and conduct a field reconnaissance of the drilling site to identify recognized environmental conditions (as defined in ASTM E-1527).

- Identify known or suspected contamination on the geotechnical drilling crew's soil investigation checklist drilling work order request. Information will include a briefly describe the location and the type (e.g., petroleum, metals, or solvents) and concentrations (if known) of contaminates that may be encountered.

If the drilling activity is suspected to generate contaminated material, notify owners, operators, and facility managers of the site. Also, coordinate waste characterization sampling with a WSDOT Hazardous Material Specialist or an environmental consultant.

Encountering contamination is more likely when drilling at sites historically used for commercial or industrial purposes, however an environmental assessment can better evaluate the potential risks and determine if suspect contamination is on site and warrants special handling and disposal. If there is no reason to suspect contamination on the site, field screening during drilling activities is appropriate.

FIELD SCREENING, CONTAINMENT AND LABELING

During drilling activity, WSDOT personnel observe drilling activities and generated waste for indications that contamination may be present. Field screening observations include visible sheen, material coloration or staining, or odor.

If field screening indicates that contamination may be present, the material must be placed in labeled 55-gallon steel drums or other suitable containers for storage pending characterization and disposal. Containers must be in good condition and kept tightly closed to keep rain out and prevent spills.

Proper labeling includes a legible "Hazardous Materials/Analysis Pending" label that clearly identifies the project site, substance, boring location, boring depths and identification number(s), date and contact information. Labeling is extremely important to support sampling methods (as described below).

TEMPORARY 90 DAY STORAGE PENDING LAB RESULTS

Drums or other waste containers must be stored at a secure WSDOT facility or appropriate fixed facility under the control of WSDOT. Waste containers must be either isolated from the public, or stored in a location where the drums do not compromise worker or public safety. The WSDOT PE will determine the proper storage location in accordance with the following stipulations:

- All waste generated at a facility operating under a RCRA ID#[1] Dangerous Waste permit must be left on-site pending lab results. Arrangements must be coordinated with the RCRA site facility manager for specific storage and disposal requirements.
- Potentially contaminated drilling material generated at a secure/safe location (i.e., fixed facility under the control of WSDOT) will remain on-site where the drilling activities occur.
- Potentially contaminated drill cuttings generated from areas that are "not under the control of WSDOT" (i.e., left in unsecure or unsafe areas) may be transported to a temporary secured location for analysis and disposal within 90 days.

The preferred location for accumulating containers of potentially contaminated material is on-site where the drilling activities occur, but it may not always be safe or practical to do so. In these instances the containers may be transported to a nearby WSDOT maintenance facility with prior approval of the maintenance superintendent. It is the WSDOT Geotechnical Division's responsibility to ensure containers are in good condition, properly labeled, with lids tightly closed, stored in a safe orderly manner and disposed within 90 days,

[1]A RCRA ID number is issued by Ecology for facilities that generate, transport, transfer, recycle, treat, store, or dispose of certain quantities of dangerous waste, as defined in the Dangerous Waste Regulation WAC 173-303. The PE should ascertain from the property owner or facility manager if the proposed geotechnical drilling site has a RCRA ID#.

CONTAMINATION CHARACTERIZATION

The type and concentration of contamination must be identified through representative sampling methods to determine a proper disposal method.

If contamination is observed during drilling activities, or if the site has known contaminants a WSDOT Hazardous Materials Specialist or environmental consultant must sample waste material prior to disposal. The following WSDOT Hazardous Material Specialists who retain the necessary training, and are qualified to collect samples include:

- Jenifer Hill (360-570-6656),
- Trent Ensminger (360-570-2587)
- Marisol Novak (360-570-6696)

Labeling waste containers at the time of drilling is extremely important to manage sampling costs. Proper labeling, knowledge of the site history and the methods used to generate the waste can allow for a targeted sampling strategy with specific laboratory analysis. For example, proper labeling and a site boring plan can help determine whether to sample all containers or a select group of containers. It can also help determine whether to have the samples tested for one specific analysis (i.e., metals) rather than a complete list which significantly increase costs. Although the disposal facility dictates the lab analysis required prior to acceptance, often demonstrating knowledge of the site, previous lab data (if any) and the process that generated the waste can provide enough justification where the disposal facility will allow for limited sampling work (which is documented in a waste profile sheet required prior to disposal acceptance).

WASTE DESIGNATION AND DISPOSAL

The disposal method for waste generated during drilling activities is determined by the waste's designation and physical form. If the waste is in the form of a liquid or sludge, other disposal methods may be necessary. The regional WSDOT project PE, Geotechnical Field Manager, Hazardous Material Specialist, and Maintenance Facility Superintendent is responsible for complying with the laws that govern waste disposal.

Solid waste material can be designated by the following three categories:

Clean Soil

If contamination is not suspected and field screening did not indicate the presence of contamination or if laboratory testing results are below regulatory cleanup levels, the material may be considered clean soil. This designation may allow for disposal at the site of origin, or an appropriate WSDOT facility, in accordance the jurisdictional health department's solid waste regulations. If material will be placed at another location other than the site of origin, then approval shall be obtained from the site manager prior to delivery.

Solid Waste

If laboratory analysis indicates that concentrations of any contaminants of concern are greater than the appropriate regulatory cleanup level, but the laboratory results do not designate the material as dangerous waste per WAC 173-303, the material is considered Solid Waste. Solid waste which is not a liquid or sludge-like, may legally be disposed of in a permitted landfill or with one of the many permitted businesses that accept such waste. Regional offices are responsible for identifying and determining the acceptability of solid waste for disposal in their region.

The Department of Ecology (http://www.ecy.wa.gov/programs/swfa/facilities/ and http://www.ecy.wa.gov/programs/swfa/solidwastedata/) can provide updated information on permitted businesses, their location, fees, and restrictions.

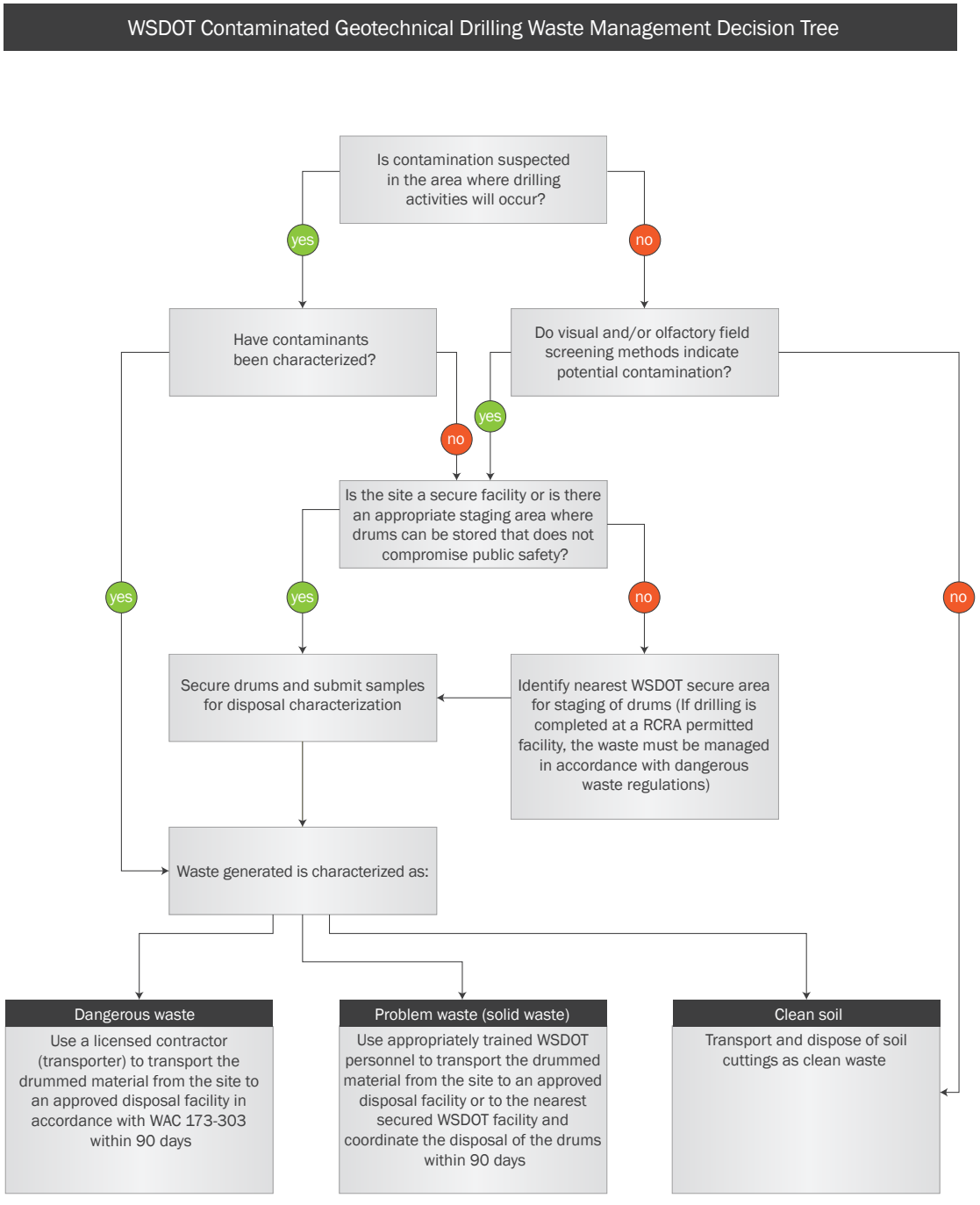
Dangerous Waste

It is highly unlikely that geotechnical drilling waste would ever designate as dangerous waster (per WAC173-303). However, if laboratory analysis indicates that waste designates as dangerous waste, disposal will be coordinated through a contractor that is licensed and permitted to handle, transport and dispose of dangerous waste. With the assistance of a WSDOT hazardous material specialist, regional offices must obtain a RCRA Site Identification Number using the Ecology Dangerous Waste Site Identification Form before offering dangerous waste for transport. A few exceptions are permitted for small quantity generators, as described in WAC 173-303-070(8). A separate identification number is necessary for each site from which dangerous waste is shipped. Because Ecology requires annual reports, limiting the number of storage sites for potentially dangerous sampling waste will reduce documentation required.

It is best to legally dispose contaminated drilling waste as soon as possible, but it must be disposed within 90 days. For Solid Waste and Dangerous Waste, copies of the following disposal documentation shall be retained by the generating facility for a minimum of 5 years:

1. waste profile sheets, and associated sampling reports,
2. waste authorization or other type of permit documenting a disposal facility's pre-approval for acceptance of material (if a facility requires such),
3. shipping manifest or bill of lading indicating the amount of material hauled to disposal, and bearing the disposal site operator's confirmation for receipt of the material.

Figure 1
Decision Tree


WSDOT Contaminated Geotechnical Drilling Waste Management Decision Tree
Is contamination suspected in the area where drilling activities will occur?
yes
no
Have contaminants been characterized?
Do visual and/or olfactory field screening methods indicate potential contamination?
yes
no
Is the site a secure facility or is there an appropriate staging area where drums can be stored that does not compromise public safety?
yes
yes
no
yes
no
Secure drums and submit samples for disposal characterization
Identify nearest WSDOT secure area for staging of drums (If drilling is completed at a RCRA permitted facility, the waste must be managed in accordance with dangerous waste regulations)
Waste generated is characterized as:
Dangerous waste
Use a licensed contractor (transporter) to transport the drummed material from the site to an approved disposal facility in accordance with WAC 173-303 within 90 days
Problem waste (solid waste)
Use appropriately trained WSDOT personnel to transport the drummed material from the site to an approved disposal facility or to the nearest secured WSDOT facility and coordinate the disposal of the drums within 90 days
Clean soil
Transport and dispose of soil cuttings as clean waste

Environmental Assessment Form for Geotechnical Drilling Activities

Project: (PE or design team leader to insert project name)
Location: (PE or design team leader to insert address, mile post or latitude and longitude)
Charge Number: (PE or design team leader to insert charge number)
Schedule for work: (PE or design team leader to insert timeline)
Environmental Coordinator: (PE or design team leader to insert name and phone number)
PE or Design Team Leader: (PE or design team leader to insert name and phone number)

Key Questions for PE or HQ WSDOT HazMat Specialist:

1) Have you reviewed and incorporated the "Contaminated Drilling Waste Management Procedures" published by the WSDOT Environmental Services Office on April 15, 2014? A copy of these procedures can be obtained by contacting Jenifer Hill at (360) 570-6656 or HillJen@wsdot.wa.gov.

2) Has NEPA/SEPA environmental documentation been prepared and reviewed for the project, such as Hazardous Materials Discipline Reports or Technical Memorandums, Phase I or II Environmental Site Assessments, or SEPA checklists (i.e., Environmental Classification Summary)?

3) If environmental documentation does not yet exist, has the project PE or the Design Team Leader coordinated with the WSDOT Regional Environmental Office to review environmental information on the Department of Ecology's (Ecology) Facility Site Atlas Database and conduct a field reconnaissance of the drilling site to identify recognized environmental conditions (RECs) (as defined in ASTM E-1527)?

4) Is the property used for a commercial or industrial use (and/or is the adjacent property used for commercial or industrial use?)?

5) If the property is a commercial or industrial, is it registered as a resource conservation and recovery act (RCRA) facility where hazardous wastes are produced, stored or are present within subsurface (i.e., contamination in soil or groundwater)?

Identify Known or Potential Contaminants of Concern: (PE or design team leader to insert potential contamination type(s) (e.g. petroleum, metals, or solvents) that may be encountered by the drilling crews during field work)
Areas of Concern at Drilling Site: (PE or design team leader to insert a description of areas where drilling may encounter contamination or where RECs have been observed)
Health and Safety Requirements: (PE or design team leader to insert personal protective equipment required and potentially needed for drilling activities if contamination is encountered)
Generated Waste Handling/Storage/Disposal: (PE or design team leader to insert project specific procedures for generated waste during drilling activities, refer to the "Contaminated Drilling Waste Management Procedures" for guidance)
Utilities Clearance Information: (PE or design team leader to insert 'One-call' and/or private locating information)

Environmental Coordinator: _____ Date:_____

PE or Design Team Leader: _____Date:_____