3. Potential Effects of the Project

How did WSDOT evaluate the project's potential effects on geology and soils?

The geology and soils analysts analyzed potential effects on geology and soils using information in available geotechnical reports, especially those provided by Landau Associates (2006; 2007a, b; 2009a, b, c, d, e). Analysts examined existing borings, test pits, and Ecology boring logs to understand the specific geology and soil conditions and identify potential effects on geology and soils. This section describes potential effects from construction and operation, identifies long-term effects, and compares differences in the effects of the alternatives.

The CTC casting basin facility in Tacoma is an operating industrial facility located in a large industrial park. WSDOT's proposed use of this site to build pontoons is consistent with its current industrial purpose and, therefore, would not produce significant, unavoidable effects on the geology and soils that would warrant analysis and/or mitigation measures. There would be no construction effects on the CTC facility site, because it is already fully operational. There also would be no long-term operational effects on geology and soils because the CTC site is situated in a heavily industrial location and the geology and soils would not be altered by the proposed use.

At Grays Harbor, WSDOT identified the project's potential effects by comparing the No Build Alternative with the two Grays Harbor build alternatives. Many of the effects at the two Grays Harbor build alternative sites would be similar due to their proximity and similar soil conditions. Differences are noted where applicable. The remainder of this section addresses only the Grays Harbor build alternatives.

> What are construction, operational, and long-term project effects and how are they measured?
>
> Effects describe how the project would directly affect the built or natural environment.
>
> Construction effects are effects that would occur while the new casting basin, ancillary and pontoon moorage facilities, and any mitigation features are built.
>
> Operational effects are effects that would occur when the pontoons are being built at the new casting basin facility in Grays Harbor and at the CTC facility in Tacoma.
>
> Long-term effects are effects that would remain after pontoon production is complete, effects of mooring pontoons over an indefinite period of time, and effects associated with mitigation features expected to remain after completion of the project.

How would construction of the casting basin temporarily affect geology and soils?

The most likely method of construction for the casting basin facility would be to dewater the site, excavate the basin, and construct temporary side slopes. An alternative construction method to be considered during design is to construct soil/cement temporary basin walls and floor by jet-grouting or deep soil mixing.

Temporary effects on geology and soils could result from several activities during construction of the casting basin and launch channel. These activities include erosion from soil movement, construction of temporary side slopes, temporary

dewatering, foundation construction, ground improvement, and slurry wall and mixed soil wall construction. The following subsections discuss potential effects of these construction activities at each alternative site.

Erosion from Soil Movement

Anderson & Middleton Alternative

Moving soil from one location to another requires operation of heavy machinery such as bulldozers, excavators, compactors, trucks, and dredge machines. Moving soil during construction would have a relatively low chance of producing much dust or erosion, because recent erosion and sedimentation control standards require extensive protective measures.

Aberdeen Log Yard Alternative

The effects of soil movement during construction at this site would be similar to those at the Anderson & Middleton Alternative site.

Temporary Side Slopes

Anderson & Middleton Alternative

Excavation of the casting basin facility would likely involve use of temporary construction side slopes. Constructing the slope too steeply or without sufficient dewatering could cause the slopes to become unstable. The slopes would be designed to withstand potentially destabilizing forces using WSDOT and American Association of State Highway and Transportation Officials (AASHTO) standard factors of safety for temporary slopes. Temporary shoring may also be used to maintain the stability of temporary side slopes under certain conditions.

Aberdeen Log Yard Alternative

The effects of temporary side slopes would be similar to those at the Anderson & Middleton Alternative site.

Construction Dewatering

Anderson & Middleton Alternative

To safely excavate the casting basin in dry conditions, WSDOT would dewater the site by pumping groundwater from a number of shallow and deep wells. Disposal of the dewatering flow is discussed in Section 4 of this technical memorandum. The groundwater elevation would be significantly lowered in the site and would thereby cause a lowering of the groundwater table beyond the site boundaries. Pumping from the dewatering system would begin approximately 2 to 4 months prior to the start of excavation and would discharge large quantities of water. If WSDOT selects the alternative construction method of constructing soil/cement temporary basin walls and floor by jet grouting or deep soil mixing, then additional construction measures may be needed to reduce groundwater flow.

The lowering of the groundwater table could potentially cause settlement within and outside the site boundaries. Settlement could potentially occur at nearby residential and commercial

structures. An analysis performed at the adjacent IDD #1 site with similar soils estimated several inches of settlement due to dewatering (Landau 2009c).

Dewatering has the potential to alter groundwater contaminant migration pathways and draw contaminants from offsite properties into the study area, requiring that dewatering water be monitored and treated before discharge into Grays Harbor.

Dewatering would occur throughout the life of the casting basin facility. The effects of operation dewatering are discussed in a later section.

Aberdeen Log Yard Alternative

For this alternative, dewatering would be required to maintain the stability of the excavation and construction of the facility. Soil Units 1 and 2 contain relatively low permeability silt such that the use of conventional dewatering methods may not be feasible or cost effective (Landau 2009e). If a dewatering system is not used, it could cause groundwater pressure and seepage forces into the excavation sides and up the base of the excavation, which would affect stability of construction slopes and the excavation bottom.

Offsite groundwater drawdown or alteration of contaminant migration pathways should be expected at this site similarly to the Anderson and Middleton site. Settlement is expected onsite and potentially offsite due to groundwater drawdown which could potentially impact nearby structures. Analysis is currently being performed to determine the extents of the dewatering effects.

Depending on the final design of the casting basin, dewatering may continue throughout the life of the facility. Operation dewatering effects are discussed in a later section.

Foundation Construction

Anderson & Middleton Alternative

The casting basin floor and walls would be constructed of pile-supported, reinforced concrete. In the most likely facility design, a vibratory hammer would drive approximately 2,500 hollow steel piles that would be filled with concrete after they are driven. An impact hammer would be used to complete the driving of each pile installation, thereby confirming its capacity. The vibratory hammer is quicker and less noisy than other pile installation methods; however, vibration and noise will result when the piles are driven into the dense or very dense soils. Although no soil cuttings are created by pile-driving, noise and vibration are often objectionable.

A hydrogen sulfide odor and methane gas were present in some of the test pits at an adjacent property (IDD #1) to the east of the site, probably due to decomposition of the wood debris in the upper fill material. Similar conditions exist at the Anderson & Middleton site, and the presence of the hydrogen sulfide odor and methane gas should be expected when excavating for the casting basin.

Aberdeen Log Yard Alternative

The effects of foundation construction at this site would be similar to those at the Anderson & Middleton site, although other foundation alternatives may be considered such as drilled shafts and mat foundations.

A drilled shaft foundation is typically 5- to 10-foot-diameter cast-in place foundation. A slurry mixed is used during drilling to keep the hole open before placing the reinforcing steel and concrete, although steel casing is sometimes used if the slurry mix is not sufficient in keeping the hole from collapsing. Construction of the drilled shafts could produce high pH spoils.

The mat foundation is an at-grade concrete slab that would support the casting basin facility. The compressibility of the upper soils could result in excessive settlement

The effects of foundation construction at this site would be similar to those at the Anderson & Middleton site. Because of the abundance of wood waste at this site, the potential for methane and hydrogen sulfide in the excavations would be higher than at the Anderson & Middleton site. During exploration, a floating petroleum product was observed in one of the borings. The release of these gases and liquids could potentially be hazardous to construction workers during excavation.

Ground Improvement

Anderson & Middleton Alternative

Ground improvement is being considered at the casting basin sites to strengthen the soil and thus minimize or avoid liquefaction and settlement. Common ground improvement methods are stone columns, jet grouting, and soil mixing.

Construction of these ground improvement elements may create high-pH spoils. These spoils could be stored onsite until the pH is low enough to allow the spoils to be exported.

Aberdeen Log Yard Alternative

The temporary construction effects of ground improvement would be similar to those at Anderson & Middleton Alternative site.

Material Export or Import

The existing fill material in the upper soil layer at both Grays Harbor build alternative sites is probably not suitable for structural fill. Construction of access roads, parking areas, laydown areas, and other facilities would require imported structural fill to replace or cover the top 18 to 48 inches of existing surface material. The project would import material for backfill behind the casting basin walls, drainage layer material, rock quarry riprap for the berm and launch channel, and aggregate for pontoon construction. The project would export material excavated from the casting basin and dredged from the launch channel to locations off the site.

Exhibit 17 presents estimated quantities of exported and imported materials at the Grays Harbor build alternative sites. The table also includes material to be dredged and transported offsite for construction of the in-water portion of the launch channel. The estimated quantities of dredge material are 23,000 cubic yards at the Anderson & Middleton site and 111,200 cubic yards at the Aberdeen Log Yard site. The launch channel at the Anderson & Middleton site would not be as long as at the Aberdeen Log Yard site, thus requiring less dredging and offsite transport of material.

EXHIBIT 17
Estimated Export, Import, and Dredging Material Quantities for Grays Harbor Build Alternative Sites

Material	Anderson & Middleton	Aberdeen Log Yard
Exported Materials[a,b]	740,000	887,000
Imported Materials[a]	450,000	550,000
Dredged Materials[a]	23,000	111,200

[a] Rounded to nearest 1,000 cubic yards.

[b] Does not include exporting of dredged material.

Source: WSDOT (2009a).

WSDOT would specify that excavated soil or stockpiles of imported material be placed at a specified distance from the perimeter walls of the proposed casting basin and buried utilities to avoid inducing slope instability or settlement that could damage the walls or utilities. Also, materials would not be stockpiled near the site boundaries to avoid affecting adjacent structures or the stability of the slopes along the water bodies.

How would pontoon-building operations affect geology and soils?

Maintenance activities would be necessary for the in-water portion of the launch channel throughout project operation. Underwater currents and other natural processes would deposit soil in the dredged portion of the launch channel and would occasionally need to be removed by dredging. The dredged materials from the launch channel would be removed to an approved disposal site. The dredging activities at the Aberdeen Log Yard would be more extensive and longer in duration than at the Anderson & Middleton site as the launch channel at Aberdeen Log Yard is significantly larger.

Launch-channel maintenance dredging would be the only project activity, other than the activities that cause effects during construction and continue through the long term, that affects geology and soils during operation. The continuing construction effects would be replacement of surface material, slope stability effects, liquefaction hazard, ground settlement, and groundwater flow or elevation changes.

How would the project affect geology and soils in the long term?

Long-term effects on geology and soils that remain after completion of the project would generally result from the following permanent features of the build alternatives:

- Project site development would result in different compressive forces on the geology and soils as areas are excavated and groundwater lowered.
- The project would result in loss of soil layers as materials are removed to accommodate project elements (such as the casting basin) or as soils are removed or replaced to improve performance of project elements.

The project's long-term effects are discussed in the following paragraphs under the topics of topographic changes, replacement of surface material, slope stability, liquefaction hazard, ground settlement, and groundwater flow or elevation changes.

Topographic Changes

Anderson & Middleton Alternative

The project would make permanent topographic changes at the Anderson & Middleton site by altering the existing berm to accommodate a launch channel, increasing the height of the berm, constructing a launch channel that extends from the casting basin facility to a specified distance offshore, and excavating a large casting basin facility. Potential effects of these changes are discussed under Slope Stability, below. The surface topography will potentially be raised approximately 1 to 2 feet to obtain a flat surface for construction of the casting basin facility.

Aberdeen Log Yard Alternative

The project would make permanent topographic changes at the Aberdeen Log Yard site similar to those at the Anderson & Middleton site, except that improvements to the berm at the Aberdeen Log Yard will not need to be as extensive because the location of the site provides more protection from wave action. Also, the launch channel is significantly longer at the Aberdeen Log Yard, requiring more ground surface modification than at the Anderson & Middleton Site.

Replacement of Surface Material

Anderson & Middleton Alternative

Permanent replacement of the surface materials would occur during site preparation activities. These activities would include construction of support access roads, parking areas, staging areas, and other related facilities. To support equipment and laydown areas, structural fill and a well-graded angular sand and gravel mixture would replace the top 18 to 24 inches of existing fill. Areas supporting haul roads may need a thicker fill section. The addition of the structural fill could potentially cause settlement across the site (see Ground Settlement, below).

Aberdeen Log Yard Alternative

Site preparation at the Aberdeen Log Yard site would be similar to that at the Anderson & Middleton site. Because past use of the site was more intensive than at the Anderson & Middleton site, there may be more removal of log waste, building slabs, protruding pilings, and buried logs than at Anderson & Middleton.

Slope Stability

Anderson & Middleton Alternative

Although the site is relatively flat, excavation of the pontoon launch channel would create permanent armored slopes along the berm and launch channel. These slopes would be subject to destabilizing forces that could cause the slopes to fail. The casting basin walls would also be subject to forces with the potential to cause slope stability problems. However, the slopes and walls would be designed and constructed to withstand potentially destabilizing forces, so that the potential for slope stability problems is small.

Aberdeen Log Yard Alternative

This site would have slopes and earth retaining structures similar to those at the Anderson & Middleton site.

Liquefaction Hazard Areas

Anderson & Middleton Alternative

At the Anderson & Middleton site, liquefiable soil layers occur in Soil Unit 2A and partially in Soil Units 1 and 2B. Geology and soils analysts estimate total settlement due to liquefaction at the site without mitigation at up to 2 feet during a 475-year earthquake, and possibly more during the design 975-year earthquake. Liquefaction could also potentially result in lateral spreading. At the adjacent IDD #1 site, analysts estimated lateral liquefaction to be 15 to 30 inches and lateral spreading to range from 2 feet at the northern boundary up to 18 feet at the berm location (Landau 2009c). Similar liquefaction and lateral spreading effects would be expected at the Anderson & Middleton site. Liquefaction and lateral spreading would have an adverse effect on the casting basin walls and foundation. Even though the Anderson & Middleton site would undergo operation dewatering, liquefaction during an earthquake could still occur because sediments below the casting basin and outside the cone of dewatering would remain saturated. Liquefaction mitigation measures are discussed in Section 4.

Aberdeen Log Yard Alternative

The Aberdeen Log Yard site is susceptible to liquefaction and lateral spreading. Studies are currently ongoing to determine the extent and magnitude of these seismic hazards. Liquefaction and lateral spreading effects to the casting basin walls and foundation would be similar to those at the Anderson & Middleton site.

Ground Settlement

Anderson & Middleton Alternative

Several project features could cause long-term soil settlement unless minimized by the project design. Increasing the effective weight of soils by dewatering, backfilling behind the perimeter walls of the casting basin with soils that are heavier than the existing soils, and adding structural fill and all-weather surfacing layers across the site for laydown and access could cause settlement of several inches to feet (Landau 2009c). Settlement of this magnitude is unacceptable because it would probably not be uniform and would therefore damage buried pipes containing utilities and create an unusable working surface.

In addition, long-term settlement could potentially be experienced at nearby residential and commercial structures due to site preparation activities. Settlement would also result from the compression or recompression of Soil Units 1 through 3. Finally, settlement could cause additional down-drag loads on the pile foundations for the casting basin.

> What is down-drag load?
>
> A down-drag load occurs when soil around a deep foundation settles, causing the soil to exert extra downward force on the foundation.

Typical engineering solutions to minimize long-term settlement include the following:

- Preloading the soil so that most of the anticipated long-term settlement occurs prior to construction
- Installing vertical drains before final grading and utility placement so that the predicted settlements occur quickly; this could potentially be done in combination with preloading
- Strengthening the ground by installing soil cement columns, stone columns, or grout columns to minimize the total settlement over any time period
- Reducing the weight behind the casting basin walls (for example, by using closed-cell polystyrene blocks or light-weight concrete behind the casting basin walls so that minimal settlement is induced)

The design would consider groundwater flow conditions, foundation support of the casting basin, and construction scheduling in order to implement the proper solution for minimizing settlement.

Aberdeen Log Yard Alternative

The effects of settlement at the Aberdeen Log Yard site would be similar to that of the Anderson & Middleton site except that the nearby areas are more densely developed, putting more industrial structures in the zone of dewatering influence. At the adjacent wastewater treatment plant, 5 feet of fill was placed during construction, which caused an estimated 14 to 16 inches of settlement with several more inches of settlement occurring the following 10 to 20 years (Shannon and Wilson 2001).

There has been more past development at this site than at the Anderson & Middleton site, so there is a higher potential for existing buried piles, slabs, tanks, and previously consolidated

soil that would cause more differential settlement under the facility loads. It would be difficult or impossible to predict where this differential settlement would occur, so operation of the facility will include contingencies for frequent regrading and repair of buried utilities.

Organic materials may decay and compress for years or even decades. Because of the higher volume of wood waste present at this site, as well as high organic matter content within the soil, settlement may occur over a longer period than at the Anderson & Middleton site.

Groundwater Flow or Elevation Changes

Anderson & Middleton Alternative

The proposed casting basin design would use permanent dewatering to minimize buoyant forces on the casting basin facility. A permanent dewatering system would likely consist of a drainage layer around and under the basin, connected to a series of vertical drains that extend to an elevation of about –32 feet MLLW or to the top of Soil Unit 2 (see Exhibit 11), whichever is deeper.

If not mitigated or accounted for in design, the effects of dewatering would likely extend offsite, causing potential ground settlement at nearby residential and commercial structures. Further geotechnical investigations will be required in order to identify appropriate and reasonable mitigation measures. Most of the settlement would occur during temporary construction dewatering as discussed in the section titled *How would project construction temporarily affect geology and soils?* The Water Resources Technical Memorandum (WSDOT 2009b), Appendix T in the Draft EIS, provides more information about groundwater.

Aberdeen Log Yard Alternative

Due to the presence of low permeable upper soil, a dewatering design similar to the one used at the Anderson & Middleton site would be costly and may not be feasible (Landau 2009c). Effects of operation dewatering and appropriate mitigation would be similar to that at the Anderson & Middleton site.

Potential Uplift

Anderson & Middleton Alternative

Operation dewatering would keep the groundwater at a manageable level for the foundational piles supporting the casting basin. If the operation dewatering were to fail, the potential of an uplift force on the piles and casting basin caused by a high groundwater table could cause significant structural damage to the casting basin facility unless contingency plans were in place to flood the basin when the project is complete. An alternative basin support system could be designed for the piles and basin floor and walls that would withstand partial or full uplift.

Aberdeen Log Yard Alternative

The potential for uplift would be similar to that at the Anderson & Middleton site.

How would the alternatives compare in their effects on geology and soils?

This section describes differences in project effects by comparing the effects of the No Build Alternative to the effects of the build alternatives, then comparing the effects of the two Grays Harbor build alternatives.

No Build Alternative

The main difference between the No Build Alternative and the build alternatives is that, with the No Build Alternative, the sites would not be developed and thus would not be affected by project construction and development. However, no improvements would be made at the alternative sites. This could have the following effects on the sites.

Seismic Vulnerability

The No Build Alternative would leave the Anderson & Middleton site soils vulnerable to liquefaction during a seismic event. If liquefaction were to occur, the existing armored shoreline could move into Grays Harbor. Sand boils and other surface disturbance that could have temporary effects on surface water quality could also occur.

> What are sand boils?
>
> A sand boil is sand and water that come out onto the ground surface during an earthquake typically caused by liquefaction at shallow depths (USGS 2009). The sand appears to be "boiling," hence the name.

Seismic vulnerability at the Aberdeen Log Yard site would be similar to that at the Anderson & Middleton site.

Berm Improvement

The existing berm at the Anderson & Middleton site serves as an armored shoreline, and the berm at the Aberdeen Log Yard site is primarily used to control storm water runoff. With the No Build Alternative, the height of existing berms at the Anderson & Middleton and Aberdeen Log Yard sites would not be increased and eroded sections would not be repaired. Without the project improvements, the berms would continue to be susceptible to increased erosion and possible inundation from large storms.

Grays Harbor Build Alternatives

Exhibit 18 provides a summary of differences between the two build alternatives (see the Effects sections above for details).

EXHIBIT 18
Geology and Soils Summary of Effects

Type of Effect	Anderson & Middleton Site	Aberdeen Log Yard Site
Casting basin construction	Casting basin excavation volume: 740,000 cubic yards	Casting basin excavation volume: 887,000 cubic yards
	Launch channel excavation volume: 100,000 cubic yards (onshore) and 23,000 cubic yards (offshore)	Launch channel excavation volume: 112,000 cubic yards (onshore) and 111,200 cubic yards (offshore)
	Imported material volume: 450,000 cubic yards	Imported material volume: 550,000 cubic yards
	Potential for offsite soil settlement due to construction dewatering	Potential for offsite soil settlement due to construction dewatering, but slightly lower than with the Anderson & Middleton Alternative
Pontoon-building operation	Periodic launch channel dredging; volumes unknown at this time	Periodic launch channel dredging; volumes unknown at this time
Long-term	Potential for soil settlement as a result of dewatering activities and site filling on offsite facilities is low	Potential for soil settlement as a result of dewatering activities and site filling on offsite facilities is low.
	Potential for liquefaction and lateral spreading during a large earthquake	Potential for liquefaction and lateral spreading during a large earthquake
	Potential for long-term contaminant migration toward the permanent dewatering system requiring long-term water treatment is low	Potential for long-term contaminant migration toward the permanent dewatering system requiring long-term water treatment is low
Pontoon moorage	Sediment scouring or buildup beneath moored pontoons could occur but should be negligible	Sediment scouring or buildup beneath moored pontoons could occur but should be negligible
Unavoidable adverse[a]	None	None

[a] Unavoidable adverse effects are effects that remain after avoidance and minimization measures are applied.

4. Mitigation

What measures would WSDOT propose to reduce negative project effects?

This section discusses methods and practices that WSDOT could incorporate into the project to best avoid or minimize negative effects. Proposed avoidance and minimization measures are discussed below for erosion and sedimentation control, slope stability, disposal of dewatering flow, ground settlement, and stabilization in liquefaction hazard areas.

Erosion and Sedimentation Control

Anderson & Middleton Alternative

WSDOT could reduce erosion and sedimentation resulting from project construction by implementing erosion and sedimentation control practices to achieve water quality standards

and applying, at a minimum, best management practices (BMPs) as dictated by guidelines issued by Ecology, WSDOT, and the designers. BMPs could include the following:

- Install quarry spalls and possibly truck washes where construction vehicles would exit from the site
- Require regular sweeping and washing of adjacent roadways
- Require silt fences downslope of all exposed soil
- Construct quarry spall-lined temporary ditches, with periodic straw bales or other sediment catchment dams
- Require temporary covers over soil stockpiles and exposed soil
- Construct temporary sedimentation ponds for removal of solids prone to settling prior to discharge
- Place limits on the area exposed to runoff at any given time

WSDOT and local agency personnel may monitor compliance with the above-listed requirements and may use monetary fines and withholding of progress payments as enforcement tools.

There may also be requirements for no visible dust. Frequent construction-site watering or other dust-mitigation alternative would meet this requirement.

Aberdeen Log Yard Alternative

Erosion and sedimentation control mitigation efforts at this site would be similar to those at the Anderson & Middleton site.

Slope Stability

Anderson & Middleton Alternative

The potential for destabilizing slopes and earth retaining structures can be mitigated through the use of proper design and construction. The design of slopes and earth-retaining structures (both temporary and permanent) would include standard factors of safety against movement during construction, long-term static conditions, and long-term seismic conditions. To enable the launch channel, berm slopes, and earth retaining structures to withstand potentially destabilizing forces, the design would use WSDOT and AASHTO standard factors of safety (FS) for both global static (minimum FS = 1.5) and seismic (minimum FS = 1.0 to 1.1 or limited earthquake-induced deformations) conditions.

To further ensure stability, a layer of quarry rock riprap placed along the entire length of the berm just above where the existing riprap meets the beach/mudflats would armor the toe of the slope against wave action. Quarry riprap would line the launch channel.

Aberdeen Log Yard Alternative

Slope stability mitigation efforts at this site would be similar to those at the Anderson & Middleton site.

Disposal of Dewatering Flow

Anderson & Middleton Alternative

For water handling during project construction and operation, water quality must meet the state's water quality standards. Fueling areas may require covers and spill containment features. Groundwater and stormwater runoff would be kept separate from process water. Turbidity and pH would be monitored and the system designed to allow temporary water storage and treatment if necessary.

Aberdeen Log Yard Alternative

Dewatering flow mitigation efforts at this site would be similar to those at the Anderson & Middleton site.

Ground Settlement

Anderson & Middleton Alternative

WSDOT would conduct further geotechnical investigations to refine settlement estimates and to identify appropriate and reasonable mitigation measures. If potential settlements caused by project construction and operation could damage pipes, structures, or rail lines, WSDOT could take one or more of the following measures:

- Prepare plans for repair or reconstruction, mobilize repair or reconstruction materials to the site, monitor settlement, and be prepared to repair damage if it occurs
- Reduce the settlement-inducing drawdown in the areas of concern by constructing temporary or permanent groundwater cutoff walls
- Re-inject groundwater locally near the facilities of concern so that compressible soils are not dewatered
- Underpin sensitive structures
- Relocate the facilities over ground that has been improved to be less compressible
- Design an alternative that does not require as much dewatering as the current plan

Aberdeen Log Yard Alternative

Ground settlement mitigation efforts for this site would be similar to those at the Anderson & Middleton site. A monitoring program could be implemented to verify that settlements near adjacent facilities are not approaching potentially damaging levels; if such monitoring suggested that settlement could become damaging, alternative construction methods and best management practices would be considered and implemented as appropriate.

Stabilization in Liquefaction Hazard Areas

Anderson & Middleton Alternative

Ground improvement could mitigate the effects of liquefaction and lateral spreading at the site. Examples of typical methods of ground improvement include the following:

- 3-foot-diameter stone columns of compacted gravel placed every 7 to 15 feet
- Grouted columns of cement and soil that range in diameter from 2 to 3 feet

The zone of improvement extends vertically from the ground surface to the limits of liquefiable soil, which at the Anderson & Middleton site could be 80 feet or more. WSDOT would make improvements for liquefaction only around important structures and expensive utilities. In the case of a seismic event, liquefaction-induced settlement would occur around the protected structures, and sandboils and lateral spreading would occur away from the structures.

Aberdeen Log Yard Alternative

Liquefaction mitigation efforts for this site would be similar to those at the Anderson & Middleton site.

How could WSDOT compensate for unavoidable negative effects?

Excavation and import of materials, as well as dredging and transport of dredge spoils, would be unavoidable effects of the project. These unavoidable effects have an insignificant effect on the geology and soils resource, so no compensation would be necessary. Other effects such as settlement, slope stability, and erosion control can be limited or eliminated through the use of mitigation and proper design and construction techniques.

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