PORT OF PORTLAND

MEMORANDUM

To: Eric Swanson, City of Gladstone
Jim Whynot, City of Gladstone

From: Port of Portland

Date: Feruary 26, 2016

Re: Dahl Beach – Bulkhead Mitigation Project: Updated Technical Information and Basis for the Concept Design, Including Redesigned the Parking Lot Area Project Footprint

1. INTRODUCTION

This memorandum summarizes the revised (30%) concept design for the Port of Portland's Dahl Beach – Bulkhead Mitigation Project (henceforth the Dahl Beach Mitigation Project) and the technical considerations that informed the development of the design.

The initial Project concept was documented in memorandum to the City of Gladstone dated October 30, 2015. The initial concept design was developed in coordination with Gladstone City staff and council. However, members of the public and fishing organizations raised concerns on the Parking Lot Area concept based on impacts to fishing access. The fishing organizations, members of the public, and Oregon Department of Fish and Wildlife requested the City and Port modify the design to preserve access for individuals with mobility limitations by removing the upstream portion of the parking lot instead of the downstream portion. Based on these concerns, the Port redesigned the Parking Lot Area project footprint.

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The purpose of this memorandum is to provide the City of Gladstone with details on the Dahl Beach Mitigation Project technical studies, surveys, engineering factors, restoration goals, and other information that supported the design process. The memorandum summarizes the technical background for the overall design, including the redesigned the Parking Lot Area footprint and other design details that have been refined based on new information and input received after the October 30, 2015 memorandum. In addition to the technical studies and input from the public, the overall design and recent design refinements also incorporated input from the City and federal agencies, and considered public safety factors.

The 30% design level represents a refined concept based on the technical studies with suitable detail for review and permitting. The project team gathered Project area-specific data and information from various sources for the project design process. The background information and technical studies are included in the appendices as follows:

- Historical aerial photography – Cascade Environmental Group, LLC (Appendix A)
- Geotechnical report – Hart Crowser, Inc. (Appendix B)
- Level 1 sediment evaluation – Anchor QEA, LLC (Appendix C)
- Reference site memorandum – Cascade Environmental Group, LLC (Appendix D)
- Draft geomorphic report – Waterways Consulting, Inc. (Appendix F)

In addition to these studies, topographic and bathymetric surveys were conducted to provide current land and river channel elevations within the Project area.

2. THE MITIGATION PROJECT SITE

The Project includes restoration activities at the Project site on City property, which consists of the Parking Lot Area located within Dahl Beach Park and the Bulkhead Removal Area located in Meldrum Bar Park (Figure 1).

2.1 Parking Lot Area

The Parking Lot Area is an asphalt parking lot with riprap armoring located at the confluence of the Willamette and Clackamas Rivers. Site restoration would include removing approximately 53% of the existing parking lot and removing the existing asphalt, concrete, and riprap below ordinary high water (OHW) and in the riparian area. After removing the imported material, the area will be graded and native vegetation will be established (Figures 2a and 2b). The concrete and associated riprap armoring would be recycled or repurposed outside of the river channel and floodplain; typical shoreline contours would be restored, and native trees and shrubs would be established. This will result in approximately 0.28 acre of active channel margin (ACM) habitat and 0. 03 acre of riparian habitat in an area currently covered by an asphalt parking lot, concrete, and riprap.

2.2 The Bulkhead Removal Area

The Bulkhead Removal Area is located on the bank and within the channel of the Willamette River, approximately 700 feet downstream of the Parking Lot Area, and includes a failing sheetpile bulkhead and eroding riverbank. The bulkhead was constructed sometime in the 1950s, fell out of use, and ultimately failed in the early 2000s, apparently due to the undermining of the sheetpiles from the Willamette River channel degradation and erosion. The bulkhead area, which spans low to high flow elevations, creates localized bank erosion and degraded channel habitat conditions. Site restoration would include removing the existing failed bulkhead structure, including all riprap and sheetpiles, grading the riverbank to a stable gradient at the bulkhead and adjacent bank areas, and restoring native vegetation. These actions will result in restoration of approximately 0.25 acre of ACM and shallow water habitat and 0.22 acre of riparian habitat (Figures 2a and 2b).

2.3 Actions Outside the Two Restoration Areas

Two additional actions will be implemented outside the Parking Lot and Bulkhead Removal areas as components of the overall plan. A stormwater facility will be constructed at the Parking Lot Area to intercept runoff and provide treatment from the parking areas located upslope. Additionally, sand, gravel, and cobbles will be applied to the existing riprap that protects the portion of the parking lot that will be retained, adjacent to the Parking Lot Area of the Project. The sand, gravel, and cobble will fill interstitial spaces of the riprap, decreasing the opportunities for use by predatory fish.

3. BENEFITS OF MITIGATION

The Project would provide the following ecological benefits:

- Mitigation would be provided in the tidally influenced Lower Willamette River, near the confluence of the Clackamas and Willamette Rivers, an important location for aquatic organisms, including ESA-listed salmonids.
- Mitigation includes restoration of the river's active channel margin (ACM), shallow water, and riparian habitat at two work areas, for a combined total of 0.78 acre.
- Mitigation includes restoration of 0.53 acre of ACM (and some shallow water) habitat by removal of hardened bank (concrete, asphalt, riprap, and sheetpile) and 0.25 acre in the riparian area.
- The combined mitigation would include restoration activities that would occur between elevations of approximately -4 to +42 feet NAVD88 (Figures 3a and 3b), overlapping with elevations of the impact site, and significant restoration activities would occur below OHW in the ACM.

The Project compliments the City's other nearby restoration efforts, including the Rinearson Natural Area Portland Harbor Superfund Natural Resource Damages Assessment (NRDA) restoration project and the Clackamas Basin River Council's Clackamas Confluence Restoration Project funded by Oregon Watershed Enhancement Board. Providing additional restoration in the vicinity of these projects expands on the benefits of all the projects.

4. PROJECT SITE—BASELINE CONDITIONS

4.1 Location

The Project is located along the northeast bank of the confluence of the Clackamas and Willamette Rivers (near Willamette river mile 25) in the City of Gladstone, Oregon, within Section 19 in Township 2 South, Range 2 East (Figure 1). It consists of two work areas located on adjacent city-owned parks: the Parking Lot Area at the Dahl Beach Park (0. 31 acre) and the Bulkhead Removal Area (0.47 acre) at Meldrum Bar Park, located approximately 700 feet downstream.

The Project site is bounded on the north by Dahl Park Road and a golf course, on the south by the Willamette and Clackamas Rivers, and on the east and west by City park land and beach (Figure 4).

4.2 Topography

Elevations within the Project boundaries range from approximately the ordinary low water (OLW), which varies to +42 feet NAVD88. Topography at the Parking Lot Area is nearly level and situated on a riprap-

reinforced terrace between a gently sloping lower beach and upper riverbank; the Bulkhead Removal Area includes steeply sloped beach (60 to 80% grade) and an approximately 40-foot-high eroding riverbank with areas of nearly vertical slopes.

4.3 Land Use—Historical and Current

Prior to settlement, it is assumed that the Project site functioned as part of the ACM and riparian area of two major rivers and provided habitat for salmonid species as well as other fish and wildlife. Pre-settlement vegetation maps obtained from the Bureau of Land Management General Land Office depict the Project site as covered in closed canopy wetland and riparian forest featuring a mix of deciduous trees and shrubs with small quantities of conifers.

Land use and conditions at the Project site have changed significantly over time as the metropolitan area has developed, including along the Willamette River shoreline. Historical aerial photographs (University of Oregon 2015; Appendix A) dating from 1936 to the present were reviewed to assess site land use alterations and history.

Inspection of the historical aerial photographs indicates that the area surrounding the Project site was largely in agricultural cultivation from 1936 to 1980. The condition of the beach and banks within the Project site fluctuates through the years due to the dynamic nature of the Willamette River channel. The quantity and type of riparian vegetation cover also changes over time. By 1980, the Project site's use as a recreational area is evident. The Project site looks mostly unchanged since the 1998 aerial photo, other than the failure of the sheetpile bulkhead.

The sheetpile bulkhead appears to have been constructed in the early 1950s for a log ship loading facility that was in operation from the early 1950s to the early 1970s. During the winter of 2005/2006, the riverbank destabilized, a slope failure occurred, and a large portion of the bulkhead metal structure fell into the river channel. The slope failure likely occurred due to the metal structure becoming undermined as a result of Willamette River bed degradation and resulting erosion. The Willamette River bed began degrading in the 1950s as a result of upstream damming and gravel mining, which reduced bedload and lowered channel elevations. Since the initial failure, the structure has continued to degrade and the riverbank has continued to erode. The bulkhead and bulkhead appurtenances currently protrude from the water and the eroding riverbank with thick wire cables, riprap, and large metal anchors present along the eroding riverbank.

Development of the Dahl Beach Park parking lots (clearing and/or grading) appears to have begun by 1980. By 1990, the parking lots are in use, and by 1998, the lots have been paved and appear much as they do currently. The Project site is zoned by the City as Open Space (OS).

An underground utility locate found no underground utilities other than the NW Natural high-pressure gas transmission line just east-southeast of the Bulkhead Removal Area.

4.4 Hydrology and Soils

Hydrology at the Project site is driven almost entirely by the Willamette River, and hydrology at the Project site is subject to dynamic fluvial processes of flooding, channel deposition, and bank scour from high velocity flows.

The OHW for the Project site was delineated based on Willamette River gauge data collected at sites upstream (#14207770 Oregon City) and downstream (#14211720 Portland) of the Project site and adjusted to account for the Project site location relative to the gauges. The OHW was determined to be +25.4 feet NAVD88 based on a 2-year return interval, though seasonal and tidal influences cause fluctuations (sometimes dramatic) in water level within the site diurnally and throughout the year. Field indicators of OHW, such as scour and drift lines and the transition from gravel/cobble beach to vegetated bank, occur at elevations that vary between +20 to 26 feet, corroborating the flow data. Due to the primary influence of the Willamette River on site hydraulics, the OHW elevation of +25.4 feet was applied for this plan. OLW levels have not been established; however, at the #14207770 Oregon City gauge on October 5, 2015, low water levels were at approximately +5.7 NAVD88 (+2.2 feet NGVD29).

Soil survey maps produced by the Natural Resource Conservation Service Web Soil Survey for Clackamas County shows Camas gravelly sandy loam occurring over the upper elevations of the bulkhead removal area and the remainder of the project site as Riverwash. Camas gravelly sandy loam consists of very deep, excessively drained soils formed in mixed sandy and gravelly alluvium occurring on floodplains with slopes of 0 to 5% at elevations of 50 to 3,000 feet. This series is rated as predominantly nonhydric (2% of map units rated as hydric) and is prone to frequent flooding.

The area of Riverwash occurs at slopes of 0 to 3%. Riverwash occurs on floodplains and is composed of well-drained sand and gravel alluvial deposits. It is rated as hydric (100% of map units rated hydric) and also prone to frequent flooding.

4.5 Existing Habitat Types

The following habitat definitions relate to habitat for juvenile Chinook salmon in the Lower Willamette River. These definitions have been derived from a variety of sources and are meant to precisely describe types of habitat that are included in the Portland Harbor Natural Resources Trustee Council's Habitat Equivalency Analyses (HEA). Both work areas within the Project site include the ACM and riparian forest habitat types.

4.5.1 ACM

The ACM is defined as shoreline area occurring between OHW and OLW, and much of the Project site is located within this zone. ACM at the Project site is composed of gravel-cobble beach and steep riverbank, with armoring or other hardened surfaces such as asphalt, concrete, sheetpile materials of the bulkhead, and riprap. The vegetation communities are composed of species tolerant of frequent flooding, and can be characterized as a forested vegetation community, with woody shrubs present as a sub-layer. Species identified within the Project site include young black cottonwood (Populus balsamifera; facultative species [FAC]), sandbar willow (Salix fluviatilis; facultative wetland [FACW]), Himalayan blackberry (Rubus armeniacus; facultative upland species [FACU]), field bindweed (Convolvulus arvense; no indicator [NI]), and prostrate knotweed (Polygonum aviculare; FAC), along with a few occurrences of Japanese knotweed (Fallopia japonica; FACU) and large-flowered collomia (Collomia grandiflora; obligate upland species [UPL]). The ACM at both work areas within the Project site are heavily degraded due to the presence of hardened surfaces (sheetpile bulkhead, riprap, and the parking lot), steep slopes (>11%) caused by development, lack of habitat structure, lack of vegetation cover, and the presence of invasive vegetation.

4.5.2 Riparian

Riparian habitat is defined as area within 200 feet landward of the OHW and is present within the two Project work areas. The riparian area within the Parking Lot Area is paved; the riparian area in the Bulkhead Removal Area includes forested vegetation communities (also with a shrub sub-layer) and paved areas. Forest vegetation includes black cottonwood of mixed ages with an understory composed largely of Himalayan blackberry. Patches of wild Clematis (Clematis vitalba; UPL), English ivy (Hedera helix; NI), and false brome (Brachypodium sylvaticum; NI) also occur within the forest stand. Riparian habitat in both areas of the Project site are currently degraded due to the presence of steep and eroding slopes, hardened surfaces, impervious pavement, lack of habitat structure, lack of vegetation cover, and presence of invasive species.

4.5.3 Aquatic Habitat

A wetland and other waters delineation was conducted by Cascade Environmental Group in summer 2015 for the Project site. No wetlands were found within the project site, and the WOTUS delineated within the Project site includes the Lower Willamette and Clackamas Rivers. The Lower Willamette is a large and highly modified river that is 303(d) listed as water quality limited by the Oregon Department of Environmental Quality (ODEQ) for many parameters including temperature, bacteria, heavy metals, polychlorinated biphenyls, and other pollutants (ODEQ 2012).

The lower Clackamas River has a smaller active channel and more limited flow regime than the Willamette River; however, the Clackamas River at the confluence shares the same characteristics as the Lower Willamette River: it is 303(d)-listed as water quality limited for the same parameters, the riverbank and channel habitats are degraded, and it supports ESA listed salmon and steelhead trout populations.

The presence of a parking lot, remnant bulkhead structures, associated riprap, asphalt and concrete below OHW, lack of a developed riparian vegetation community, and limited large wood in and adjacent to the channel all contribute to the poor aquatic habitat quality at the Project site.

4.6 Fish and Wildlife

As described above, the Project site contains ACM and riparian forest habitat types. Riparian habitat quality is compromised due to abundant invasive species cover and the presence of asphalt, concrete, riprap in both areas, and metal structures at the bulkhead. The presence of a few mature black cottonwoods and Douglas fir trees in the forested areas provides limited roosting and nesting sites for some large raptors, and a dense shrub layer provides some cover, foraging, and nesting sites for other birds and wildlife. These habitats, however, are degraded by the predominantly invasive understories that do not provide adequate habitat to support a diversity of wildlife uses. The riparian forest habitat most likely supports bird and mammal species adapted to urbanized areas dominated by Himalayan blackberry: American crows (Corvus brachyrhynchos), turkey vultures (Cathartes aura), song sparrows (Melospiza melodia), black-capped chickadees (Poecile atricapillus), American robins (Turdus migratorius), Eastern gray squirrels (Sciurus carolinensis), nutria (Myocastor coypus), opossum (Didelphis virginana), and raccoons (Procyon lotor).

The gravel-cobble beach provides some ACM habitat for wading birds and piscivorous mammals to hunt, but the lack of riparian vegetation and large wood, and the presence of the paved areas and metal

structures severely limit habitat quality. Waterfowl less sensitive to habitat impacts, such as Canada geese (Branta canadensis) and mallards (Anas platyrhynchos), are likely to use existing ACM habitat and have been observed in the area.

The Project site historically and currently supports ESA-listed anadromous fish species, including rearing and migration habitat for Chinook and coho salmon and steelhead trout (ODFW 2013). The area is documented as Essential Salmonid Habitat by the Oregon Department of State Lands (DSL; Oregon Administrative Rule 141-102), and Essential Fish Habitat (EFH) for Chinook and coho salmon by the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) EFH mapper (NOAA 2015).

5. MITIGATION DESIGN

The Project design approach is direct restoration accomplished by removing human-constructed features, restoring habitats, and re-engaging river processes. The Project will remove hardened features (parking lot, riprap, boulders and debris, and sheetpile materials and other structures associated with the remnant bulkhead); recontour the riverbanks underneath and adjacent to the bank hardening features to more stable and natural profiles; revegetate the restored riverbank with native species; and incorporate wood habitat structures at the Parking Lot Area.

The Project site 30% design (Appendix E) has been developed based on available information including topographic and bathymetric surveys, geotechnical analysis, geomorphic analysis, reference site reconnaissance, and historical aerial photo review. In addition to achieving the restoration goals of re-engaging riverine processes, the design also considered input from the City and public safety factors. The Parking Lot Area mitigation limits are defined by the allowable loss of the parking lot available for public fishing access, as determined by the City; the Bulkhead Removal Area mitigation limits are defined by grading requirements to establish a stable bank gradient, post bulkhead removal, to avoid potential slope failure. To meet the objectives for habitat restoration, as well as the needs of the City, the design will establish stable conditions along the riverbanks. After the stable conditions are established, the site is expected to engage river process that over time will result in small-scale evolution of the ACM, including bank scour, evolution of substrate through deposition, and creation of small bank and shallow water habitat elements associated with localized scour and deposition.

5.1 Construction Overview

Construction of the Project will be accomplished using heavy equipment, including crane equipment operated from a barge or beach areas, and other land-based equipment such as front end loaders, excavators, and dump trucks. All construction activities will comply with local, state, and federal regulations, and authorization will be obtained from all applicable agencies, as required. Impacts to existing natural resources will be avoided or minimized to the extent possible.

5.2 Construction Sequencing and Timing

Construction will begin with the clearing of any invasive vegetation in both the Parking Lot Area and the Bulkhead Removal Area in the spring, before earthwork begins, to minimize the spread of propagules through construction activities. The initial clearing will mechanically remove aboveground biomass, and subsequent invasive control will focus on complete removal of the root systems through grading or excavation. The entire footprint of the Project will be graded, ensuring complete removal of the

invasive species present on the site. Invasive species will be disposed of, and appropriate agencies will be informed, in accordance with noxious weed laws; invasive species may be composted at a City facility or hauled to a landfill for disposal.

Demolition of the hardened areas including removal of asphalt, riprap, boulders, gravel, and debris in the Parking Lot Area, removal of the sheetpile, and other appurtenances at the Bulkhead Removal Area (concrete blocks, cables, etc.) will begin following invasive species removal. The initial clearing will mechanically remove aboveground biomass, and subsequent invasive control will focus on complete removal of the root systems through grading or excavation. The entire footprint of the Project will be graded, ensuring complete removal of the invasive species present on the site to the extent possible and in accordance with permit conditions. All work performed below OHW will occur during the in-water work window for the Project site, established by the Oregon Department of Fish and Wildlife (ODFW) as July15 to August 31; work above OHW may commence earlier to meet the Project schedule.

Grading within the ACM and riparian area will occur at both work areas after invasive species removal is complete and hardening features have been removed. At the Bulkhead Removal Area, overburden material will be removed from on top of the failed sheet piles, and then the piles will be removed using a crane. Sheet piles will be cut 3 feet below finish grade and buried in place if fully removal isn't feasible. Finish grading of the riverbank will likely begin at the top of slope and then move downslope as final grade is established.

Large wood habitat structures will only be installed at the Parking Lot Area, because the Bulkhead Removal Area's hydrologic condition would not collect large wood. The Parking Lot Area will include two wood structures; the multi-piece structures will be installed and anchored to remain stable beyond the monitoring period. Wood structures include logs without rootwads, logs with root wads, large boulders and compacted granular fill as ballast, and individual members will be pinned together with threaded rebar at junction points. Hex nuts and washers will be threaded onto the rebar to secure the members together, and these will be countersunk into the log. The rebar will be trimmed to minimize the extent of these features beyond the outside diameter of the log. Wood structures will be installed as a component of site grading.

All graded areas will be seeded for erosion control. After work is completed, construction fencing will be removed and a new section of permanent fence will be installed at the edge of the parking lot, located above the Bulkhead Removal Area. Signs identifying the restoration areas and discouraging heavy public access to allow vegetation to be established will also be installed at locations indicated on site plans.

Native woody species will be installed between fall and spring, following earthwork. Native plants will be installed by hand, in areas located above 18 feet NAVD88. Irrigation will be provided via a watering truck, filling at a nearby water hydrant.

Additional invasive vegetation treatment will occur as needed in the fall after construction is completed and will be ongoing during the maintenance period. Native woody plants will be installed in fall/winter following site grading work.

Timing	Activity
Spring 2016	Removal of invasive plants
Summer 2016	Additional follow-up removal of invasive plants as needed
	Demolition of paved areas
	Removal of riprap, boulders, gravel, and debris
	Removal of sheetpile and bulkhead artifacts
	Grading at both mitigation areas
	Installation of large wood structures at Parking Lot Area
	Seeding for erosion control
	Construction of new Bulkhead Removal Area fence section
	Installation of "Natural Area" signage
Fall 2016	Additional removal of invasive plants as needed
Fall 2016/Spring 2017	Installation of native woody plants

5.3 Parking Lot Area Demolition and Grading

Parking Lot Area demolition and grading includes removing approximately 53% of the existing parking lot asphalt, removal of boulders, riprap, gravel, and debris on the northern edge of the lower parking lot and recontouring the previously paved area to a more natural ACM profile (Appendix E, Sheet C1). The grading strategy generally includes minimized slopes in lower elevation zones (approximately 5:1 where possible) where woody vegetation is not expected to establish, and includes steeper slopes (up to 3:1) where revegetation with woody species will help anchor the soil. Slope grading has been designed to preserve as many existing trees as possible; however, the design requires that a few trees be removed during site grading. These trees are older black cottonwoods that are not suitable for use as large wood habitat structures due to the soft or decaying wood. The Port will work to repurpose the removed trees as feasible.

5.4 Bulkhead Removal Area Demolition and Grading

Construction at the Bulkhead Removal Area will include removal of sheetpile and its associated artifacts (cables, anchoring blocks, and riprap) from the ACM and shallow water habitat and grading the ACM to a more stable and natural profile (Appendix E, Sheet C2). Stable bank profiles have been identified adjacent to the site and along the Willamette River at the nearby reference sites. All design elements are in accordance with the recommendations of the Report of Geotechnical Engineering Services (Appendix B) and appropriate for the site's geomorphic conditions. The proposed slope at the Bulkhead Removal Area is 2H:1V to establish stable slope conditions in a manner that will engage riverine processes and allow for some minor erosion and evolution of the ACM over time. Buried debris, such as cables or anchoring blocks (i.e., deadman) will be cut flush with finished grading surface and left in place when complete removal is infeasible. The Port will monitor the site to evaluate if riverine processes cause minor erosion in the Project area causing the buried debris to resurface. The Port would perform additional cutting or removal in the event buried cables or concrete become exposed. This approach

would be considered under the adaptive management for the site, since the degree of future exposure is unknown and cutting of nonnative materials could impact vegetation or other project elements.

Some minor areas of filling will be necessary in scour areas, located near the existing sheetpiles. Scour areas will be filled with native material and compacted to stabilize placed material, to support the 2H:1V slope. Above the slope, approximately 2,909 square feet of asphalt will need to be removed from an existing parking lot to facilitate the full grading extent. At the top of the slope, a 5-foot offset will be maintained from the top of slope to the edge of the parking area to remain. The existing fence along the existing edge of pavement will be removed and a new fence will be installed along the parking area, tying in to the existing fence to remain. Slope grading has been designed to preserve as many existing trees as possible; however, the design requires that a few existing trees be removed. These trees are also older black cottonwoods that are not suitable for use as large wood habitat structures due to the soft or decaying wood.

5.4.1 Sheetpile Removal

The concrete, riprap, and associated bulkhead metal structures and associated debris will be removed to the greatest extent practicable during site demolition activities. The sheetpiles will be pulled out of the ground using heavy equipment operated from beach and possibly a barge, such as a crane, an excavator, chains, and other methods to gain leverage for removal. The contractor will excavate at the base of the piles to remove pressure, as well as pull on the structures as necessary to remove the piles. If piles cannot be fully removed, sections will be cut a minimum of 36 inches below finish grade and covered with soil to match finish grade.

A 34-foot section of sheetpile wall extends parallel to the shoreline and is buried in the riverbank slope. This section will be excavated to below grade, cut in place, and then buried. Abandonment of this section of wall in place follows recommendations of the Report of Geotechnical Engineering Services (Appendix B) to maintain slope stability.

5.4.2 NW Natural Gas Transmission Line

A NW Natural gas transmission line is located near the southeastern edge of the Bulkhead Removal Area. No excavation is proposed directly above the gas transmission line, but excavation will occur within the 10-foot safety zone on the west side of the line. According to preliminary conversations with NW Natural, the gas transmission line in this area is buried sufficiently deep to accommodate the proposed removal of 1-foot depth of material within 5 feet of the gas line. NW Natural is currently verifying the depth of the line and will be on site when excavation occurs within 10 feet of the line.

5.5 Material Placement

Nonnative materials, such as concrete, asphalt, riprap, and sheetpiles, will be removed and disposed of off-site at appropriate disposal or recycling facilities. Native materials excavated to establish design grades will be placed on gravelly beach areas near the Project site to allow for substrate recruitment into the river system. Materials will be primarily a mix of cobbles, pebbles, and mineral soil excavated from the slope above the existing bulkhead; materials will be hauled to beach areas with similarly sized substrate and spread in shallow lifts. Once spread, spoils will be washed to allow translocation of fines into the beach, below the larger particles. Finish grade surfacing below the revegetation elevation of 18’

NAVD88 is to consist of large-cobbles similar to existing river bed material in the vicinity of the Project. Gravelly material will not be disposed of in portions of the beach with sandy or finer substrate.

5.5.1 Sediment Evaluation

An application has been submitted to the U.S. Army Corps of Engineers (USACE) Portland Sediment Evaluation Team for review. The *Dahl Beach Mitigation Site Level 1 Sediment Evaluation* (Appendix C) states that multiple lines of evidence demonstrate that sediments at the project areas should qualify for beneficial use as habitat material based on a "very low" ranking (formerly exclusionary status), according to the guidelines provided in the Sediment Evaluation Framework (SEF; USACE et al. 2009). The report states that these lines of evidence include a lack of fines and carbon, lack of potential sources and exposure pathways (e.g., stormwater conveyances), and no exceedances of SEF screening levels. On November 23, 2015, the Port was notified of a "No-Test Determination" decision made by the USACE stating that the site meets conditions that exclude it from the necessity of chemical testing. Site sediments are, therefore, suitable for use as habitat material during regrading of the restoration areas to form a more natural shoreline or to be placed on the beach in surrounding areas to keep the material within the system.

While the SEF results indicate the sediments are safe to use in habitat restoration, it should be noted that the Project reach is within a reach of the Willamette River that is 303(d) listed as water quality limited by the DEQ for many parameters including temperature, bacteria, heavy metals, polychlorinated biphenyls, and other pollutants (DEQ 2010). The lower Clackamas River at the confluence shares the same characteristics as the Lower Willamette River: it is also 303(d) listed as water quality limited for the same parameters.

Controlling sediment erosion and turbidity will be the primary environmental concerns during construction, and these can be controlled through project permits using standard upland and in-water best management practices (BMPs). The Port will coordinate with USACE through the construction permitting process.

5.6 Large Wood Structures

Two large wood structures will be constructed at the Parking Lot Area to improve habitat for listed species, and to improve site stability. The structures will consist of three to eight members each, with a mix of rootwads and cut logs. Each member will be 15 to 25 feet in length with a minimum diameter at breast height of 18 inches. Large boulders and compacted granular fill will be placed on top of the structures as ballast, and individual members will be pinned together with threaded rebar at junction points. Hex nuts and washers will be threaded onto the rebar to secure the members together, and these will be countersunk into the log. The rebar will be trimmed to minimize the extent of these features beyond the outside diameter of the log. The pins are necessary to allow the downward forces of the ballast to act on the entire structure as a single unit and prevent movement of individual members.

5.7 Stormwater

Stormwater quality for areas of existing pavement that drain toward the Project site will be improved through the installation of an approximately 10-foot wide, shallow, vegetated stormwater treatment basin. Topographic surveys determined that runoff from approximately one-fourth of the upper parking

lot pavement flows onto the Project site. This runoff is not treated under existing conditions. It appears to flow some distance down the driveway toward the lower parking lot before discharging over the steep riprapped bank to the river below.

Treatment of runoff from these surfaces would be improved through construction of a shallow vegetated basin. The shallow vegetated basin would allow sediment and attached pollutants to settle out and allow for vegetative uptake or adsorption of other pollutants.

The stormwater treatment basin is designed to meet the Standard Local Operating Procedures for Endangered Species (SLOPES) to Administer Maintenance or Improvement of Stormwater, Transportation, or Utility Actions Authorized or Carried Out by the U.S. Army Corps of Engineers in Oregon (SLOPES for Stormwater, Transportation or Utilities; NMFS 2014) standards (50% of the volume from the 2-year 24-hour design storm). Runoff from relatively small storms is expected to be treated and infiltrate entirely. Runoff from larger storms will exceed the capacity of the facility and discharge over bank to the river below. The overflow outlet is being designed to discharge through a gravel and cobble strip adjacent to the existing paved path leading to the beach below. High flows are small enough (the 25-year, 24-hour design storm peak flow is estimated to be 0.40 cfs) that they are expected to flow through the granular strip material (subsurface) and not over the top of it. Any overflow is expected to disperse along the length of the granular strip material and into the adjacent site graded finish surfacing material, which will also be relatively porous.

A bioswale and filter strips were also considered as possible treatment mechanism, but were deemed infeasible to implement effectively. A bioswale is infeasible because of site geometric constraints and existing drainage flow patterns. Filter strips are not appropriate in this location because runoff discharging into the Project area does not sheet flow off of the edge of pavement. Instead, the runoff concentrates to some degree before discharging over the steep bank.

Additional stormwater treatment design details will be provided as part of the 60% design development submittal.

5.8 Plantings

Native vegetation communities will be restored to improve habitat. Native vegetation will be restored above the scour line at the Project site by seeding and installing native species, controlling invasive species, and retaining existing native vegetation where present. Vegetation restoration elements are shown in Figure 2b (see also Appendix E—30% Design Plans).

The Project planting plan was developed based on multiple criteria: review of reference sites, consideration of native plant recruitment potential, consistency with Portland Harbor NRDA restoration guidance, and to discourage heavy public intrusion. Four reference sites were reviewed in the Project vicinity; species occurrence relative to both observable scour line and estimated OHW elevations were recorded and considered for use in the Project planting plan (Appendix D). The reference site findings were incorporated into the other project goals as follows:

- Black cottonwood is a dominant tree species in all reference sites, occurring throughout both the ACM and riparian elevations. This species will be planted within the ACM zone of the Project site;

natural recruitment of black cottonwood is expected to occur and allow it to spread to the riparian areas over time.

- Oregon ash is present at all reference sites and found in both the ACM and riparian elevations; it will be planted in the ACM elevations.
- Douglas fir was observed in only one of the reference sites, but it was observed to occur in the Project vicinity. For this reason, Douglas fir is included in the riparian areas of the Bulkhead Removal Area. Douglas fir was included to diversify detritus inputs beyond deciduous species alone. Inputs of Douglas fir will provide more durable materials into the Willamette system as trees mature and are eventually recruited into the channel. Big leaf maple is also planted in the Bulkhead Removal Area riparian zone because it was observed at reference sites.
- The riparian zone of the Parking Lot Area is very small (0.03 acre) and, therefore, planted with the same planting palette as the ACM portion of that mitigation area.
- Thorny species, such as clustered rose and Douglas hawthorn, were included in the planting plant to discourage public encroachment onto the planted portions of the mitigation areas.
- Planting densities follow guidance developed by the Portland Harbor Trustee Council Restoration Committee, establishing dense stands and vegetative cover to meet project goals.

Woody vegetation will be bare root and all plants will be procured from native plant nurseries in northwestern Oregon or southwestern Washington. Trees will be installed at 10 feet on-center (oc) and shrubs will generally be installed at 3 feet oc. Table 1 shows the project planting plan.

Table 1
Proposed Planting Plan

Common Name	Scientific Name	Quantity
Parking Lot Area—Forested ACM Planting Area 18 to 25.4 feet NAVD88 (0.20 acre or 8,551 ft^2)		
Black cottonwood	*Populus balsamifera sp. trichocarpa*	21
Black hawthorn	*Crataegus douglasii*	21
Oregon ash	*Fraxinus latifolia*	21
Cascara	*Frangula purshiana*	21
Clustered rose	*Rosa pisocarpa*	432
Snowberry	*Symphoricarpos albus*	432
Bulkhead Removal Area—Forested ACM Planting Area 18 to 25.4 feet NAVD88 (0.10 acre or 4,356 ft^2)		
Black cottonwood	*Populus balsamifera sp. trichocarpa*	15
Black hawthorn	*Crataegus douglasii*	15
Oregon ash	*Fraxinus latifolia*	15
Cascara	*Frangula purshiana*	15
Clustered rose	*Rosa pisocarpa*	215
Snowberry	*Symphoricarpos albus*	215

Bulkhead Removal Area—Forested Riparian Planting Area 25.4 to 42 feet NAVD88 (0.23 acre or 10,019 ft^2)		
Big leaf maple	*Acer macrophyllum*	50
Douglas fir	*Pseudotsuga menziesii*	50
Tall Oregon grape	*Berberis aquifolium*	500
Snowberry	*Symphoricarpos albus*	500

5.8.1 Invasive Species

Invasive vegetation will be cleared in both the Parking Lot Area and the Bulkhead Removal Area in the spring, before earthwork begins, to minimize the spread of propagules through construction activities. Following clearing, the Project area will be graded, removing invasive species root systems and effectively – eradicating invasives from the mitigation site. Post-earthwork, graded areas will be seeded with seed mixes developed for the varying hydrologic conditions that will be present post-restoration.

Follow-up treatment of invasive species will occur in the fall after construction is complete and continue throughout the maintenance and monitoring period.

5.9 Irrigation

The Project occurs within park properties, where existing irrigation infrastructure is present. Irrigation will be provided directly to the Bulkhead Removal Area and the Parking Lot Area on an as needed basis, likely by a watering truck. The watering truck will access an existing fire hydrant, located between the two mitigation areas, providing easy access for filling.

5.10 Signage

Signs that discourage heavy public access will be installed along the edges of the revegetated areas and at potential access points, as shown in Figure 2a. The signs will be approximately 8 × 10 inches, installed on metal posts, and will incorporate text that is designed to discourage public access into planted areas.

Impacts due to public intrusion into the mitigation area will be monitored and addressed as part of the Project's adaptive management approach. Trails, vandalism, or other adverse impacts stemming from public misuse will be reported and addressed dependent on the location and type of impact. City staff will be informed of the issue and provided with a recommended remedy, such as installing additional signage, re-planting, or additional public outreach.

5.11 Cumulative Impacts from Construction

Impacts to existing natural resources or threatened and endangered species as a result of Project construction will be avoided or minimized to the extent possible with the use of appropriate BMPs. Any impacts are expected to be minor, short-term construction effects that will not affect offsite resources or the goals of the two nearby restoration project sites. Wildlife and fish species that have been observed or are potentially present within the Project site include ESA-listed threatened salmonid species. Except for the removal of a small segment of the sheetpile, all work will take place in dry conditions and all work below OHW will take place within the narrow Clackamas River ODFW in-water work window (July 15 – August 31). It is expected that three sites (Dahl Beach, Rinearson Natural Area,

and Clackamas Confluence Restoration Project) that are located on Gladstone property will all be permitted under the SLOPES to Administer Stream Restoration and Fish Passage Improvement Activities Authorized or Carried Out by the U.S. Army Corps of Engineers in Oregon (SLOPES V Restoration; NMFS 2013) and as such will all follow BMPs intended to minimize and avoid impacts to ESA listed species or critical habitat.

The project appropriate BMPs from SLOPES V that will be employed to minimize and avoid construction effects on threatened and endangered species include the following:

- Minimize the extent and duration of earthwork, e.g., compacting, dredging, drilling, excavation, and filling.
- Operate machinery for in-water work from the top of bank or within dry beach areas to the extent practicable.
- Complete earthwork in riparian areas and stream channels as quickly as possible.
- Cease project operations when high flows may inundate the project area, except for efforts to avoid or minimize resource damage.
- Flag areas before any significant ground disturbance or entry of mechanized equipment or vehicles into the construction area to identify: i. Sensitive areas, e.g., wetlands, water bodies, ordinary high water, spawning areas; ii. Equipment entry and exit points; iii. Staging, storage, and stockpile areas.
- Flag all buffer areas and no application zones before any herbicide use.
- Protect and retain native riparian vegetation to the extent practicable by depicting these communities on construction drawings and avoiding construction activities in these areas.
- Stage construction equipment (when feasible), fuel, and supplies in areas away from water resources and inspect machinery daily for fuel or lubricant leaks, such that contaminants from the staging area cannot be deposited in the floodplain or stream.
- Dispose of any material not used in restoration and not native to the floodplain outside of the functional floodplain.
- Use sediment barriers such as compost berm downslope from construction activities and above the tideline to intercept any surface flow that might transport sediment to the Willamette or Clackamas Rivers.
- Install additional sediment barriers if eroded sediment appears likely to be deposited in any waters during construction. Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabric.
- Soil stabilization using wood fiber mulch and tackifier (hydro-applied) will be used to reduce erosion of bare soil. These materials will be free of noxious weeds and nontoxic to aquatic and terrestrial animals, soil microorganisms, and vegetation.
- Remove temporary erosion controls after construction is complete and the site is fully stabilized.
- Post written procedures for notifying environmental response agencies, including an inventory and description of all hazardous materials present, and the storage and handling procedures for their use. Maintain a spill containment kit, with supplies and instructions for cleanup and

disposal, adequate for the types and quantity of hazardous materials present. Train workers in spill containment procedures.

- Temporarily contain any waste liquids generated under an impervious cover, such as a tarpaulin, in the staging area until the wastes can be properly transported to, and disposed of, at an approved receiving facility.
- Before entering the project site, power wash all heavy equipment, vehicles and power tools, allow them to fully dry, and inspect them to make certain no plants, soil, or other organic material adhering to the surface.
- Before entering the water, inspect any watercraft, waders, boots, or other gear to be used in or near water and remove any plants, soil, or other organic material adhering to the surface.
- Inspect all equipment, vehicles, and power tools for fluid leaks before they leave the staging area.
- Before operation within 150 feet of any waterbody , and as often as necessary during operation, thoroughly clean all equipment, vehicles, and power tools to keep them free of external fluids and grease and to prevent leaks and spills from entering the water.
- Generators, cranes or other stationary heavy equipment operated within 150 feet of any waterbody must be maintained and protected as necessary to prevent leaks and spills from entering the water.
- After construction is complete, obliterate all temporary access roads and paths, stabilize the soil, and revegetate the area.
- Temporary roads and paths in wet areas or areas prone to flooding must be obliterated by the end of the in-water work window. Decompact road surfaces and drainage areas, pull fill material onto the running surface, and reshape to match the original contours.
- Restore any significant disturbance of riparian vegetation, soils, stream banks or stream channel.
- Seed all soils above 18’ elevation (NAVD88) following grading and excavation activities.
- Remove all project related waste; e.g., pick up trash, sweep roadways in the project area to avoid runoff-containing sediment, etc.
- Loosen compacted areas of soil when necessary for revegetation or infiltration.
- Grade slopes to ensure stability and seed disturbed areas immediately after they reach finished grade to control erosion.

BMPs specific to the bulkhead removal from the barge include the following:

- Keep all equipment (e.g., bucket, steel cable, vibratory hammer) out of the water, grip sheetpiles above the waterline to the greatest extent possible, and complete all work during low water and low current conditions.
- Slowly lift the sheetpile from the sediment and through the water column.
- Place the sheetpile in a containment basin on a barge deck, pier, or shoreline without attempting to clean or remove any adhering sediment.

6. RESTORED HABITAT AREAS—PROPOSED CONDITIONS

This section describes the elevations and restored condition of the target habitat types in the Project area.

6.1 Active Channel Margin

Existing ACM habitat will be improved and expanded through removal of existing hardened surfaces (concrete, asphalt, riprap, and sheetpile material), grading to restore stable slopes along Willamette riverbanks, and by restoring native forested vegetation community. Fish will have access to a larger amount of ACM habitat after hardening material is removed from both work areas and riverbanks are graded to stable gradients, exposing additional beach and vegetation below OHW. The total post-restoration ACM habitat will include approximately 0.53 acre currently impacted by the presence of pavement, a sheetpile bulkhead wall, riprap, and debris; this includes 0.28 acre in the Parking Lot Area and 0.25 acre in the Bulkhead Removal Area. This habitat type will extend from the OLW (varies in elevation) to the OHW of +25.4 feet NAVD88, or the approximate 2-year flood elevation.

Post-restoration, ACM habitat areas will include native forested communities, large wood habitat structures where appropriate, and gravel beach. The restored gravel beach occurs below approximately +16 feet NAVD88 at the Parking Lot Area and below +18 feet NAVD88 at the Bulkhead Removal Area, consistent with the adjacent beach areas. These areas occur below the observable existing scour line, at elevations where native species were not observed near the mitigation areas or at reference sites. Planted areas below +25.4 feet NAVD88 provide a transition community between the shallow water area of the Willamette River and the riparian community upslope.

6.2 Riparian Forest

Riparian habitats will be improved by removing hardened surfaces, grading to establish stable riverbank slopes; and planting a native forested vegetation community. The total post-restoration riparian habitat will be 0.25 acres, including 0.03 acre in the Parking Lot Area and 0.22 acre in the Bulkhead Removal Area. The riparian habitat in the Project extends from +25.4 feet NAVD88 to approximately +42 feet NAVD88.

The riparian habit will be planted with trees and shrubs to promote a native vegetation community. Existing habitat will be enhanced with supplemental native species plantings and invasive species control, where needed.

7. REFERENCES

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ODFW, 2013. Oregon Fish Habitat Distribution. Vector digital data. June 27, 2013. Available from: http://nrimp.dfw.state.or.us/nrimp/default.aspx?pn=fishdistdata.

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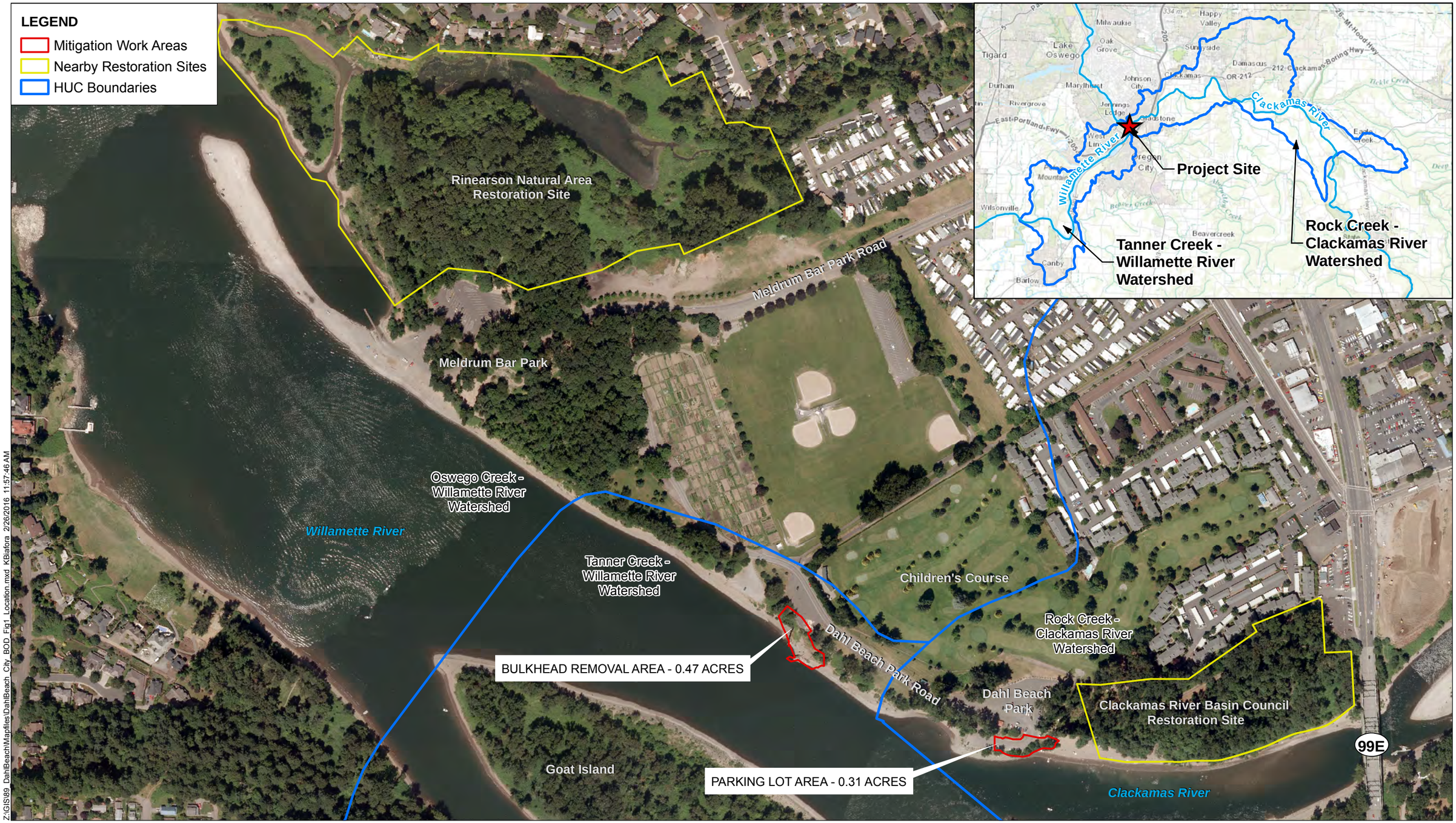
USACE (U.S. Army Corps of Engineers [Portland, Seattle, Walla Walla, and Northwest Districts]), USEPA (U.S. Environmental Protection Agency, Region 10), Ecology (Washington Department of Ecology), Washington Department of Natural Resources, DEQ (Oregon Department of Environmental Quality); Idaho DEQ, NMFS, and U.S. Fish and Wildlife Service. 2009. Sediment Evaluation Framework for the Pacific Northwest. May 2009.

FIGURES



ANCHOR QEA

CASCADE ENVIRONMENTAL GROUP

NOTES:
Data Source: USGS Orthoimagery 2010; USGS, National Hydrography Network, 2013.

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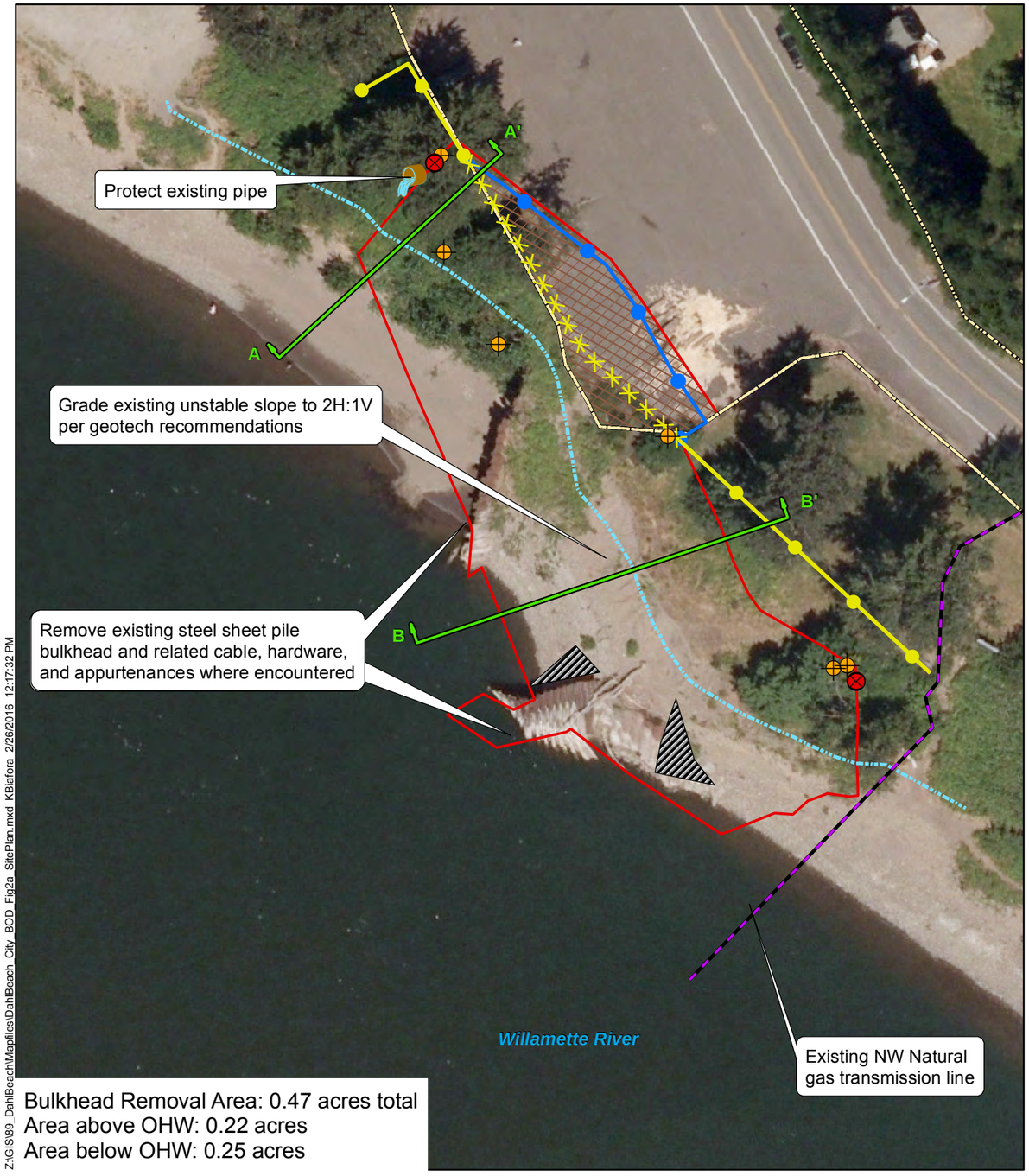
Figure 1
Dahl Beach Mitigation Project Vicinity Map
Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon



Bulkhead Removal Area: 0.47 acres total
Area above OHW: 0.22 acres
Area below OHW: 0.25 acres

Parking Lot Area: 0.30 acres total
Area above OHW: 0.03 acres
Area below OHW: 0.28 acres

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ANCHOR QEA

CASCADE ENVIRONMENTAL GROUP

NOTES:
Aerial Source: USGS Orthoimagery, 2010

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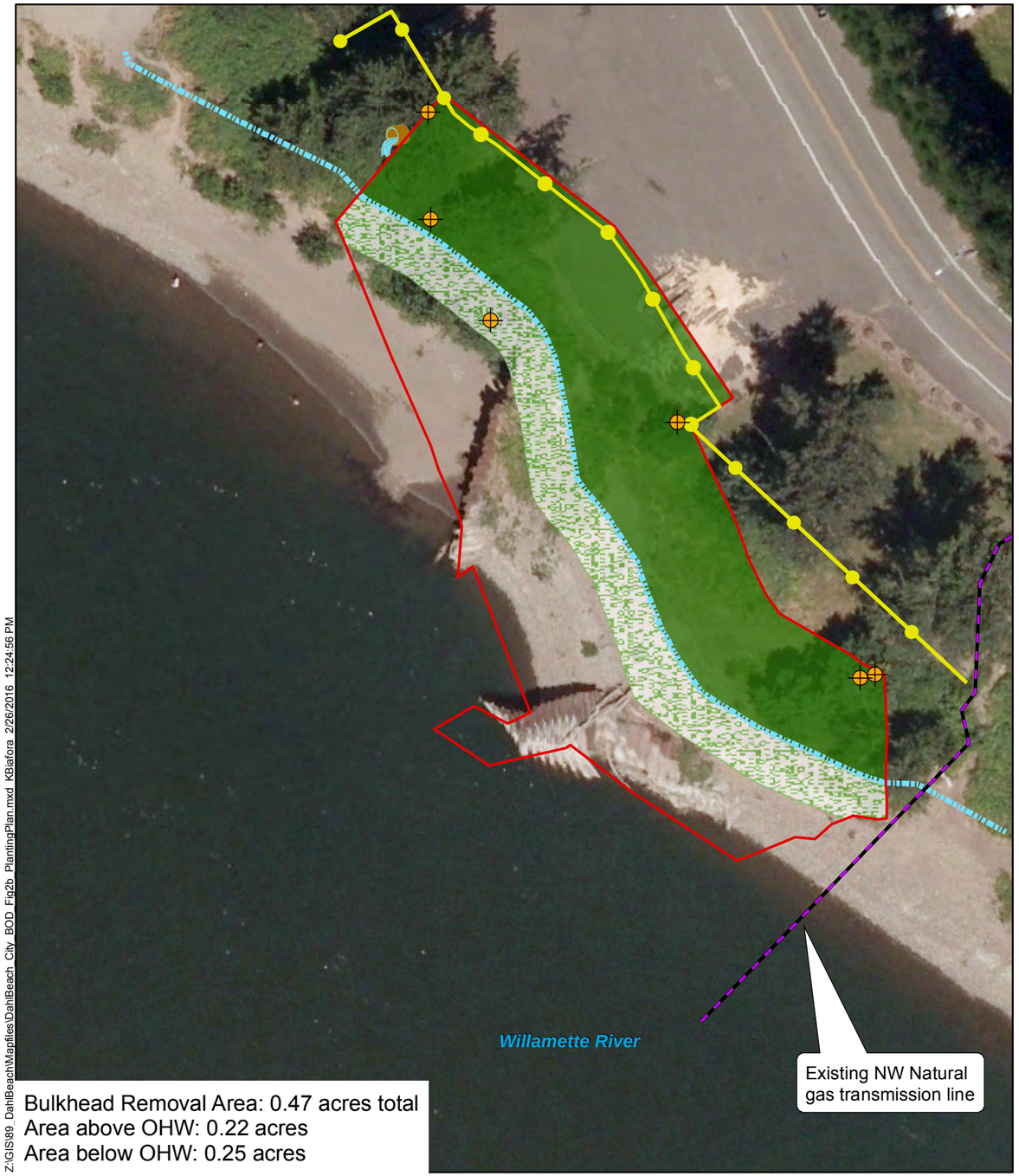
Figure 2a
Dahl Beach Mitigation Project Site Plan
Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon



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ANCHOR QEA

CASCADE ENVIRONMENTAL GROUP

NOTES:
Aerial Source: USGS, 2010.

Feet
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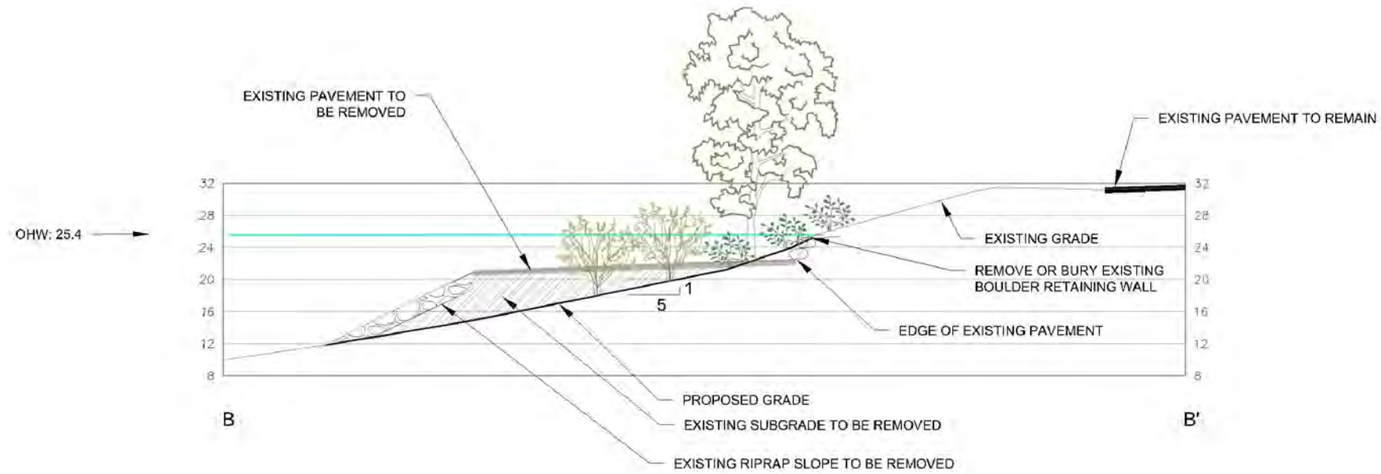
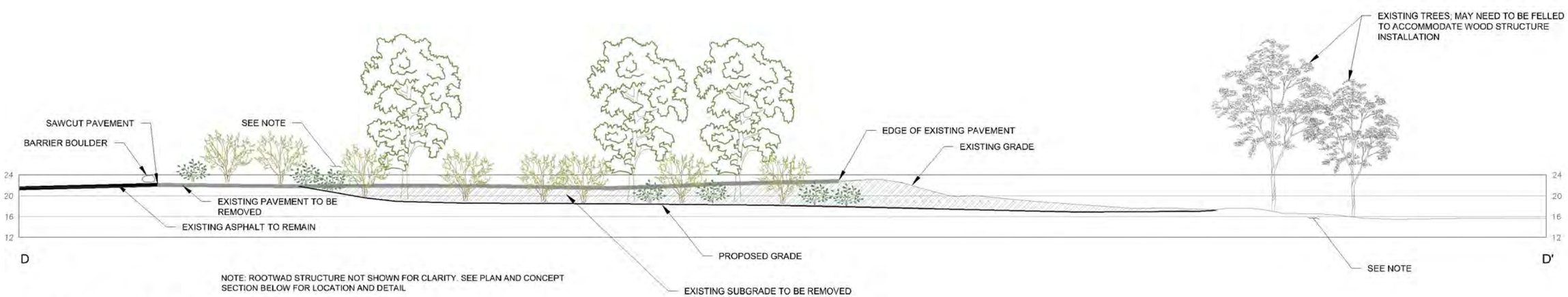
Figure 2b
Dahl Beach Mitigation Project Planting Plan
Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon



SECTION B-B': PARKING LOT AREA

SCALE: VERT. 1"=20' HORIZ. 1"=20'



SECTION D-D': PARKING LOT AREA

SCALE: VERT. 1"=20' HORIZ. 1"=20'

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ANCHOR QEA

CASCADE ENVIRONMENTAL GROUP

Feet
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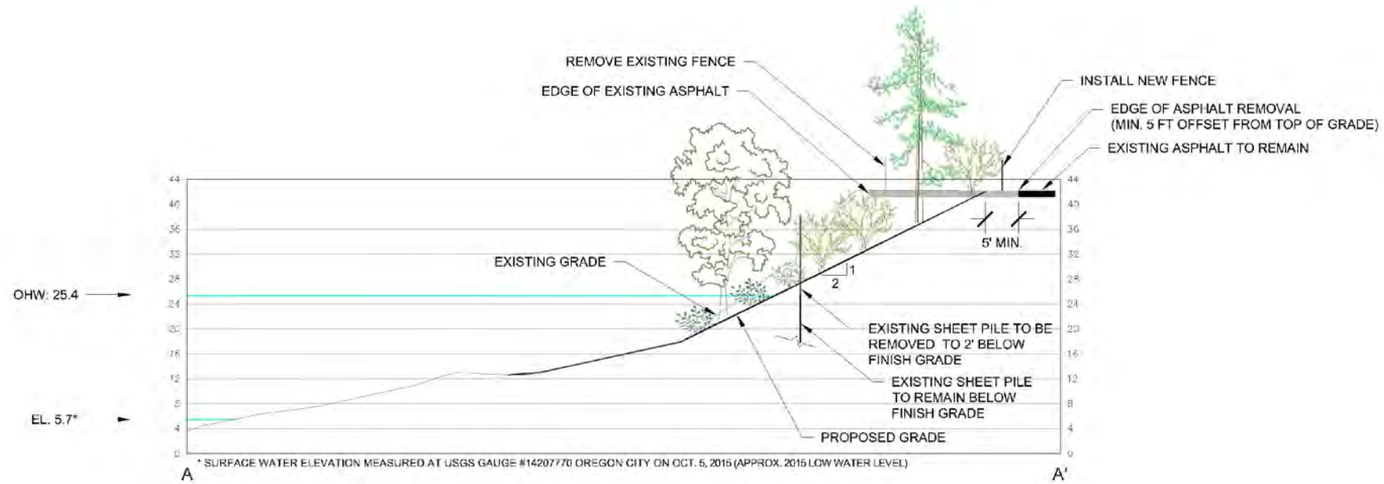
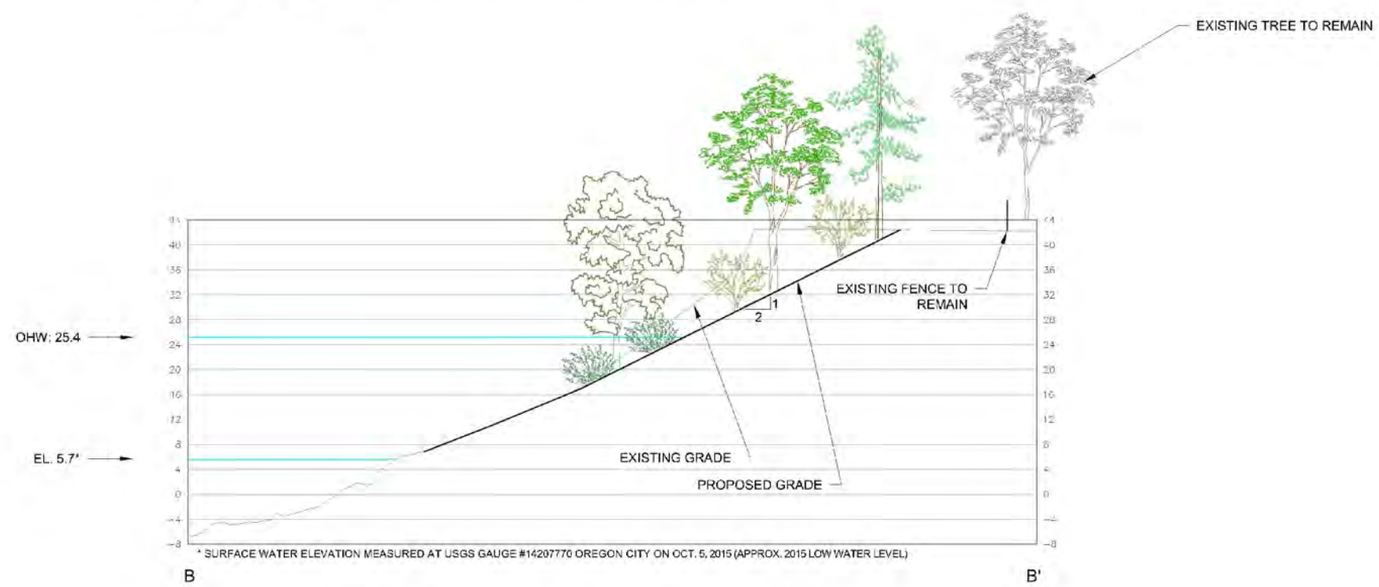
Figure 3a
Dahl Beach Mitigation Project Parking Lot Area Cross Sections
Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon



SECTION A-A': BULKHEAD REMOVAL AREA

SCALE: VERT. 1"=10' HORIZ. 1"=10'



SECTION B-B': BULKHEAD REMOVAL AREA

SCALE: VERT. 1"=10' HORIZ. 1"=10'

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CASCADE ENVIRONMENTAL GROUP

Feet
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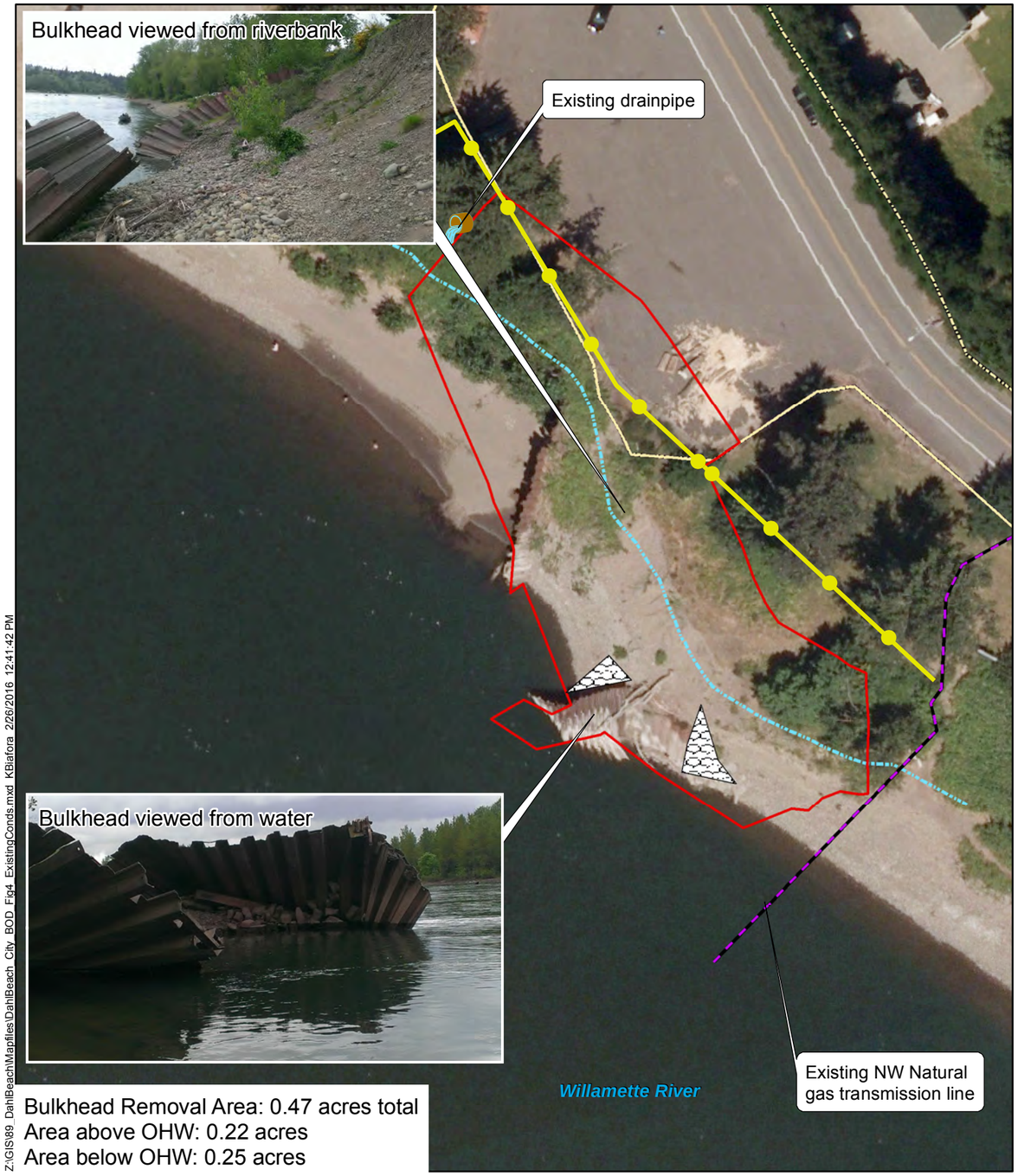
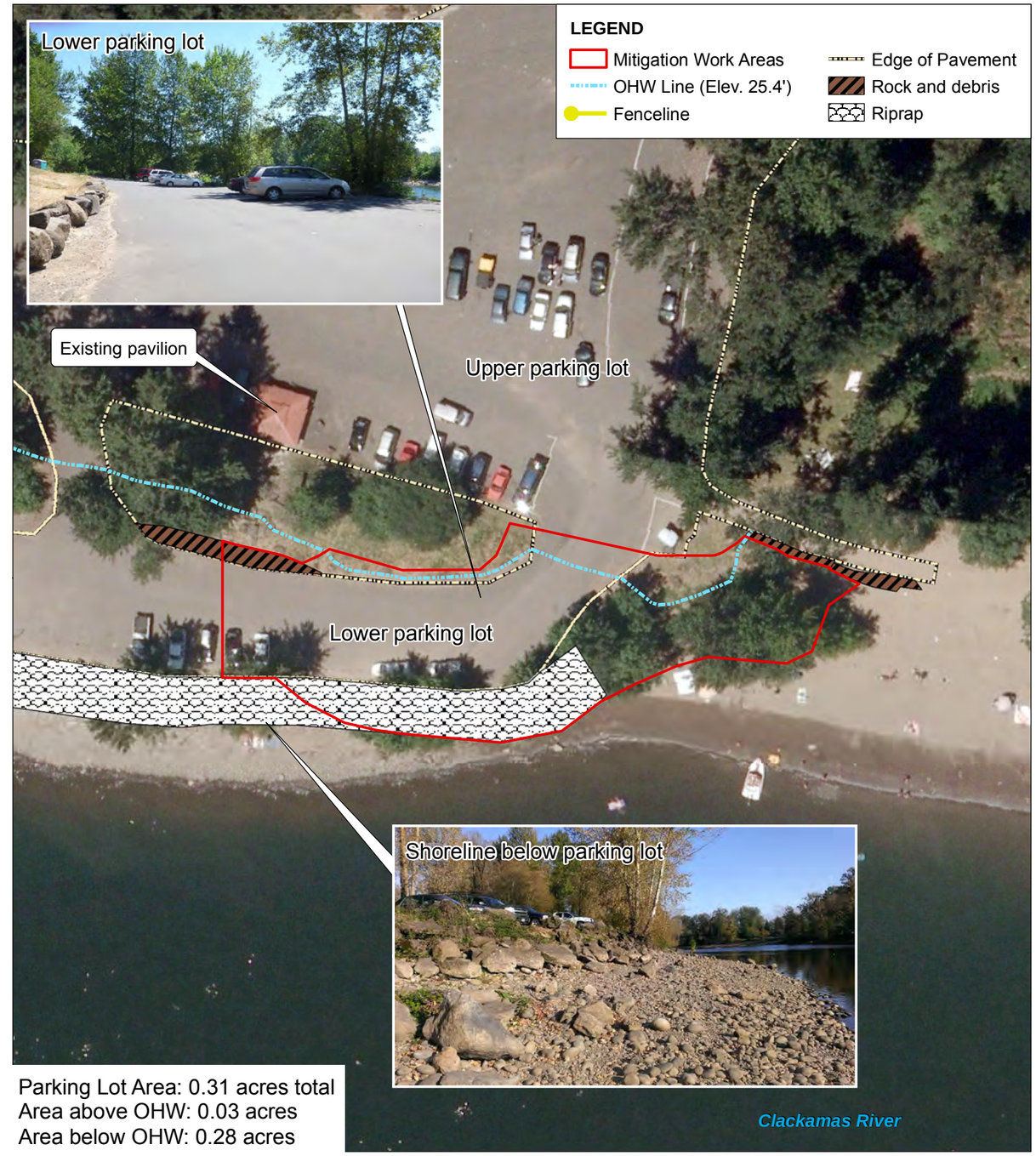
Figure 3b
Dahl Beach Mitigation Project Bulkhead Removal Area Cross Sections
Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon



Bulkhead Removal Area: 0.47 acres total
Area above OHW: 0.22 acres
Area below OHW: 0.25 acres



Parking Lot Area: 0.31 acres total
Area above OHW: 0.03 acres
Area below OHW: 0.28 acres

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ANCHOR QEA

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NOTES:
Aerial Source: USGS Orthoimagery, 2010

Feet
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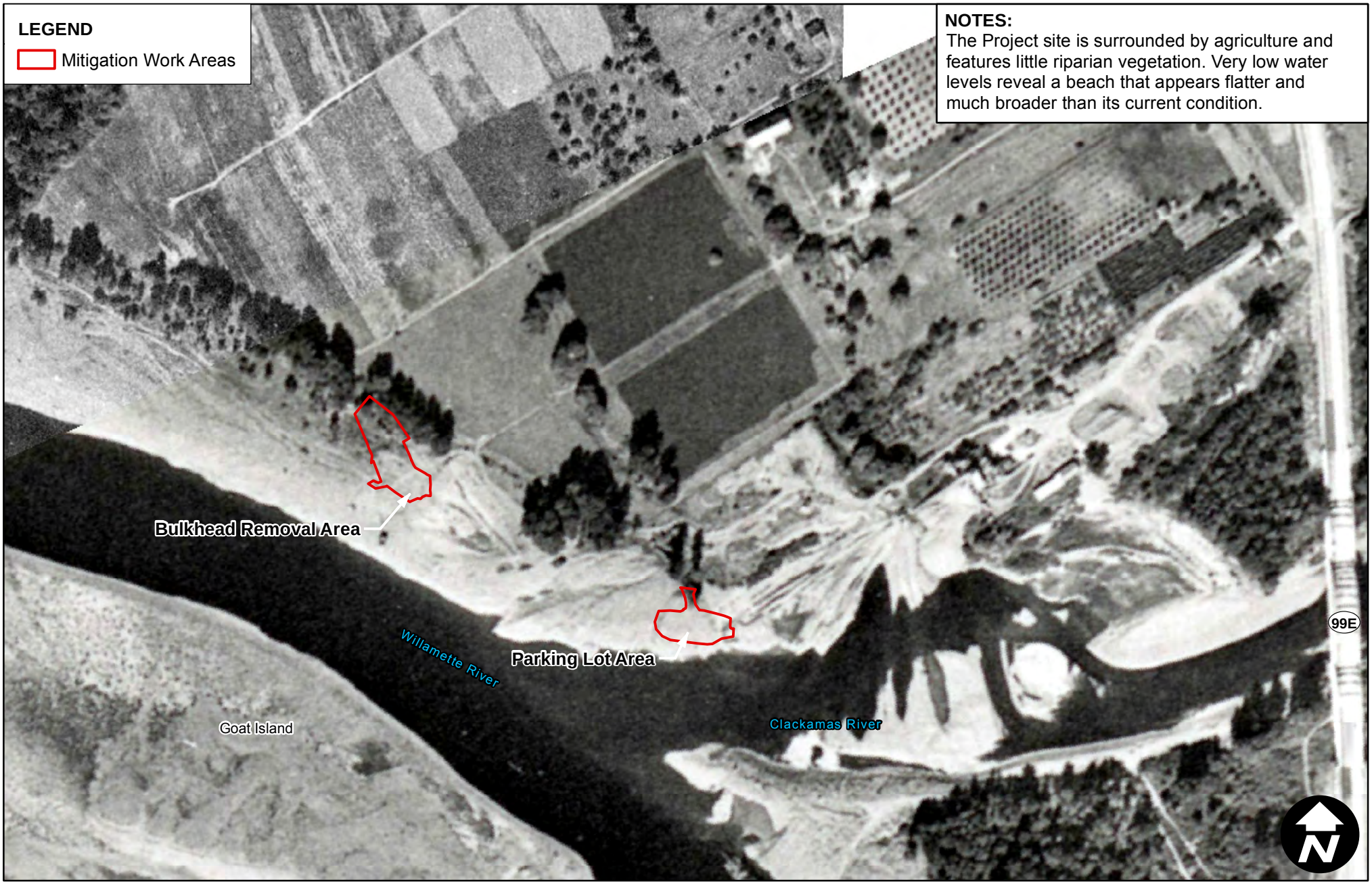
Figure 4
Dahl Beach Mitigation Project Existing Conditions
Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon

APPENDIX A
DAHL BEACH MITIGATION PROJECT
HISTORIC AERIALS



Date: 10/29/2015

Scale: 1 inch = 300 feet

Aerial Source: University of Oregon Map & Aerial Photography Library.

Appendix A. Dahl Beach Mitigation Project Historical Aerials - 1936

CASCADE ENVIRONMENTAL GROUP

Feet
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Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon

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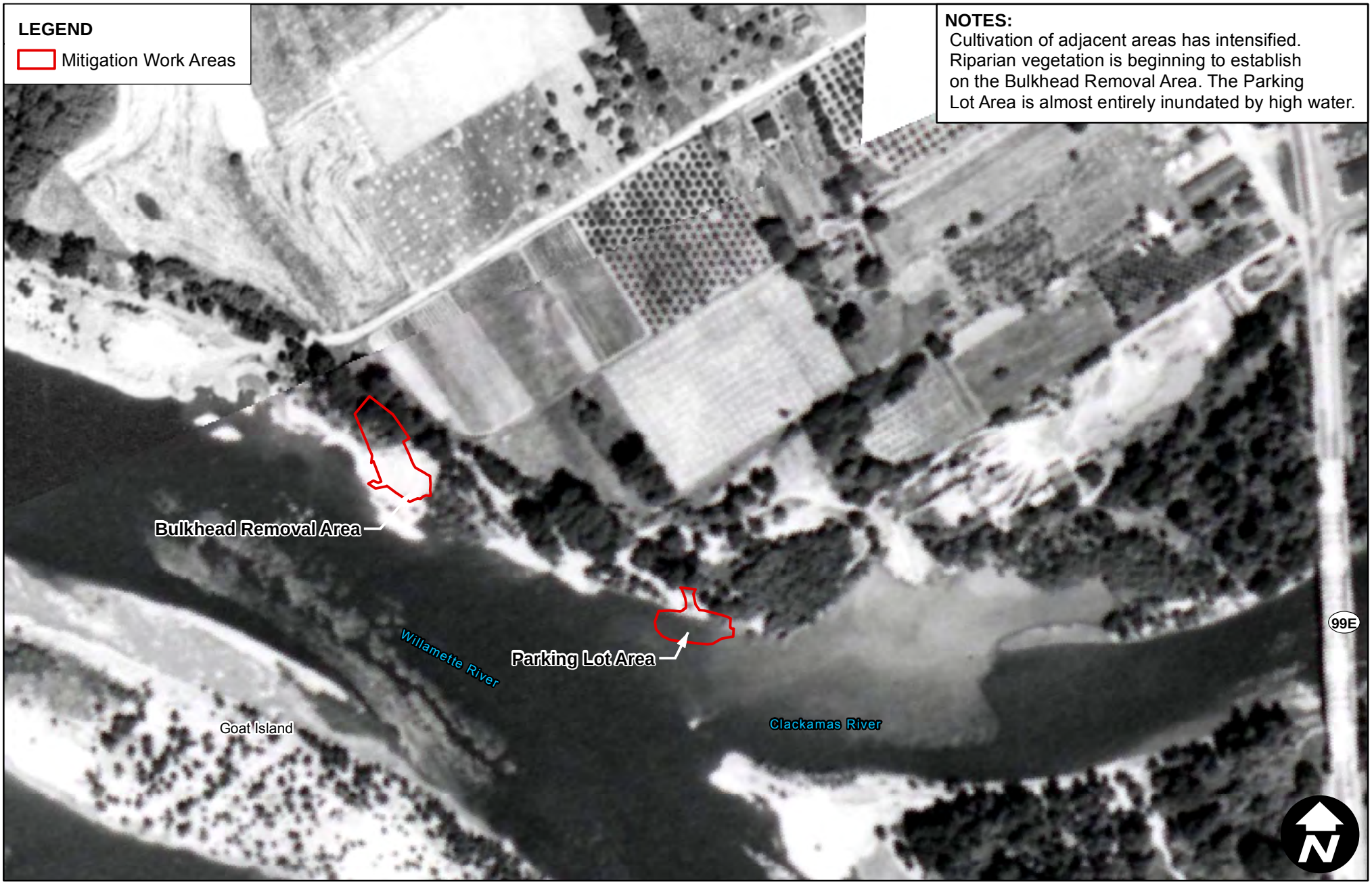

Date: 10/29/2015

Scale: 1 inch = 300 feet

Aerial Source: University of Oregon Map & Aerial Photography Library.

Appendix A. Dahl Beach Mitigation Project Historical Aerials - 1948

CASCADE ENVIRONMENTAL GROUP

Feet
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Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon

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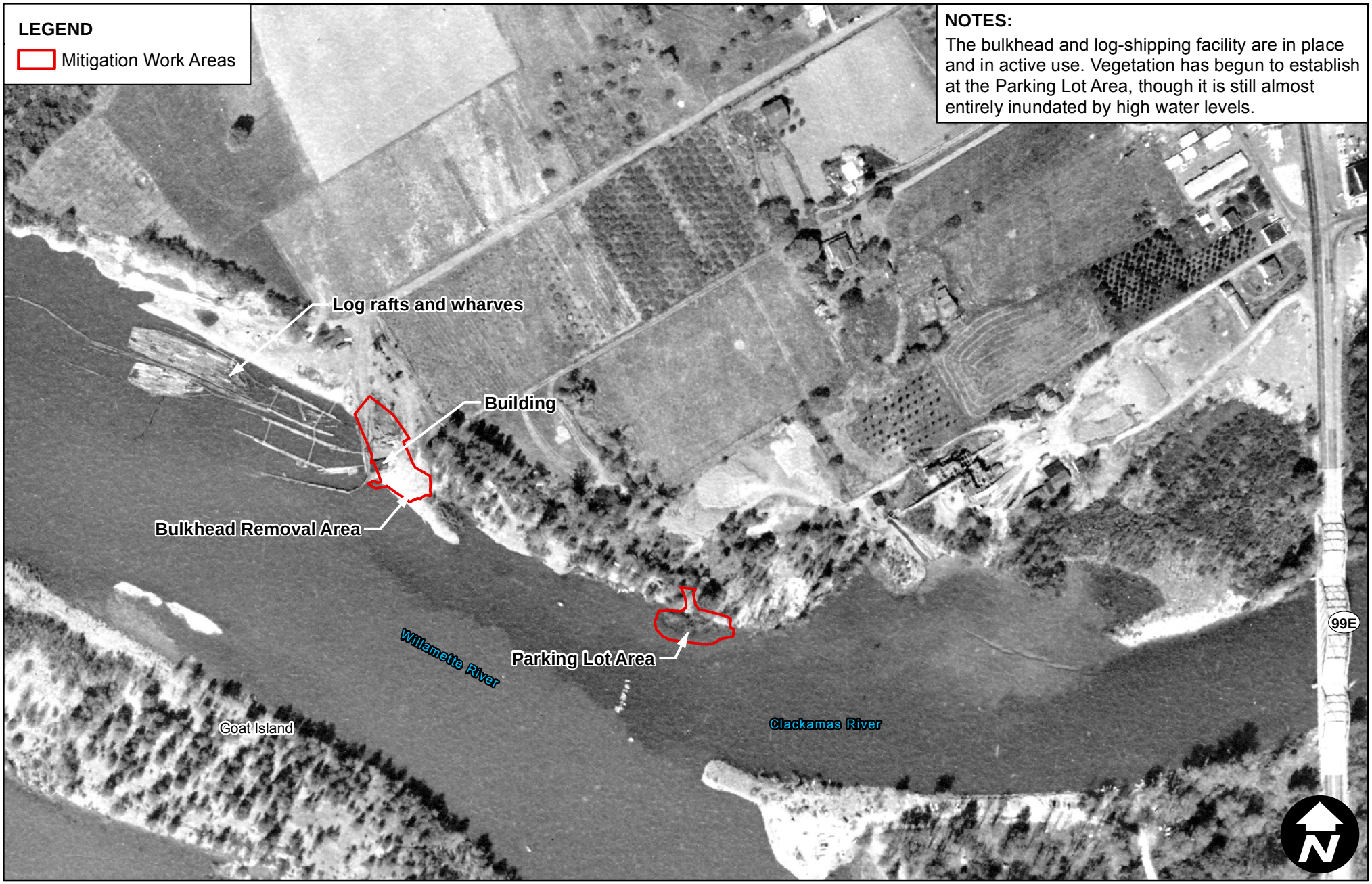

Date: 10/29/2015

Scale: 1 inch = 300 feet

Aerial Source: University of Oregon Map & Aerial Photography Library.

Appendix A. Dahl Beach Mitigation Project Historical Aerials - 1956

CASCADE ENVIRONMENTAL GROUP

Feet
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Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon

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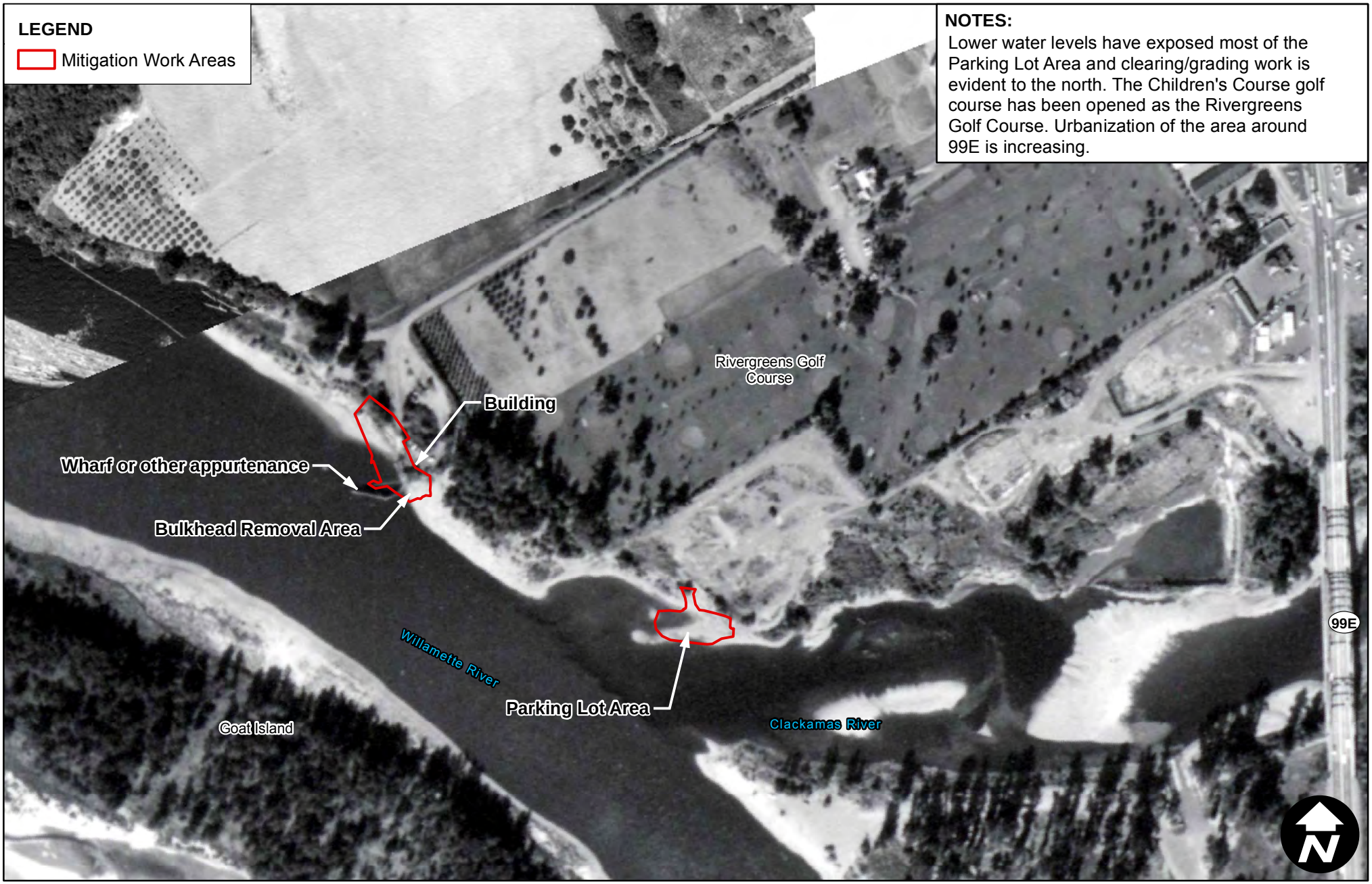

Date: 10/29/2015

Scale: 1 inch = 300 feet

Aerial Source: University of Oregon Map & Aerial Photography Library.

Appendix A. Dahl Beach Mitigation Project Historical Aerials - 1964

CASCADE ENVIRONMENTAL GROUP

Feet
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Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon

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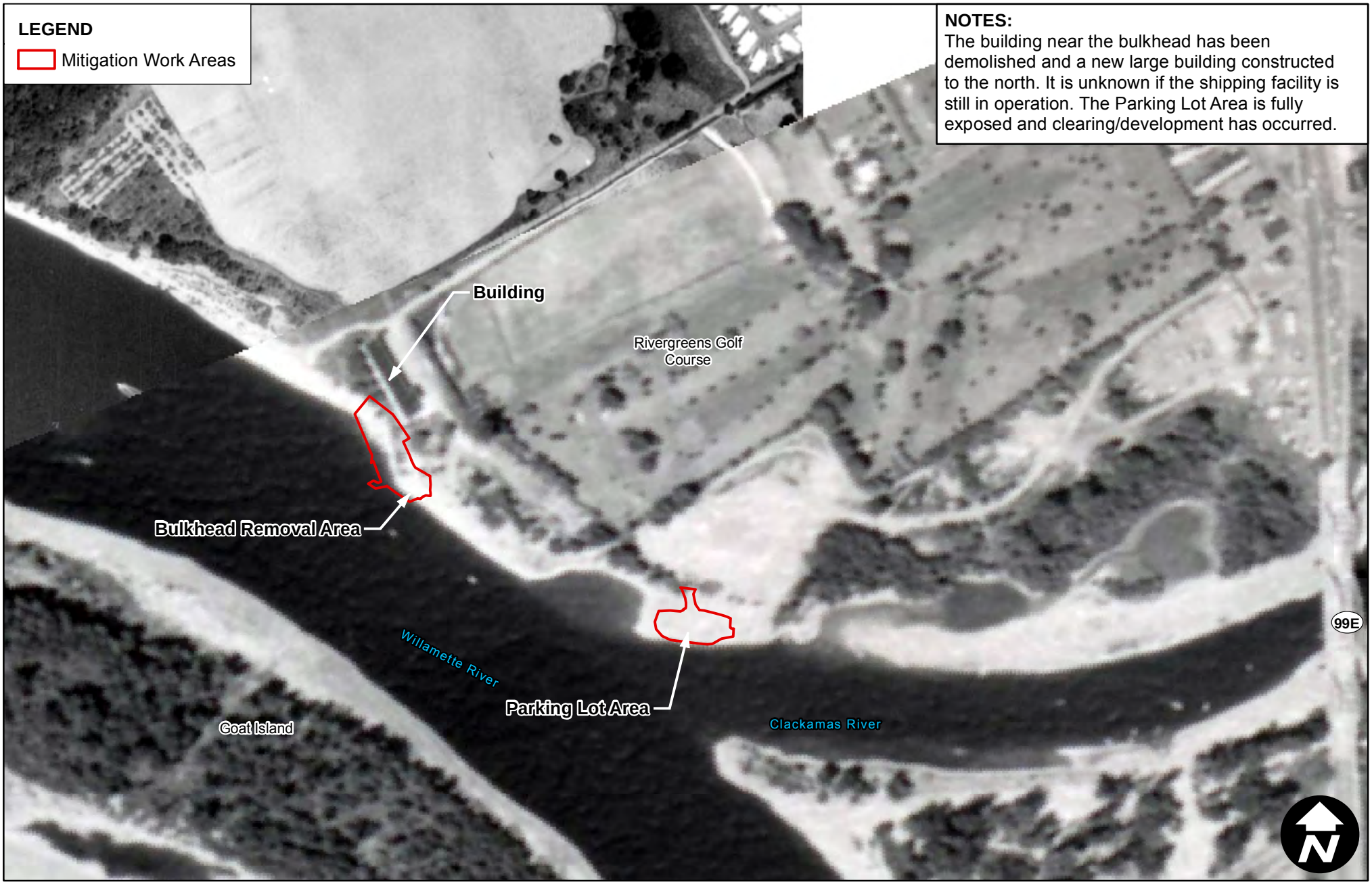

Date: 10/29/2015

Scale: 1 inch = 300 feet

Aerial Source: University of Oregon Map & Aerial Photography Library.

Appendix A. Dahl Beach Mitigation Project Historical Aerials - 1973

CASCADE ENVIRONMENTAL GROUP

Feet
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Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon

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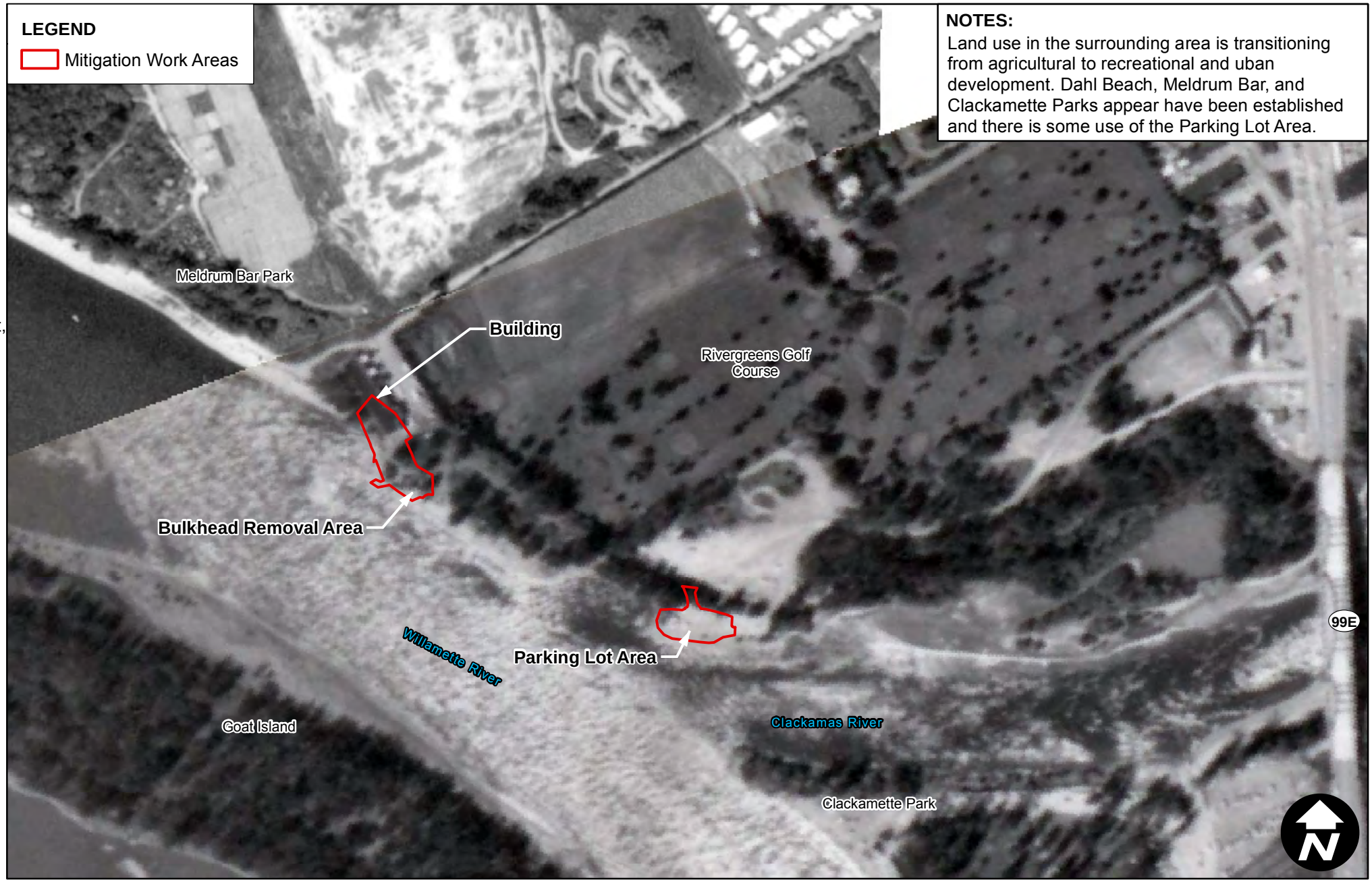

Date: 10/29/2015

Scale: 1 inch = 300 feet

Aerial Source: University of Oregon Map & Aerial Photography Library.

Appendix A. Dahl Beach Mitigation Project Historical Aerials - 1980

CASCADE ENVIRONMENTAL GROUP

Feet
0 250 500

Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon

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Date: 10/29/2015

Scale: 1 inch = 300 feet

Aerial Source: University of Oregon Map & Aerial Photography Library.

Appendix A. Dahl Beach Mitigation Project Historical Aerials - 1990

CASCADE ENVIRONMENTAL GROUP

Feet
0 250 500

Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon

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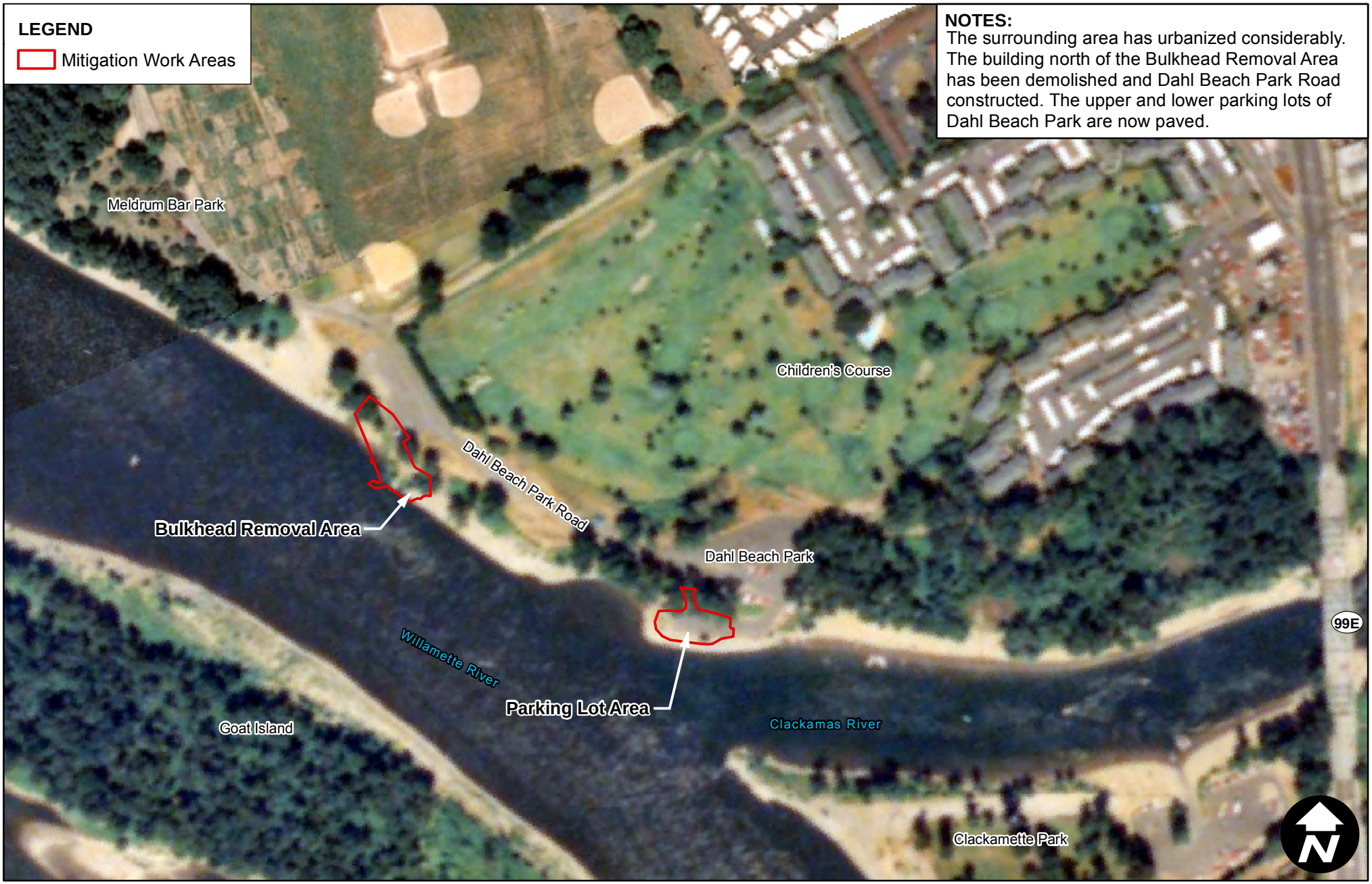

Date: 10/29/2015

Scale: 1 inch = 300 feet

Aerial Source: University of Oregon Map & Aerial Photography Library

Appendix A. Dahl Beach Mitigation Project Historical Aerials - 1998

CASCADE ENVIRONMENTAL GROUP

Feet
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Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon

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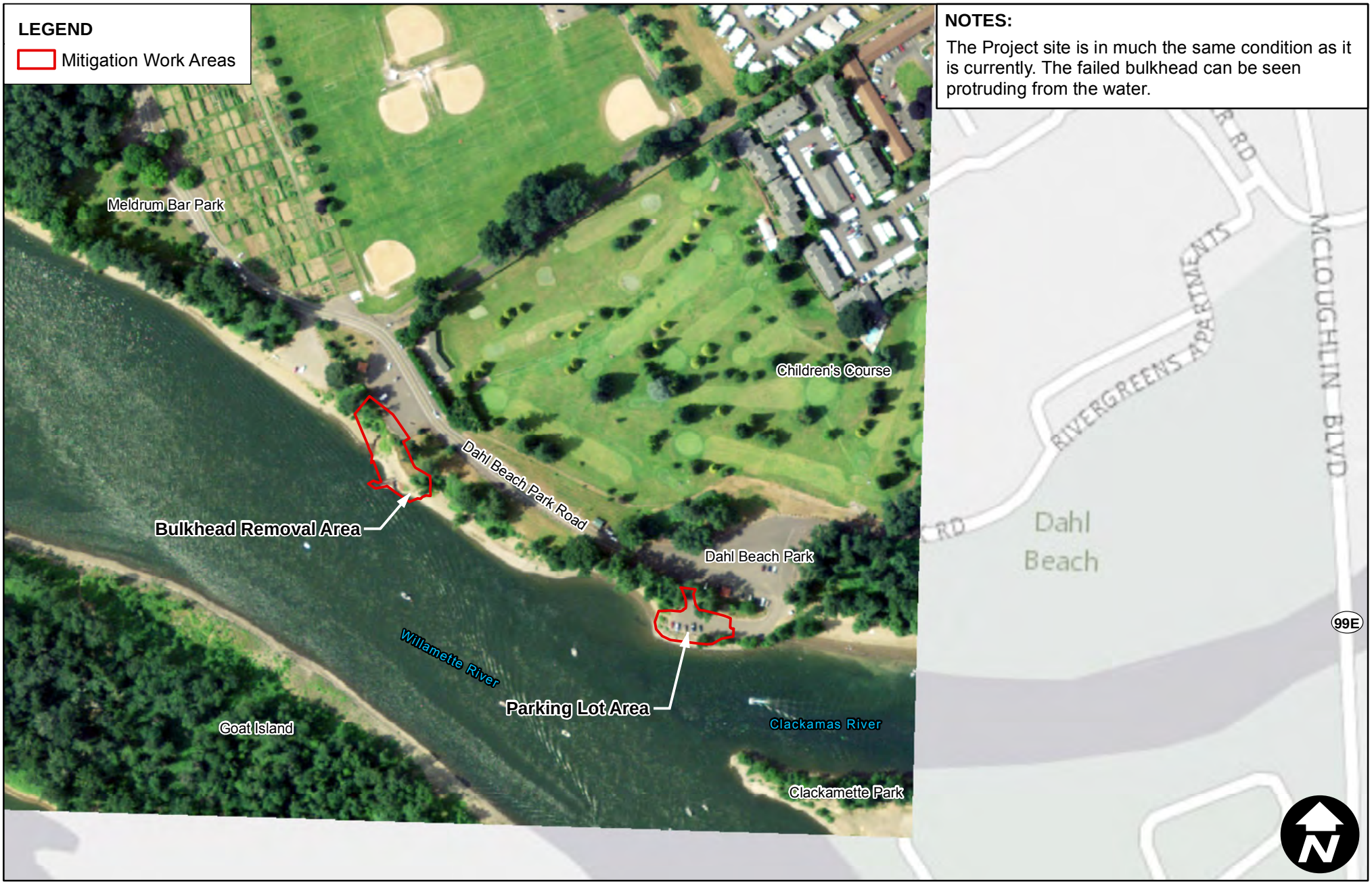

Date: 10/29/2015
Scale: 1 inch = 300 feet
Aerial Source: University of Oregon Map & Aerial Photography Library; ESRI, 2015.

Appendix A. Dahl Beach Mitigation Project Historical Aerials - 2009

CASCADE ENVIRONMENTAL GROUP

Feet
0 250 500

Terminal 4 Phase I Removal Action Draft Mitigation Work Plan
Port of Portland, Portland, Oregon

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APPENDIX B
REPORT OF GEOTECHNICAL ENGINEERING SERVICES

Report of Geotechnical Engineering Services

Dahl Beach Mitigation Project

Gladstone, Oregon

Prepared for

Cascade Environmental Group

October 27, 2015

15984-03

HARTCROWSER

Report of Geotechnical Engineering Services

Dahl Beach Mitigation Project

Gladstone, Oregon

Prepared for

Cascade Environmental Group

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15984-03

Prepared by

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Report of Geotechnical Engineering Services

Dahl Beach Mitigation Project

Gladstone, Oregon

1.0 INTRODUCTION

Hart Crowser, Inc., is pleased to submit our report of geotechnical engineering services for the Dahl Beach Mitigation project in Gladstone, Oregon. Our work was completed in general accordance with our July 10, 2015 proposal, which detailed our scope and fee.

The project includes rehabilitation of the shoreline at two locations along the Willamette River and Clackamas River waterfronts, referred to as the Bulkhead Removal and Parking Lot Sites in this report. The Bulkhead Removal Site consists of a derelict sheet pile bulkhead on the east shore of the Willamette River approximately 900 feet downriver from its confluence with the Clackamas River. Based on our review of available aerial photography, it appears the bulkhead experienced a catastrophic failure during the winter of 2005/2006. We understand the sheet piles will be removed and the site will be regraded to better reflect a more natural river shore. We understand the regrading will consist mainly of cuts; however, one small fill is planned near the toe of the bulkhead. The Parking Lot Site consists of an existing asphalt paved parking lot located on the northeast shore of the Willamette/Clackamas River confluence. We understand the approximate western half of the parking lot will be demolished and the site will be regraded to better reflect a more natural river shore landscape.

This report contains the results of our analysis and provides recommendations for geotechnical design and construction for the two sites. The report is organized into several sections. The first section provides an overview of the project information discussed in the text. The main body of the report presents our geotechnical engineering findings and recommendations in detail. Figures are presented at the end of the text. The locations of the project sites are shown on Figure 1, the layout showing existing conditions at the Bulkhead Removal Site is shown on Figure 2, and the layout showing existing conditions at the Parking Lot Site is shown on Figure 3. Supporting information is included in the appendices. Appendix A contains subsurface exploration logs, and Appendix B contains the results of our slope stability modeling.

2.0 SCOPE OF SERVICES

The purpose of our work was to evaluate soils at both sites and provide earthwork recommendations for the sites, with an emphasis on final slope conditions. Our specific scope of work was detailed in our proposal and generally included the following tasks.

- Reviewed existing published geotechnical information and geologic maps that covered the site and vicinity.
- Advanced three borings to depths ranging from 11.5 to 31.0 feet below ground surface (bgs).

- Conducted a program of laboratory testing on select soil samples.
- Completed engineering analysis to evaluate the effects of removing the sheet piles at the bulkhead site and to develop earthwork recommendations.
- Prepared this draft report outlining our findings and recommendations, including information related to the following:
  - Subsurface soil and groundwater conditions,
  - Site preparation and grading,
  - The results of our slope stability modeling at the Bulkhead Removal site, and
  - Bulkhead removal recommendations.
- Provided project management and support services, including coordinating staff and subcontractors and conducting telephone consultations and email communications with the design team.

3.0 SITE CONDITIONS

3.1 Surface Conditions

Ground surface elevations are referenced to the NAVD 88 vertical datum.

Bulkhead Removal Site: The Bulkhead Removal Site is bound by the Willamette River on the southwest, beaches on the northwest and southeast, and Dahl Park Road on the northeast. A derelict ruptured sheet pile bulkhead is present in two pieces extending into the river. The bulkhead was originally oriented approximately northwest-southeast prior to failure. Several steel-braided cables extend into the slope behind the wall. An abandoned concrete wall, or possibly a strip footing, is present at the crest of the slope on the west border of the parking lot. The concrete wall/footing is flush to the adjacent parking lot asphalt and appears to be a part of a demolished structure formerly present at the site. The concrete wall/footing is underpinned by a steel sheetpile bulkhead extending approximately 30 feet beyond the intersection of the ruptured bulkhead and the parking lot. The natural slopes surrounding the site are vegetated with large shrubs, tall grasses, and several mature trees.

The site varies significantly in elevation moving from east at the crest of the slope to west in the riverbed. The ground surface varies from an average of elevation -7 feet in the river to elevation 42 feet at the crest of the slope. A bathymetry survey completed for the project indicates a scour hole approximately 50 feet in diameter and approximately 6 feet deeper than the surrounding riverbed near the toe of the wall. The ground surface behind the crest of the slope is generally flat at approximate average elevation 42 feet. The ground surface immediately behind the wall has sloughed back to an approximate 1.5 horizontal to 1 vertical (1.5H:1V) slope. An approximately 10-foot-tall, near-vertical terrace is present behind the wall just below the slope crest. Natural and riverbed slopes surrounding the site lie at slopes of up to a 1.5H:1V grade.

Parking Lot Site: The Parking Lot Site is bound by the rivers on south and west, and parking lots on the east and north. A riprap-protected slope lies below the parking lot. The natural slopes surrounding the site are vegetated with large shrubs, tall grasses, and several mature trees.

The ground surface is relatively level in the parking area, with an average elevation of 21 feet. Two approximately 30- to 40-foot-wide driveways, lying at an approximately 5H:1V slope, connect the lower parking lot project area to another parking lot above the site. The ground surface at the top of the driveways is at elevation 30 feet. The riprap-protected slope below the parking lot project area, and natural slopes northwest of it, lie at an approximate 2H:1V grade. Riverbank slopes below the riprap slope are relatively shallow lying at about 6H:1V.

3.2 Geologic and Soil Mapping

The geology of the site was mapped by the Oregon Department of Geology and Mineral Industries Geological Map of the Oregon City 7.5' Quadrangle, Clackamas County, Oregon (Madin 2009). The map indicates the site is underlain by Quaternary alluvial and terrace gravel, sand, silt, and clay deposits overlying Tertiary Columbia River Basalt (CRB). Site explorations encountered materials consistent with the geologic mapping, with the exception that CRB was not encountered.

The near-surface soils at the site are mapped by the U.S. Department of Agriculture (USDA) as found on the Web Soil Survey website (USDA 2006). The Web Soil Survey indicates that Camas Gravelly Sandy Loam is mapped at the Bulkhead Removal Site and Riverwash is mapped at the Parking Lot Site. Camas soil is described as excessively drained alluvium formed on stream floodplains. Permeability of the soil is listed as high (2 to 6 inches/hour). Riverwash soil is described as well-drained alluvium formed on stream floodplains. Permeability of the Riverwash soil is not provided. The Web Soil Survey indicates the Riverwash unit is frequently flooded.

3.3 Subsurface Conditions

3.3.1 General

Soil conditions interpreted from geologic maps and our explorations, in conjunction with soil properties inferred from field observations and laboratory tests, formed the basis for the conclusions and recommendations in this report. Appendix A describes our field exploration procedures and presents field data and logs.

We completed explorations at the site by advancing three borings, designated B-1A, B-1B, and B-2, to depths between 11.5 and 31.0 feet bgs on July 30, 2015. Borings B-1A and B-1B were completed at the Bulkhead Removal Site, while boring B-2 was completed at the Parking Lot Site. It should be noted that boring B-1B was completed when the drilling subcontractor accidentally dropped a steel sampler into boring B-1A at a depth of 20 feet, above the intended boring depth, blocking completion of boring B-1A. Therefore, boring B-1B was completed approximately 10 feet north of boring B-1A to the intended depth of 31.0 feet. The boring locations are shown on Figures 2 and 3.

Descriptions of the subsurface conditions encountered at the two sites are provided below.

3.3.2 Soil Conditions

Bulkhead Removal Site

Approximately 3.5 inches of asphalt pavement was encountered at the ground surface in borings B-1A and B-1B. Gravel, cobbles, and boulders were encountered underlying the asphalt in borings B-1A and B-1B, extending to the maximum depth explored. The gravel, cobbles, and boulders contain varying sand content ranging from approximately 20 to 30 percent and varying silt content from 5 to 10 percent. Based on Standard Penetration Test (SPT) blow counts, the relative density of the gravel, cobbles, and boulders ranges from medium dense to very dense, but is more typically dense to very dense. An approximately 3-foot-thick silty sand lens was encountered in the gravel, cobbles, and boulders soil unit at a depth of approximately 14 feet bgs. Based on SPT blow counts, the relative density of the silty sand is medium dense.

Parking Lot Site

Approximately 3 inches of asphalt pavement was encountered at the ground surface in boring B-2 underlain by approximately 4 inches of crushed aggregate base fill. Gravel, cobbles, and boulders were encountered underlying the asphalt and aggregate base in Boring B-2, extending to the maximum depth explored. The gravel, cobbles, and boulders are sandy with fine to coarse sand and contain trace silt. Based on SPT blow counts, the relative density of the gravel, cobbles, and boulders ranges from loose to dense.

Limitations

The subsurface information used for this study represents conditions at discrete locations across the project sites. Actual conditions in other areas could vary. The nature and extent of any variations in subsurface conditions may not become evident until construction begins. If significant variations are observed at that time, we may need to modify our conclusions and recommendations accordingly to reflect actual site conditions.

3.3.3 Groundwater

Groundwater was not encountered in the borings completed at the site. We anticipate groundwater will closely follow the nearby Willamette River and Clackamas River levels and could approach the ground surface during flooding events.

4.0 SLOPE STABILITY ANALYSIS FOR BULKHEAD REMOVAL SITE

4.1 General

We completed slope stability analyses at the Bulkhead Removal site in the approximate location of Cross Section A-A' as shown on Figure 2. Soil properties used in the analyses were estimated from testing of similar soils from other projects we have completed and from our experience with similar soils. The cross sectional surface geometry was based on a topographic survey completed by Waterways Consulting, Inc. Subsurface stratigraphy was interpreted from our borings and our observations of soils exposed in the site slopes. We evaluated the stability of the existing slopes in

their current geometry with varying water levels from elevation 42 feet to elevation 15 feet. We re-evaluated the slopes with new geometry to develop a recommendation for final gradients that would achieve a satisfactorily stable slope and prevent excessive cuts and fill. The soil parameters used in our analysis are shown in Table 1.

Table 1 – Soil Properties Used in Stability Analyses

Soil Unit	Friction Angle (Degrees)	Cohesion (psf)	Moist Unit Weight (pcf)
Sand	32	0	115
Gravel, Cobbles, and Boulders	36	15	130

Notes: psf = pounds per square foot • pcf = pounds per cubic foot

The soil parameters and subsurface stratigraphy were determined as noted above. However, the parameters were modified within a reasonable range of expected values to achieve a temporary stability for the slope in its current geometry.

Our analysis used the computer program SlopeW, which models the stability of the slope in terms of a factor of safety (FS) against sliding for a series of potential failure surfaces with different geometries. Potential failure surfaces were modeled as a rotational failure using the Spencer's Method of Slices, a derivation of the original method of slices. The Spencer method satisfies both moment and force equilibrium and accounts for both normal and shear forces acting between the slices. An FS value of 1.0 reflects a condition in which the resisting and driving forces along the failure surface are equal and a failure could occur if the resisting forces are reduced or the driving forces are increased. An increasing FS value presents a more stable slope and a decreasing FS a less stable slope. An FS value below 1.0 means the slope will theoretically fail, as the forces resisting failure are less than those driving it. For any given slope geometry, subsurface stratigraphy, and soil parameters modeled in the program, the lowest FS value calculated among all the failure surfaces is considered the *critical failure surface*.

Analysis figures are provided in Appendix B. The calculated FS values are shown in Table 2 for the critical failure surface in each condition prior to ("Existing") and after finish grading is complete ("Regraded"). Changes in FS due to the proposed cut would reflect changes in stability of the slope due to the grading. The results of our analyses show that the slopes in their current configurations are marginally stable. Therefore, if an external destabilizing influence occurs, such as a large surcharge load placed near the crest of the slope or scour at the toe of the slope, a slope failure would be likely. Our analyses have determined that a final slope angle of 2H:1V will be relatively stable under varying water levels of the adjacent rivers. It should be noted that regardless of final slope configuration, erosion will continue to act as a destabilizing influence. Some maintenance may be required to maintain the stability of the slope beyond this project. The level of maintenance will depend on the extent and severity of future erosion.

Table 2 –Stability Analysis Results for Existing and Regraded Geometry, Section A-A'

Condition	FS Value	Notes
Case 1: High Water Existing	1.07	Water at Elevation 42 feet
Case 2: High Water Regraded	1.53	Water at Elevation 42 feet
Case 3: Low Water Existing	1.03	Water at Elevation 15 feet
Case 4: Low Water Regraded	1.46	Water at Elevation 15 feet
Case 5: Ordinary High Water Existing	0.98	Water at Elevation 25 feet
Case 6: Ordinary High Water Regraded	1.37	Water at Elevation 25 feet

5.0 CONCLUSIONS

Our evaluations indicate the site is suitable for the proposed grading, provided the recommendations in this report are included in design and construction. Considerations for the design and construction of the fill include the following items.

- The results of our stability analyses indicate final cut and fill slope angles should not exceed 2H:1V.
- The small fill planned at the toe of the existing wall should be constructed as structural fill to provide sufficient slope stability. Based on our conversations with Cascade Environmental, we understand the fill material will consist of the gravel, cobbles, and boulders excavated from the cuts on site. Recommendations for the placement of site soils as structural fill are provided in following sections.
- One of the main objectives for the project at the Bulkhead Removal Site is to remove the existing steel sheet pile wall. It has been our experience that old sheet piles can be difficult to remove. Some construction delays and field modifications should be anticipated for this work.
- We did not encounter evidence of fill during our reconnaissance or subsurface explorations on site; however, we anticipate some undocumented fill will be present. Construction planning should anticipate the presence of fill within the zone of excavation.

  We anticipate fill will consist of the gravel, cobbles, and boulders found on site. However, in our experience, fill often contains man-made objects, including construction debris (such as concrete, brick, steel, lumber, and other materials), organic materials (such as plants and wood), and in some cases general garbage. Fill consisting only of gravel, cobbles, and boulders soil will likely not be distinguishable from native soils and will be suitable for reuse as structural fill, provided the recommendations of *Section 6.4 – Structural Fill Placement* are followed. Fill containing debris similar to those indicated above may not be suitable for reuse as structural fill and should be evaluated by Hart Crowser prior to reuse.

The following sections of the report present our conclusions and recommendations for geotechnical aspects of the project. We developed our recommendations using our current understanding of the project and the subsurface conditions encountered during our site explorations. If the nature or location of the work is different than we have assumed, we should be notified so we can change or confirm our recommendations.

6.0 EARTHWORK RECOMMENDATIONS

Based on available information, the project consists of earthwork and demolition, including mainly cuts and one small fill to establish the recommended final slope angle.

All earthwork should be conducted in accordance with City of Gladstone Municipal Code Title 15.06 – Earthwork and Erosion Control Standards (City of Gladstone 2015) and the Oregon Standard Specifications for Construction (OSSC) (ODOT 2015). In the event of conflict between the two standards, the City of Gladstone Municipal Code should prevail. Specific recommendations for earthworks are provided in the following sections.

6.1 Demolition

Removal of the existing sheet pile walls may encounter difficulties, as the sheets may have become stuck together and the steel may have degraded over the years. Construction delays should be anticipated with regards to this. We understand that removal of the piles will be first attempted. However, if some sections of pile are not easily pulled free, the piles will be cut below finish grade and covered with on-site soils.

Based on the original wall configuration and our observations of steel cables protruding from the existing slope, we believe the wall was originally anchored by the cables to a buried deadman. It is unknown what type of deadman may be present; however, in our experience, deadmen typically consist of a set of steel sheet piles or large concrete block(s). The planned cut may daylight the deadman. We understand that if the deadman daylights in the cut, it will be cut back or broken up below final grade and covered with on-site soils.

Permanent construction debris, such as stuck sheet piles or the deadman, that are cut or broken up below final grade and covered with on-site soils should not pose a risk to the long-term stability of the slope, provided they are covered with structural fill as recommended later in this report. We recommend sheet piles be cut off and existing debris be removed to approximately 3 feet below final grade, and then backfilled with structural fill.

We understand recent reconnaissance of the site has revealed that the sheet pile wall extends along the crest of the slope approximately 30 feet northwest of the intersection of the crest and the sheets. Cuts are planned along this section of the slope to accommodate the recommended slope angle. We recommend the sheet piles along this section of wall be left in place, since they will increase the stability of the final slope configuration. The piles should be cut below final grade and covered with on-site soils as recommended above.

Materials generated during demolition of existing improvements should be transported off site for disposal or stockpiled in areas designated by the owner. In general, these materials will be suitable for reuse as engineered fill, provided they meet the specifications provided in *Section 6.4 - Structural Fill and Backfill* of this report.

6.2 Stripping and Subgrade Preparation

We understand one small fill is planned near the toe of the existing wall at the Bulkhead Removal Site. We recommend the fill be placed as structural fill so the soil provides the same level of shear resistance we assumed in our slope stability analysis. Prior to any filling, the fill area should be stripped of surficial organic material. No explorations were completed in the area of the fill; however, we anticipate the depth of stripping will be 8 to 12 inches. Actual stripping depths should be evaluated and modified as appropriate based on observations during stripping operations.

The suitability of the subgrade should be evaluated by a representative of Hart Crowser by probing with a foundation probe to identify any loose or unsuitable areas after stripping is complete. The evaluation should be conducted prior to placing fill. We anticipate that the subgrade will be loose granular material. If this is found to be the case, that subgrade will need to be compacted with several passes of a vibratory pneumatic smooth drum roller or heavy vibratory plate compactor, provided the material is near its optimum moisture. If soft silty subgrade is identified during subgrade excavation, these areas should be overexcavated to the extent indicated by Hart Crowser and replaced with structural fill as described in *Section 6.4 - Structural Fill and Backfill* of this report.

6.3 Excavation

Site soils within expected excavation depths generally consist of sandy gravel, cobbles, and boulders and silty sand. It is our opinion that conventional earthmoving equipment in proper working condition should be capable of making necessary general excavations for earthwork. The earthwork contractor should be responsible for providing equipment and following procedures as needed to excavate the site soils, as described in this report, while protecting the subgrade.

Temporary excavations are expected to be minimal for this project, including only those necessary for filling at the toe of the sheetpile wall and demolition of existing elements as noted previously in this report. Soils at the site are granular in nature and generally classify as Occupational Safety and Health Administration (OSHA) class C for purposes of excavation. The contractor should be responsible to ensure that all temporary excavations are completed in accordance with OSHA requirements, including maximum slope gradients, shoring or other measures to meet the requirements and provide for worker safety.

We recommend that permanent slopes not exceed 2H:1V to maintain the levels of stability as noted previously in this report. We recommend a setback from the top of the slope to the edge of any improvements, such as the parking lot, of 2 to 5 feet to provide some buffer for raveling and surface disturbance of the granular site soils.

6.4 Structural Fill Placement

All permanent fill placed on the site should be constructed as structural fill. Fill should only be placed over a subgrade that has been prepared in accordance with *Section 6.2 - Stripping and Subgrade Preparation* of this report. We understand that on-site soils from other portions of the project will be used as fill for the project. We recommend that the on-site sandy gravel soils be used as structural fill, provided they are free of debris, clay balls, roots, organic matter, frozen soil, man-made contaminants, and other deleterious materials. The

material should be generally well-graded and individual particles exceeding half the uncompacted lift thickness in size should be removed from the fill before placing it. In our opinion, structural fill constructed from this material should provide a comparable magnitude of shear resistance to the native soils encountered in our explorations, provided the recommendations below are used during construction.

- If the fill is placed on a slope steeper than 5H:1V, benches should be cut into the slope. An initial bench should be excavated at the toe of the existing slope with a minimum width of 5 feet and large enough to accommodate the compaction equipment to be used. The bench should be leveled flat prior to installation of the fill. The bench should extend into the existing slope a minimum of 3 feet. Additional benches should be cut into the hillslope every 3 vertical feet of fill placement that are a minimum of 3 feet wide.

- Place the fill in uniform horizontal lifts with a thickness appropriate for the material type and compaction equipment. Table 3 provides general guidance for uncompacted lift thicknesses. Boulders and cobbles were observed at the ground surface throughout the project site. In order to achieve proper compaction of the native materials, we recommend that oversized materials greater than half of the lift thickness be removed prior to placement of each lift. Lifts are typically 12 inches thick; therefore, we anticipate material larger than 6 inches will need to be removed.

- Do not place fill and backfill until the required tests and evaluation of the underlying materials have been made and the appropriate approvals have been obtained.

- Control the moisture content of the fill to ensure it can be compacted to a dense, well-keyed state. This will require that the fill is visibly moist, but not saturated. Hart Crowser shall confirm suitability of the moisture content during construction.

- Compact fill soils to a well-keyed dense state. Compaction should be verified by Hart Crowser staff through performance testing, such as probing and or other measures during construction of the fill.

- Fill slopes should be overbuilt by at least 12 inches and then trimmed back to the required slope to maintain a firm face.

Table 3 – Guidelines for Uncompacted Lift Thickness

Compaction Equipment	Guidelines for Uncompacted Lift Thickness (inches)		
	Fine-Grained Soil	Granular Soil and Crushed Rock (Maximum Size ≤ 1½ inch	Crushed Rock (Maximum Size > 1½ inch)
Plate Compactors and Jumping Jacks	4 – 8	4 – 8	Not Recommended
Rubber-Tire Equipment	6 – 8	10 – 12	6 – 8
Light Roller	8 – 10	10 – 12	8 – 10
Heavy Roller	10 – 12	12 – 18	12 – 16
Hoe Pack Equipment	12 – 16	18 – 24	12 – 16

Note: The above table is based on our experience and is intended to serve as a guideline. The information provided in this table should not be included in the project specifications.

7.0 CONSTRUCTION OBSERVATION

Satisfactory earthwork performance depends to a large degree on quality of construction. Sufficient monitoring of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Subsurface conditions observed during construction should be compared with those encountered during subsurface explorations. Recognition of changed conditions often requires experience; therefore, Hart Crowser or its representative should visit the site often enough to detect whether subsurface conditions change significantly from those anticipated.

We recommend retaining Hart Crowser to monitor construction at the site to confirm that subsurface conditions are consistent with those identified by the site explorations and that the intent of project plans and specifications relating to earthwork construction is being met. In particular, we recommend that Hart Crowser evaluate subgrade preparation and observe/test the placement/compaction of structural fill.

8.0 LIMITATIONS

We have prepared this report for the exclusive use of Cascade Environmental Group and its authorized agents for the Dahl Beach Rehabilitation Project in Gladstone, Oregon, in accordance with our July 10, 2015 proposal detailing our scope and fee. Our report is intended to provide our opinion of geotechnical parameters for preliminary design of the proposed project based on exploration locations that are believed to be representative of site conditions. However, conditions can vary significantly between exploration locations, and our conclusions should not be construed as a warranty or guarantee of subsurface conditions or future site performance.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty, express or implied, should be understood.

Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments, are only a copy of the original document. The original document is stored by Hart Crowser and will serve as the official document of record.

9.0 REFERENCES

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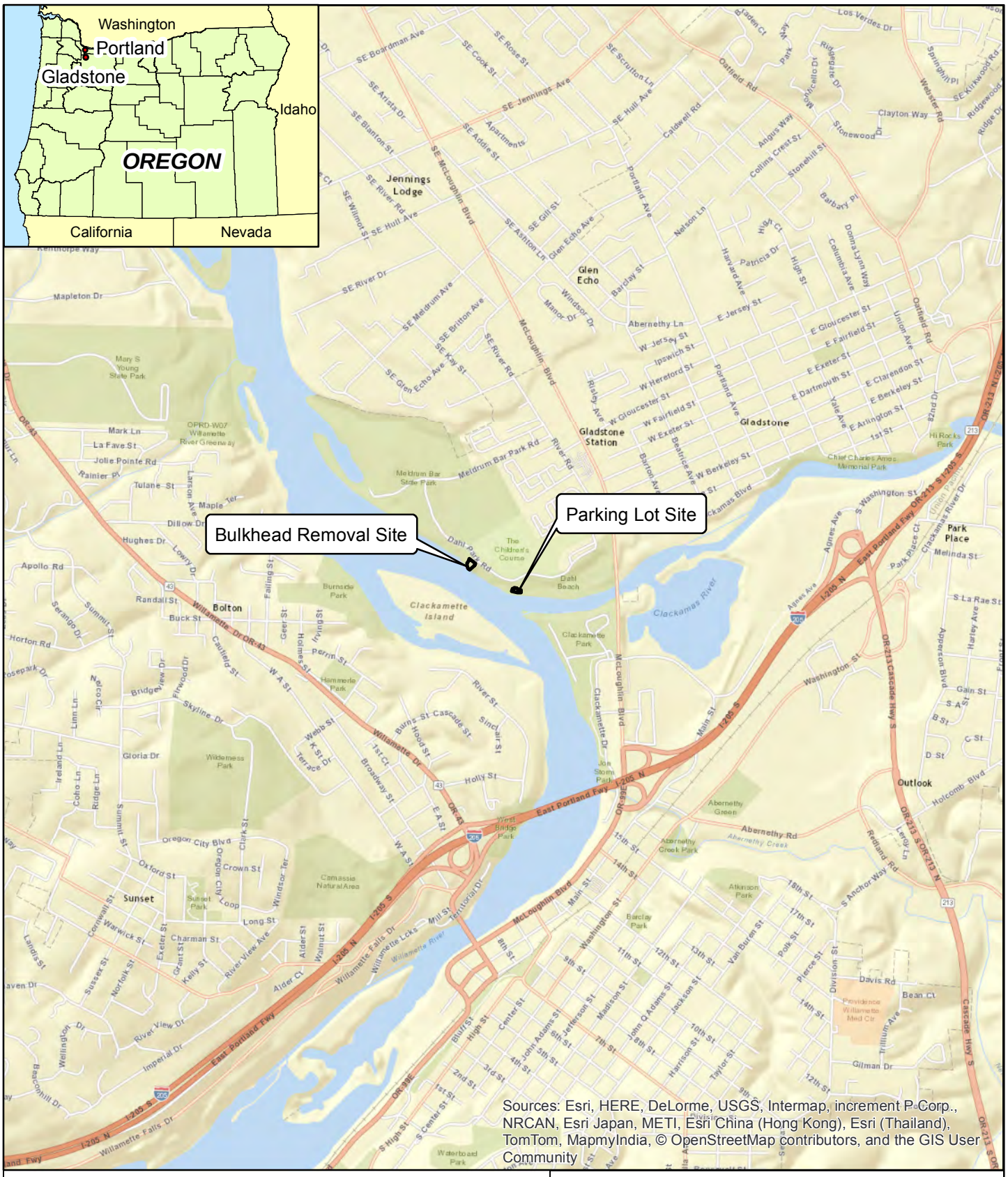

0 1,000 2,000 4,000 Feet

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Dahl Beach Mitigation Project
Gladstone, Oregon

Vicinity Map

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HARTCROWSER

Figure 1

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LEGEND

- Boring
- Cross Section
- Surveyed Elevation Contours (NAVD 88) Provided by Cascade Environmental Group 8/12/2015

0 30 60 120 Feet

Note: Locations of features are approximate.

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Dahl Beach Mitigation Project
Gladstone, Oregon

Bulkhead Removal Site Plan

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Figure 2

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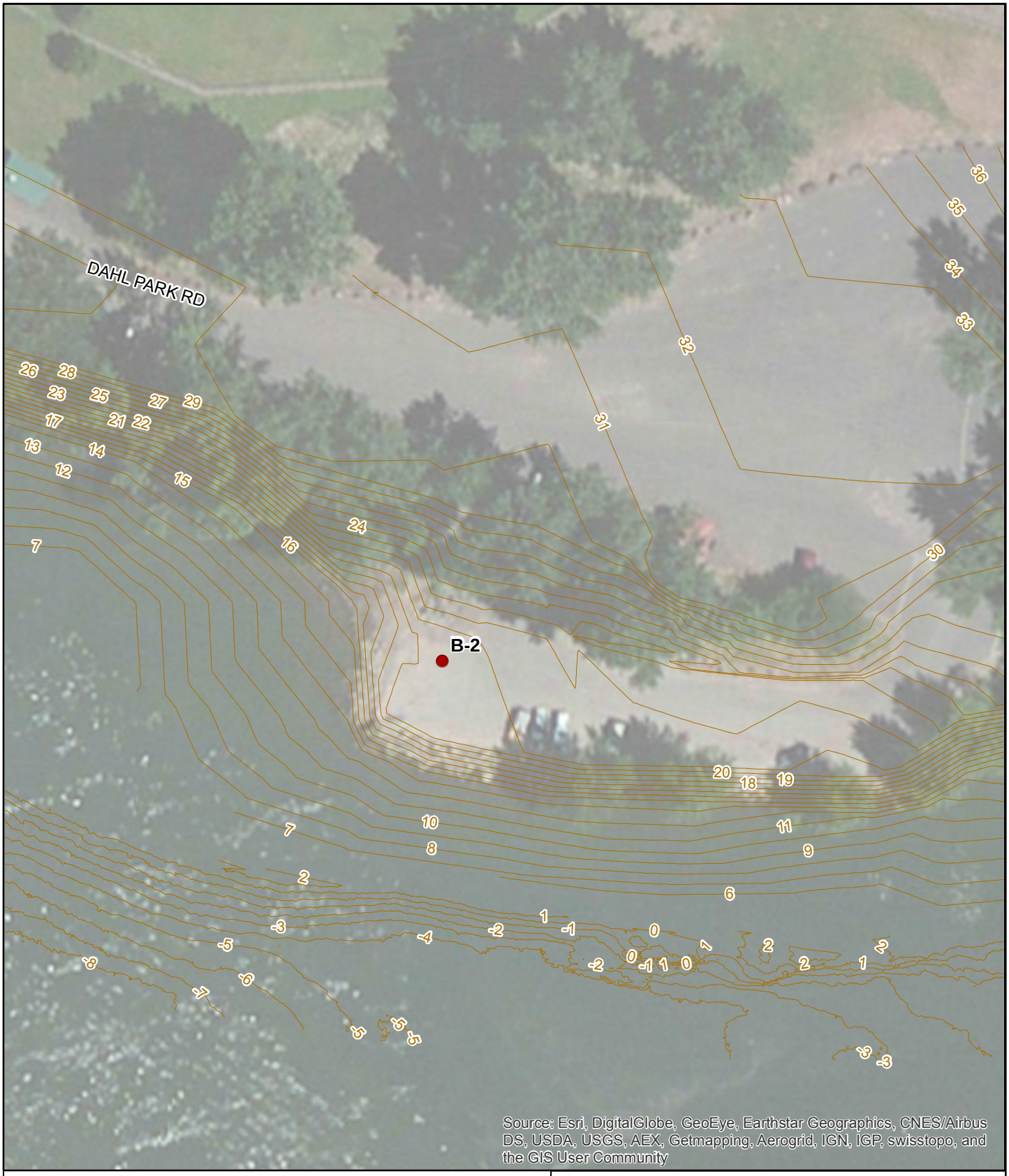

LEGEND

- Boring
- Surveyed Elevation Contours (NAVD 88) Provided by Cascade Environmental Group 8/12/2015

0 30 60 120 Feet

Note: Locations of features are approximate.

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Dahl Beach Mitigation Project
Gladstone, Oregon

Parking Lot Site Plan

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Figure 3

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APPENDIX A
Field Explorations Methods and Analysis

APPENDIX A

Field Explorations Methods and Analysis

This appendix documents the processes Hart Crowser used to determine the nature and quality of the soil and groundwater underlying the project site addressed by this report. The following sections are included:

- Explorations and Their Locations,
- Drilled Borings, and
- Sampling Procedures.

Explorations and Their Locations

Explorations at the site included three borings, B-1A, B-1B, and B-2. The exploration logs in this appendix show our interpretation of the explorations and sampling data. The logs indicate the depths where the soils change. Note that soil changes may be gradual. In the field, we classified the samples taken from the explorations according to the methods presented on the Key to Exploration Logs. This key also provides a legend explaining the symbols and abbreviations used in the logs.

Figures 2 and 3 of the report show the locations of explorations. Exploration locations were estimated in the field based on existing landmarks.

Drilled Borings

One mud rotary boring (B-1A) and two hollow-stem auger borings (B-1B and B-2) were completed at the site using a truck-mounted drill rig subcontracted by Hart Crowser. The borings were completed on July 30, 2015. The drilling was continuously observed by geotechnical staff members from Hart Crowser and detailed field logs of the borings were prepared. The logs are presented at the end of this appendix.

Sampling Procedures

Samples were obtained from the borings using a split-spoon sampler (SPT sampler) with an inner diameter of 1-1/2 inches and a split-spoon sampler (D&M sampler) with an inner diameter of 3.0 inches in general accordance with guidelines presented in ASTM D 1586. The split-barrel samplers were driven into the soil with a 140-pound hammer free falling 30 inches. The samplers were driven a total distance of 18 inches. The number of blows required to drive the samplers the final 12 inches is recorded on the boring logs, unless otherwise noted. Due to the larger D&M sampler size, the blow count field values were reduced by 50 percent on the logs to approximately correlate with the SPT blow counts shown.

Soil samples were recovered from the split-barrel sampler, field classified, and placed into watertight bags. They were then taken to Hart Crowser's laboratory for further classification.

KEY TO EXPLORATION LOGS

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SOIL CLASSIFICATION CHART

MATERIAL TYPES	MAJOR DIVISIONS		GROUP SYMBOL	SOIL GROUP NAMES & LEGEND
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	GW	WELL-GRADED GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES, >12% FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SANDS >50% OF COARSE FRACTION PASSES ON NO 4. SIEVE	CLEAN SANDS <5% FINES	SW	WELL-GRADED SAND
			SP	POORLY-GRADED SAND
		SANDS AND FINES >12% FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT<50	INORGANIC	CL	LEAN CLAY
			ML	SILT
		ORGANIC	OL	ORGANIC CLAY OR SILT
	SILTS AND CLAYS LIQUID LIMIT>50	INORGANIC	CH	FAT CLAY
			MH	ELASTIC SILT
		ORGANIC	OH	ORGANIC CLAY OR SILT
HIGHLY ORGANIC SOILS			PT	PEAT

Note: Multiple symbols are used to indicate borderline or dual classifications

OTHER MATERIAL SYMBOLS

- Concrete
- Asphalt
- Topsoil

MOISTURE MODIFIERS

- Dry - Absence of moisture, dusty, dry to the touch
- Moist - Damp, but no visible water
- Wet - Visible free water or saturated, usually soil is obtained from below the water table

SEEPAGE MODIFIERS

- None -
- Slow - < 1 gpm
- Moderate - 1-3 gpm
- Heavy - > 3 gpm

CAVING MODIFIERS

- None -
- Minor - isolated
- Moderate - frequent
- Severe - general

MINOR CONSTITUENTS

- Trace - < 5% (silt/clay)
- Occasional - < 15% (sand/gravel)
- With - 5-15% (silt/clay) in sand or gravel; 15-30% (sand/gravel) in silt or clay

SAMPLE TYPES

- Dames & Moore
- Standard Penetration Test (SPT)
- Shelby Tube
- Bulk or Grab

LABORATORY/ FIELD TESTS

- ATT - Atterberg Limits
- CP - Laboratory Compaction Test
- CA - Chemical Analysis (Corrosivity)
- CN - Consolidation
- DD - Dry Density
- DS - Direct Shear
- HA - Hydrometer Analysis
- OC - Organic Content
- PP - Pocket Penetrometer (TSF)
- P200 - Percent Passing No. 200 Sieve
- SA - Sieve Analysis
- SW - Swell Test
- TV - Torvane Shear
- UC - Unconfined Compression

GROUNDWATER SYMBOLS

- Water Level (at time of drilling)
- Water Level (at end of drilling)
- Water Level (after drilling)

STRATIGRAPHIC CONTACT

- Distinct contact between soil strata or geologic units
- Gradual or approximate change between soil strata or geologic units

Notes:

Blowcount (N) is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted) per ASTM D-1586. See exploration log for hammer weight and drop.

When the Dames & Moore (D&M) sampler was driven with a 140-pound hammer (denoted on logs as D+M 140), the field blow counts (N-value) shown on the logs have been reduced by 50% to approximate SPT N-values.

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits and probes is estimated based on visual observation and is presented parenthetically on the logs.

Refer to the report text and exploration logs for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the exploration locations at the time the explorations were made. The logs are not warranted to be representative of the subsurface conditoins at other locations or times.

KEY TO EXPLORATION LOGS - F:\GINT\OREGON_LIBRARY.GLB - 8/3/15 11:06 - F:\NOTEBOOKS\1598403_DAHL BEACH REHABILITATION\FIELD DATA\PERM_GINT\1598403_EXPLORATIONS.GPJ

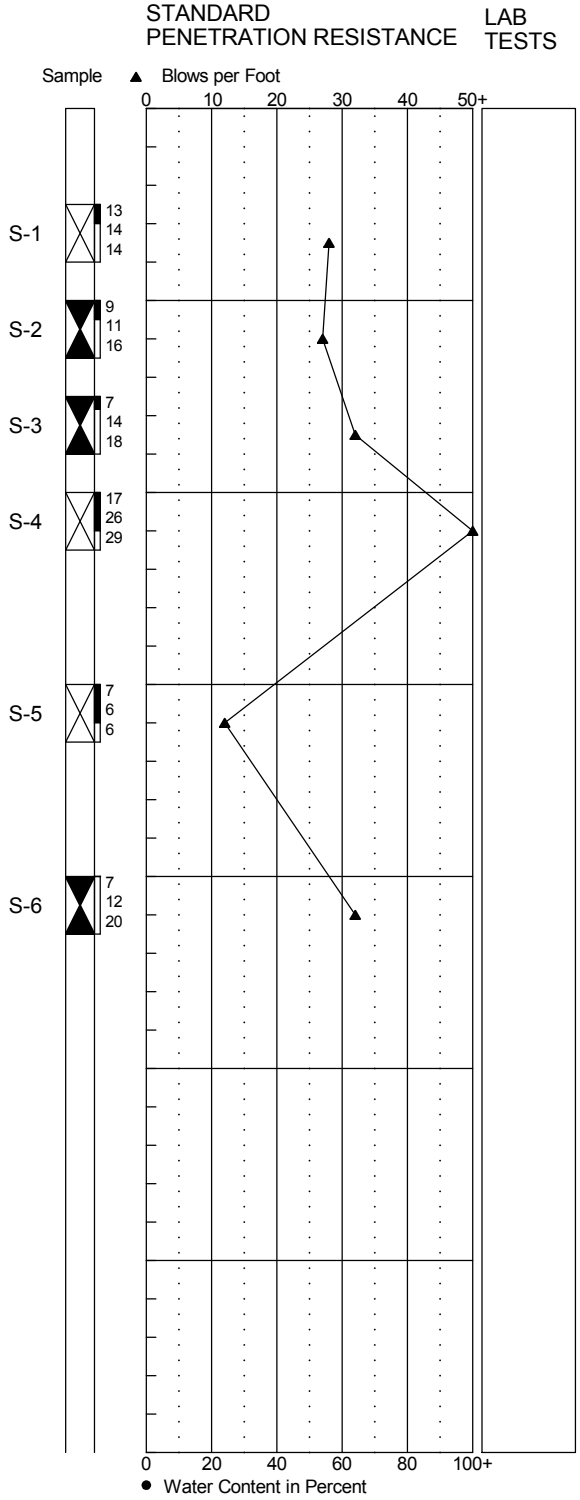
Figure A-1

Boring Log B-1A

Location: N 629625.75 E 7659906.5
Approximate Ground Surface Elevation: 42 Feet
Horizontal Datum: NAD 83 Oregon State Plane North (Feet)
Vertical Datum: NAVD 88

Drill Equipment: Mud Rotary
Hammer Type: Auto Hammer
Hole Diameter: 4 7/8 inches
Logged By: J. Alders Reviewed By: J. Alders

USCS Class	Soil Descriptions	Depth in Feet
GP	Asphalt Concrete (3.5-inch thick)	0
	Medium dense, dry to moist, gray, GRAVEL, COBBLES, and BOULDERS with fine to coarse sand, trace silt.	
	Grades to dense.	5
	Grades to very dense.	10
SM	Medium dense, moist, brown, silty fine SAND.	15
GP-GM	Dense, moist, gray, GRAVEL, COBBLES, and BOULDERS with silt and fine to coarse sand.	20
	Bottom of Boring at 21.5 Feet. Started 07/30/15. Completed 07/30/15.	25, 30, 35



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

15984-03 *10/15*

Figure A-2

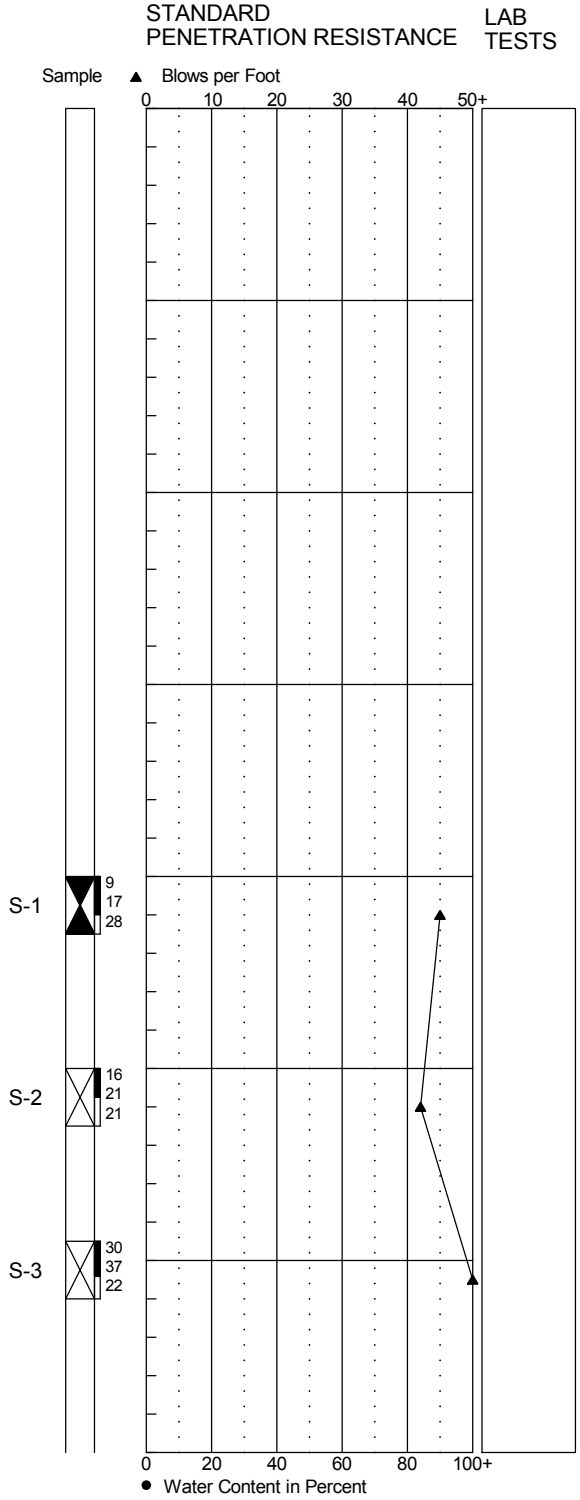
NEW BORING LOG - F:\GINT\OREGON_LIBRARY.GLB - 10/9/15 14:51 - F:\NOTEBOOKS\1598403_DAHL BEACH REHABILITATION\FIELD DATA\PERM_GINT\1598403_EXPLORATIONS.GPJ

Boring Log B-1B

Location: N 629625.75 E 7659906.5
Approximate Ground Surface Elevation: 42 Feet
Horizontal Datum: NAD 83 Oregon State Plane North (Feet)
Vertical Datum: NAVD 88

Drill Equipment: Hollow Stem Auger
Hammer Type: Auto Hammer
Hole Diameter: 8 inches
Logged By: J. Alders Reviewed By: J. Alders

USCS Class	Soil Descriptions	Depth in Feet
GP	Asphalt Concrete (3.5-inch thick)	0
	(Medium dense to very dense), dry to moist, gray, GRAVEL, COBBLES, and BOULDERS with fine to coarse sand, trace silt.	5, 10
SM	(Medium dense), moist, brown, silty fine SAND.	15
GP-GM	Dense to very dense, moist, gray, GRAVEL, COBBLES, and BOULDERS with silt and fine to coarse sand.	20, 25, 30
	Bottom of Boring at 31.0 Feet. Started 07/30/15. Completed 07/30/15.	35



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

15984-03 *10/15*

Figure A-3

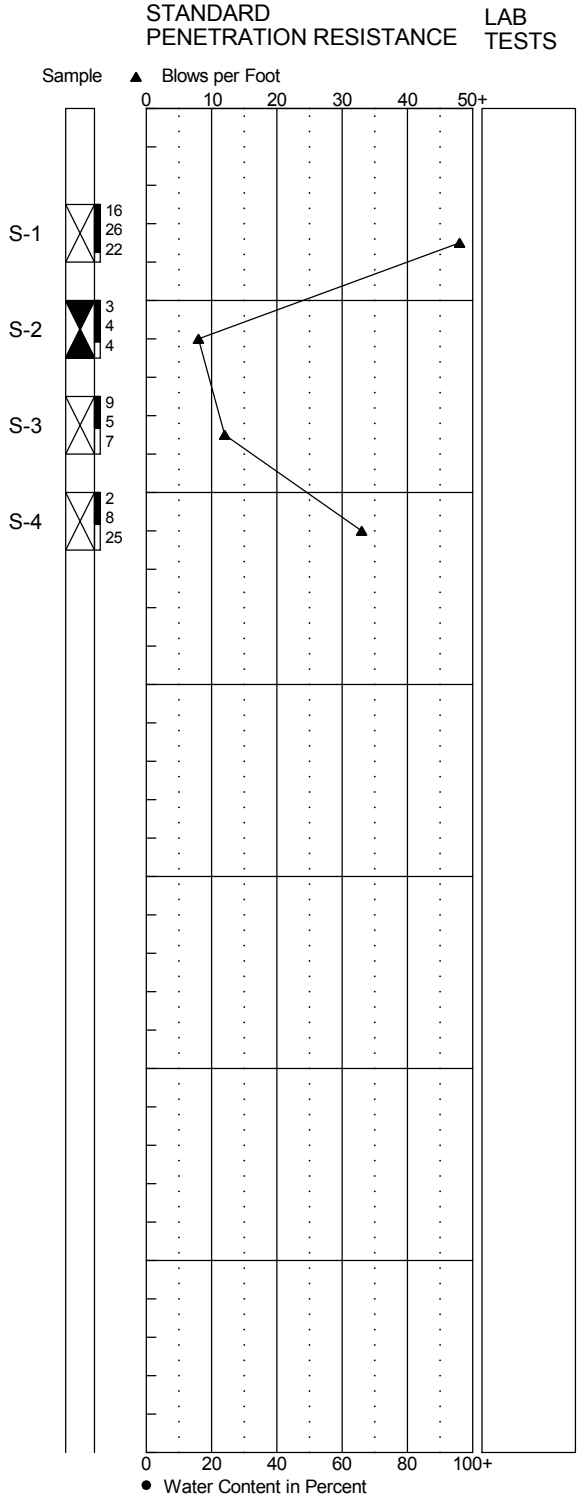
NEW BORING LOG - F:\GINT\OREGON_LIBRARY.GLB - 10/9/15 14:51 - F:\NOTEBOOKS\1598403_DAHL BEACH REHABILITATION\FIELD DATA\PERM_GINT\1598403_EXPLORATIONS.GPJ

Boring Log B-2

Location: N 629175.375 E 7660574
Approximate Ground Surface Elevation: 20 Feet
Horizontal Datum: NAD 83 Oregon State Plane North (Feet)
Vertical Datum: NAVD 88

Drill Equipment: Hollow Stem Auger
Hammer Type: Auto Hammer
Hole Diameter: 8 inches
Logged By: J. Alders Reviewed By: J. Alders

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet
GW		Asphalt Concrete (3-inch thick)	0
GP		Base Aggregate (4-inch thick)	
		Dense, dry, gray, sandy GRAVEL, COBBLES, and BOULDERS, fine to coarse sand, trace silt.	
		Grades to loose, becomes moist.	5
		Grades to medium dense.	
		Grades to dense.	10
		Bottom of Boring at 11.5 Feet. Started 07/30/15. Completed 07/30/15.	
			15
			20
			25
			30
			35



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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15984-03 *10/15*

Figure A-4

NEW BORING LOG - F:\GINT\OREGON_LIBRARY.GLB - 10/9/15 14:51 - F:\NOTEBOOKS\1598403_DAHL BEACH REHABILITATION\FIELD DATA\PERM_GINT\1598403_EXPLORATIONS.GPJ

APPENDIX B
Slope Stability Analysis

APPENDIX B

Slope Stability Analysis

General

This appendix contains the results of our slope stability analysis.

Our analysis was completed using the program Slope/W by Geo-Slope International, Ltd. The Slope/W program performs two dimensional limit equilibrium analysis to compute slope stability and determine a FS value against global failure.

The FS against global failure is simplistically defined as the ratio of the forces resisting slope movement (e.g., soil strength, soil mass, etc.) to the forces driving slope movement (e.g., gravity, earth pressure). The program predicts the location and geometry of "critical failure planes." Critical failure planes are the zones with the lowest factors of safety. A FS value less than 1.0 infers that the model is not in equilibrium and slope movement is likely to occur.

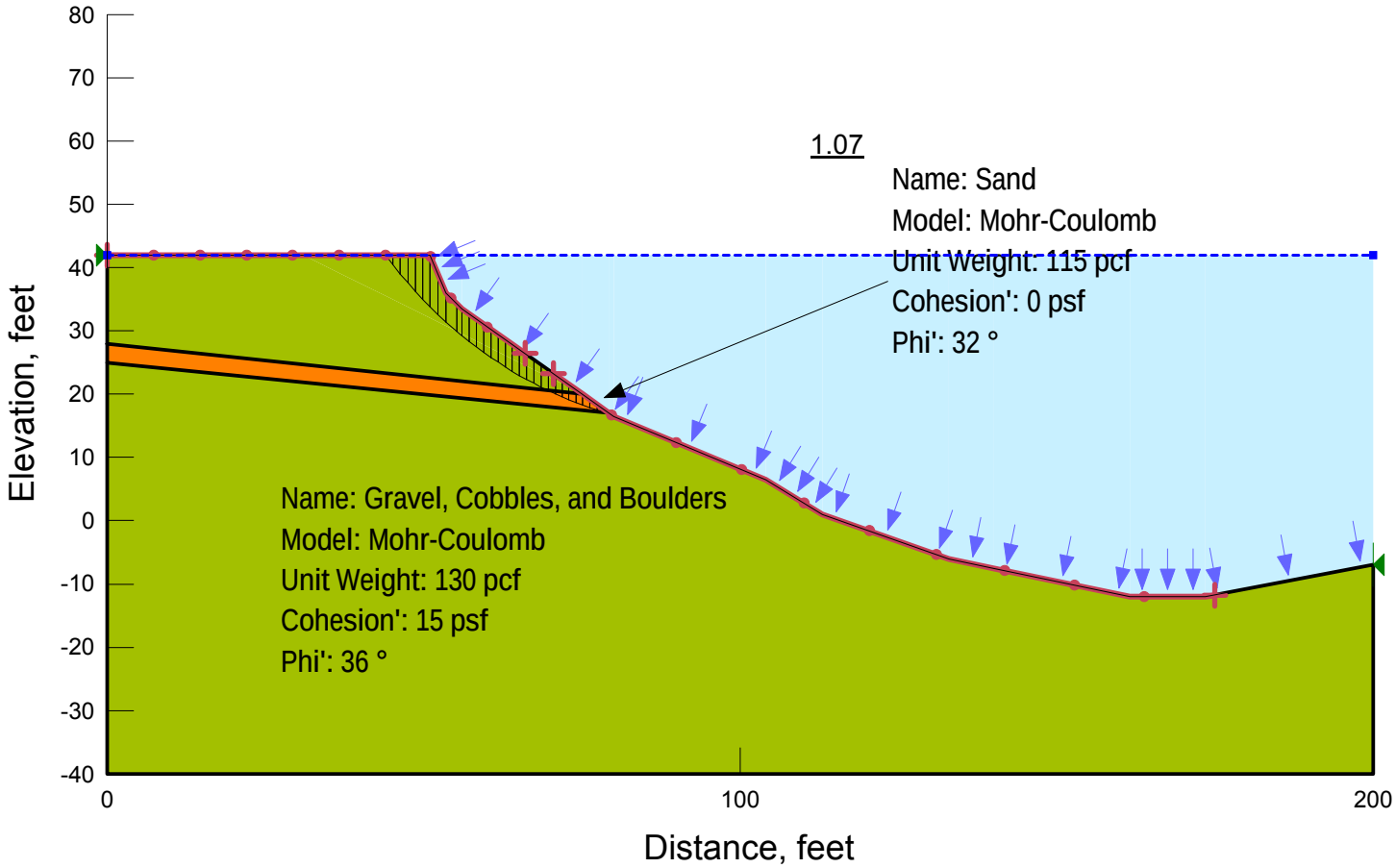
Evaluation Criteria

We used a FS value equal to 1.3 for static stability of slopes not supporting structures as our guideline for finalizing our recommended slope angle. This value was selected based on the ODOT Geotechnical Design Manual (ODOT 2014), which indicates the FS for a stable slope underlying unimproved or non-critical areas should be considered 1.3.

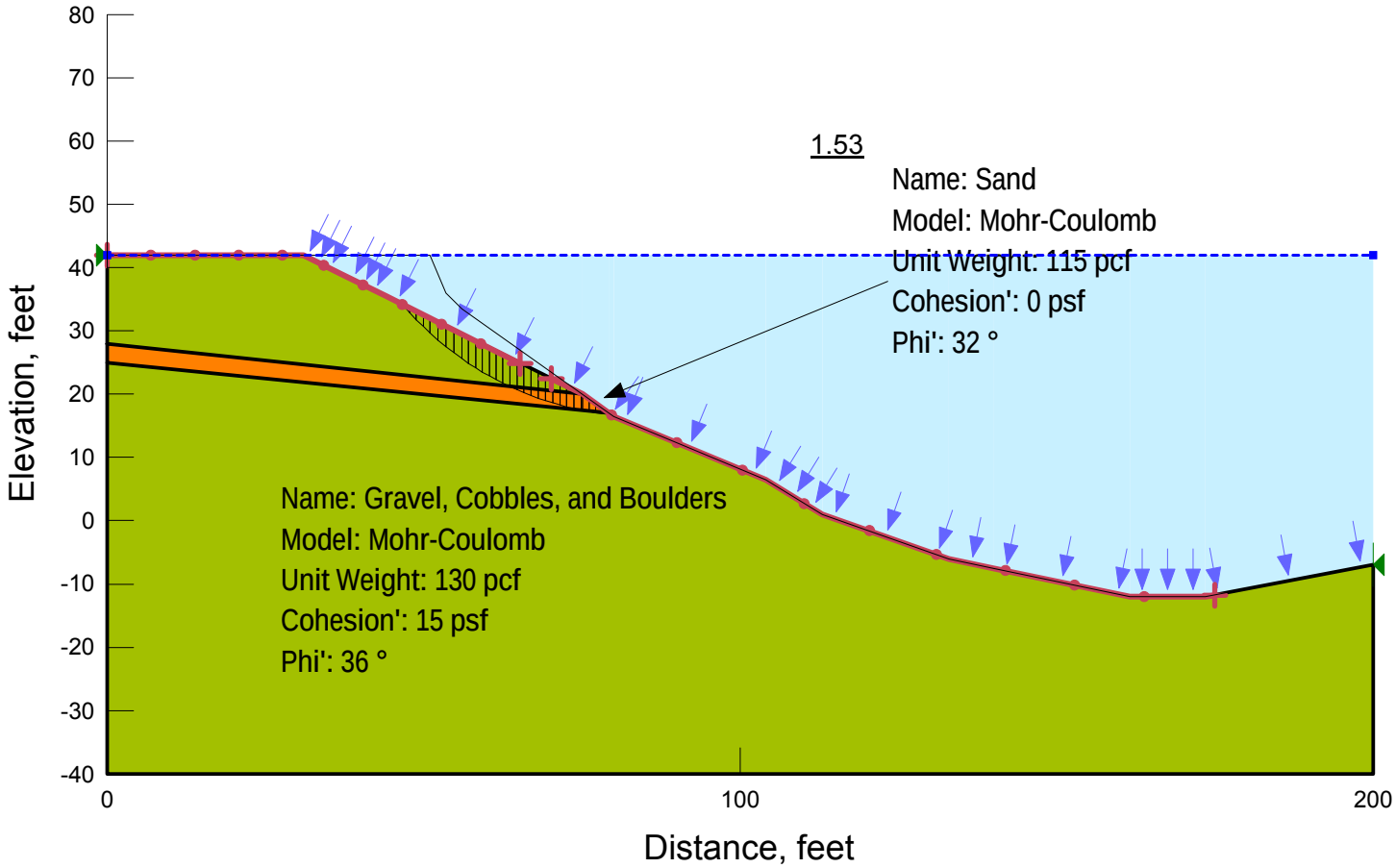
Table 2 in the report text summarizes the FS values we obtained from our analyses. All of the FS values met or exceeded the criteria spelled out above.

Output from our slope stability modeling follows in this appendix.

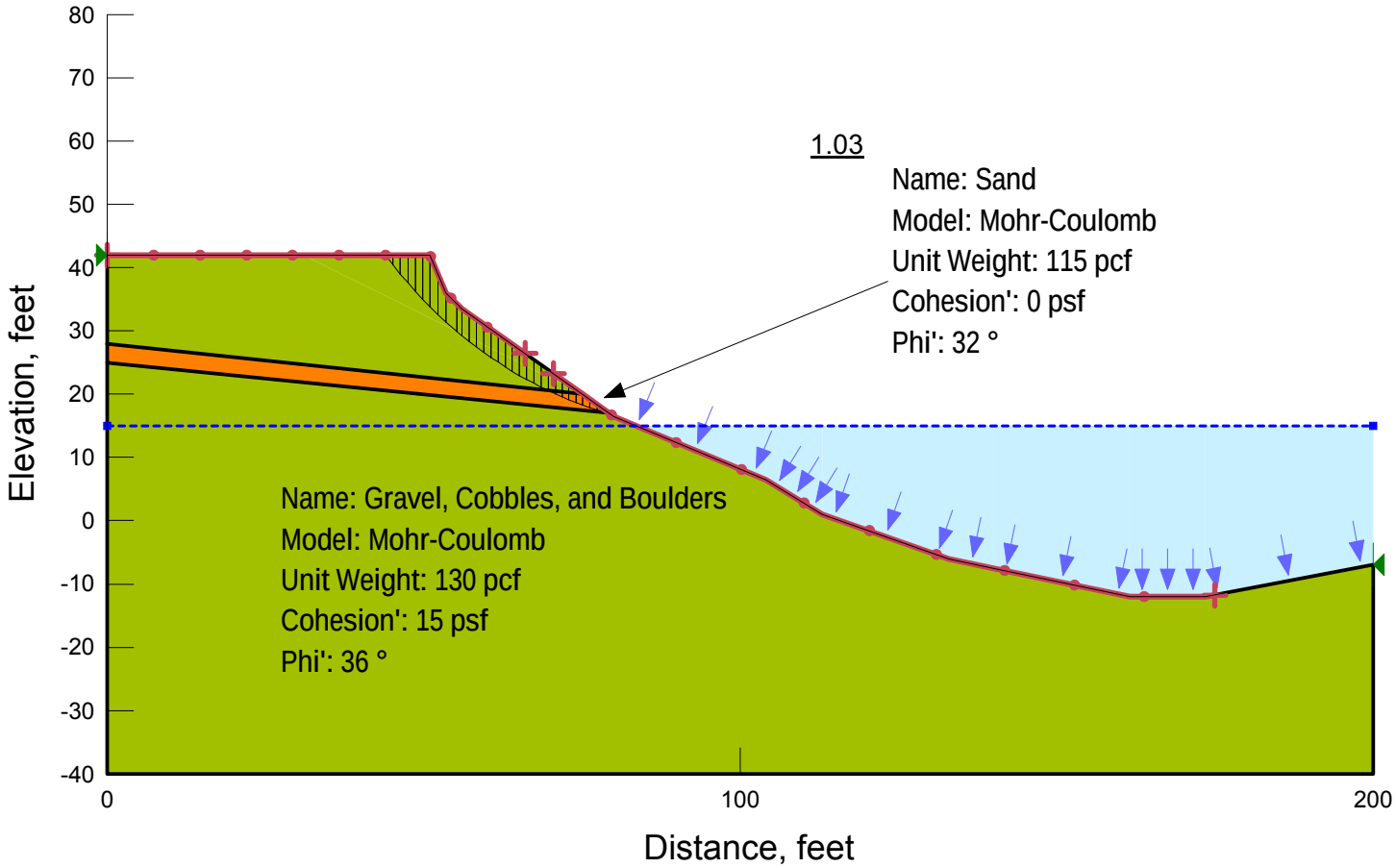
Title: Dahl Beach Stability Analysis
Created By: Jim Alders
Date: 10/8/2015
Case 1: High Water Existing
Method: Spencer



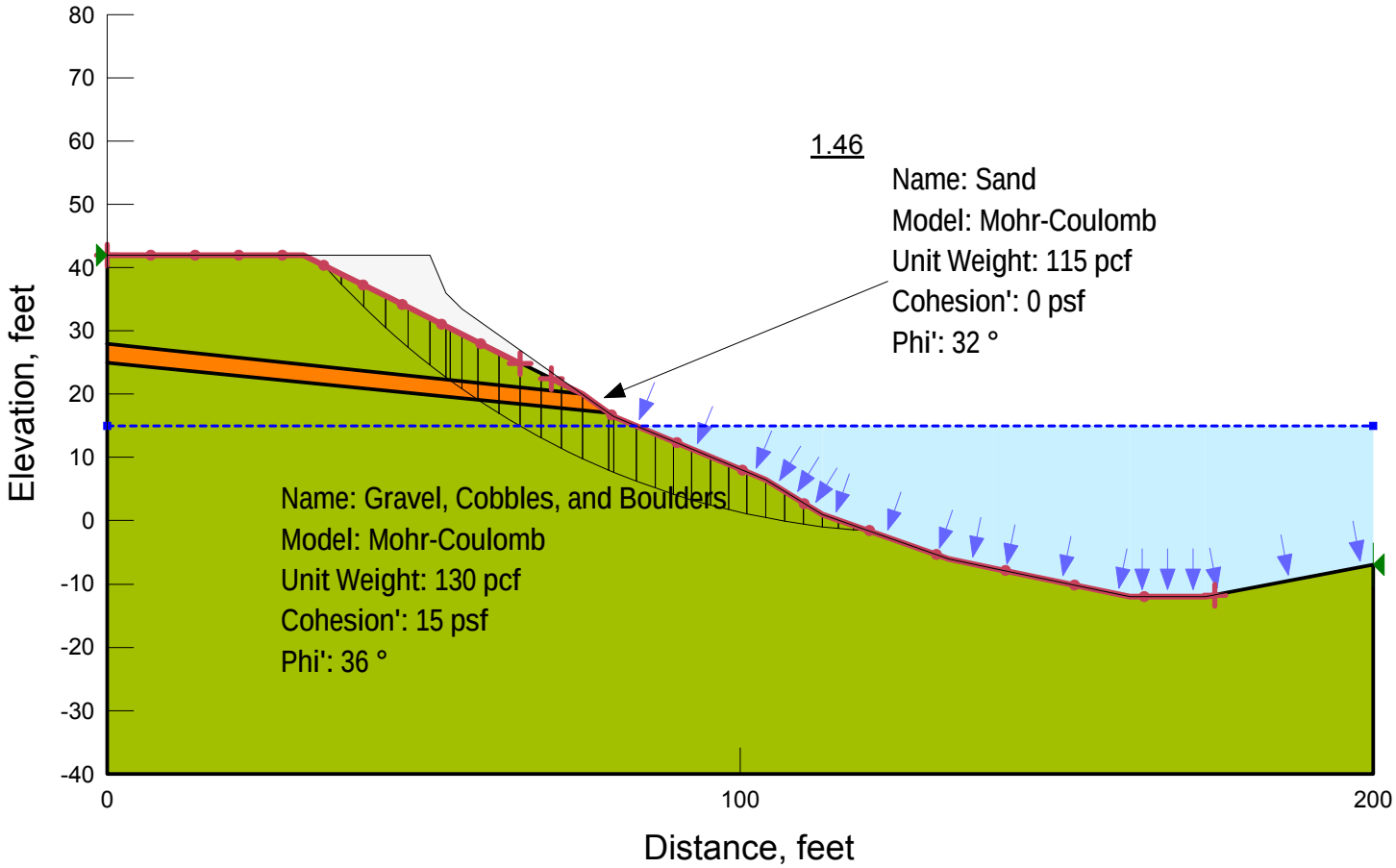
Title: Dahl Beach Stability Analysis
Created By: Jim Alders
Date: 10/8/2015
Case 2: High Water Regraded
Method: Spencer



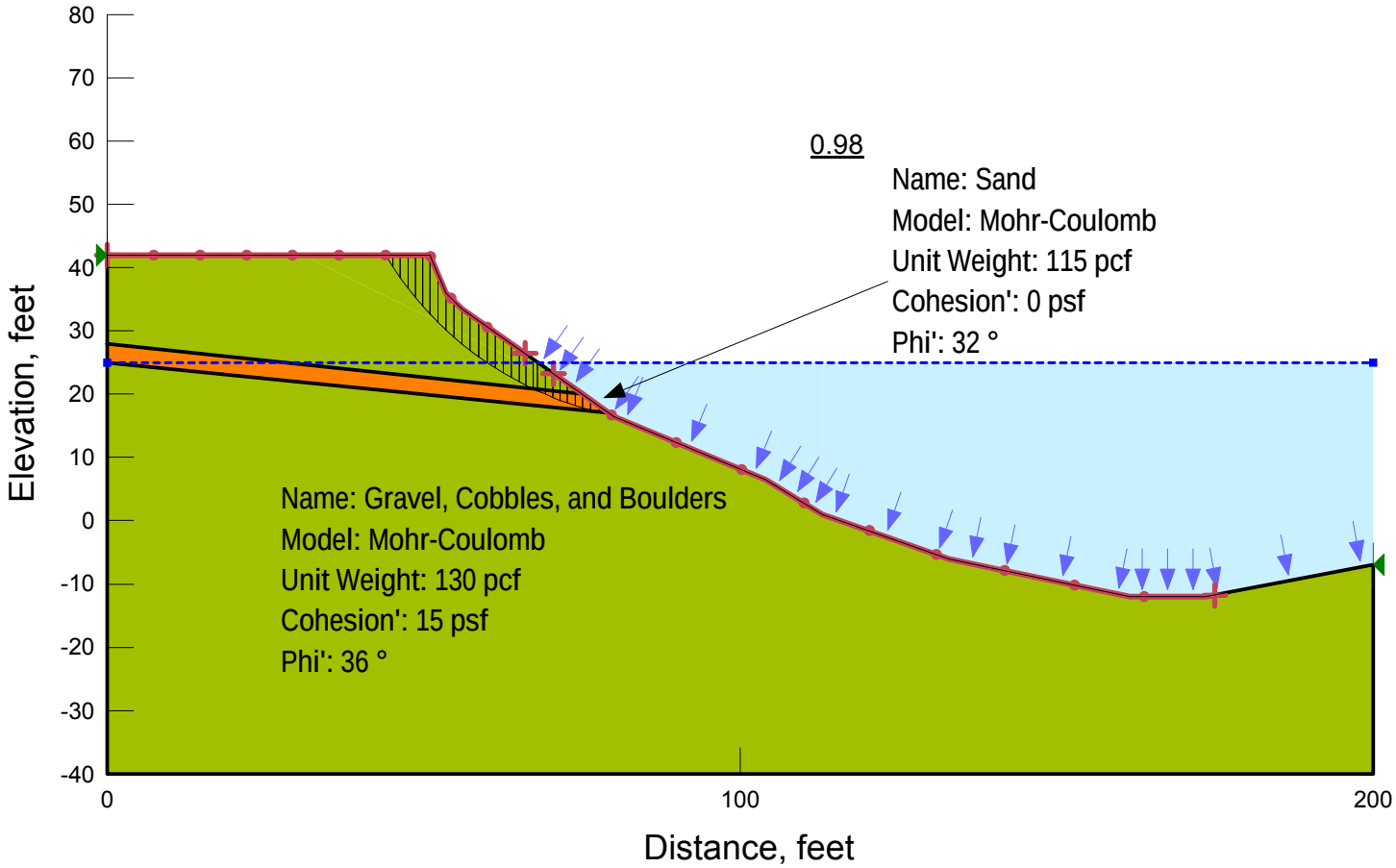
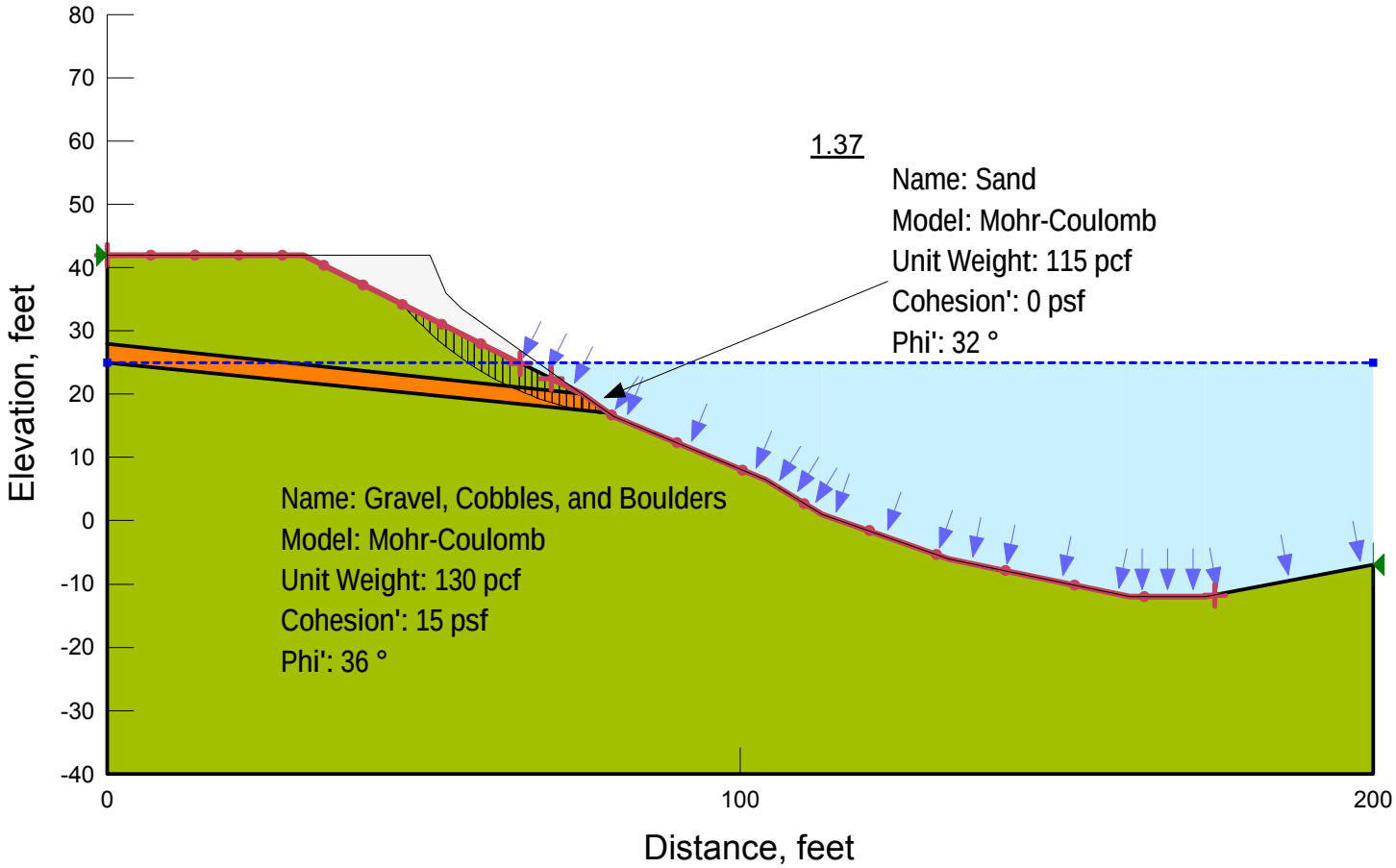
Title: Dahl Beach Stability Analysis
Created By: Jim Alders
Date: 10/8/2015
Case 3: Low Water Existing
Method: Spencer



Title: Dahl Beach Stability Analysis
Created By: Jim Alders
Date: 10/8/2015
Case 4: Low Water Regraded
Method: Spencer



Title: Dahl Beach Stability Analysis
Created By: Jim Alders
Date: 10/8/2015
Case 5: Ordinary High Water Existing
Method: Spencer



Title: Dahl Beach Stability Analysis
Created By: Jim Alders
Date: 10/8/2015
Case 6: Ordinary High Water Regraded
Method: Spencer