Appendix H
Mitigation Evaluation Work Plan

December 2023
Gasco Sediments Project Area

Mitigation Evaluation Work Plan

Prepared for U.S. Environmental Protection Agency, Region 10

GASCO0067363

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Gasco Sediments Project Area

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ABBREVIATIONS

ACM	active channel margin
ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
COP	City of Portland Datum
CWA	Clean Water Act
DGPS	differential global positioning system
DPS	distinct population segment
dSAY	discounted service acre years
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FS	feasibility study
Gasco Site	Gasco Sediments Site
HEA	Habitat Equivalency Analysis
ISS	in situ stabilization and solidification
LCR	Lower Columbia River
LWG	Lower Willamette Group
MEWP	*Mitigation Evaluation Work Plan*
NMFS	National Marine Fisheries Service
NRDA	Natural Resource Damage Assessment
ODFW	Oregon Department of Fish and Wildlife
OHW	ordinary high water
OLW	ordinary low water
PHNRTC	Portland Harbor Natural Resources Trustees Council
Project	Gasco Sediments Site Cleanup Action
PTW	principal threat waste
RAL	remedial action level
RHV	relative habitat value
USACE	U.S. Army Corps of Engineers
UWR	Upper Willamette River

1 Purpose and Overview

This *Mitigation Evaluation Work Plan* (MEWP) summarizes NW Natural's proposed means and methods to determine mitigation for implementation of the final remedial design for the NW Natural Gasco Sediments Site (Gasco Site) Cleanup Action (Project). The Gasco Site active cleanup boundaries are termed the Final Project Area. Mitigation may be required to offset unavoidable adverse impacts to aquatic habitat, consistent with the requirements of the Clean Water Act (CWA; Section 404) and Endangered Species Act (ESA; Section 7), which have been identified as Applicable or Relevant and Appropriate Requirements (ARARs) for the Project. Implementation of the MEWP will be completed as part of the CWA Section 404(b)(1) Analysis for the final remedial design, and any mitigation identified through this evaluation and the CWA Section 404(b)(1) Analysis will be considered part of the Project and evaluated in the ESA documentation; these documents will be prepared to comply with CWA Section 404 and Section 7 of the ESA ARARs.

The Gasco Site is located along the west bank of the Willamette River between river miles 6 and 7 in Portland, Multnomah County, Oregon (Figure 1). The Gasco Site is within the boundary of the Portland Harbor Superfund Site. Numerous evaluations and studies have been completed at the Gasco Site as part of the broader Portland Harbor Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigation and feasibility study (FS) process and site-specific work completed as part of the 2004 *Administrative Order on Consent for Removal Action* (CERCLA Docket No. 10-2004-0068) and 2009 *Administrative Settlement Agreement and Order on Consent for Removal Action* (CERCLA Docket No. 10-2009-0255) and *Statement of Work* (EPA 2009) with the U.S. Environmental Protection Agency (EPA). Extensive information is available in other reports about the Gasco Site and associated upland facility history, operations, nature and extent of contamination, and potential risks to human health and the environment.

NW Natural proposes to use a Habitat Equivalency Analysis (HEA)-based approach during remedial design to determine potential mitigation required for the implementation of the Project. HEA has already been used for the evaluation of aquatic habitat in the Lower Willamette River as part of the Natural Resource Damage Assessment (NRDA) Restoration process associated with the Portland Harbor Superfund Site (Stratus 2010), and HEA is currently used by the National Marine Fisheries Service (NMFS) to assess habit value for species listed under the ESA (DEQ et al. 2016). In support of these efforts, the Portland Harbor NRDA Trustees and NMFS developed relative habitat values (RHVs), which are key input parameters for the analysis. HEA has also been used by the U.S. Army Corps of Engineers (USACE) on various projects around the country to calculate appropriate mitigation requirements under CWA Section 404 since 2002 (Ray 2009). Examples of types of USACE projects using HEA include scaling various types of salt marsh, coral reef, and other kinds of restoration to offset impacts associated with deepening and widening navigation channels and harbors and conversion of aquatic habitat to upland for the placement of dredged material.

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NW Natural, as a member of the Lower Willamette Group (LWG), participated in preparation of a Programmatic Section 404(b)(1) Analysis, including a mitigation determination framework, that proposed using a similar HEA-based approach to identify potential mitigation associated with the proposed Portland Harbor Superfund Site sediment cleanup alternatives evaluated in the LWG FS. EPA took over development and finalization of the FS (EPA 2016) and used the same RHVs and HEA-based approach to evaluate existing conditions and changes to aquatic habitat associated with implementing remedial actions as part of its FS. The HEA-based approach that NW Natural plans to use for this Project to determine potential mitigation requirements is consistent with these prior efforts, with some streamlining measures, modifications, and updates to account for the most recent version of the NMFS RHVs and site-specific conditions at the Gasco Site.

HEA will be used to compare existing and proposed post-construction habitat functions to determine whether the Project results in a mitigation credit (i.e., an increase in ecological function) or debit (i.e., a decrease in ecological function) and to evaluate the impacts and benefits to ESA-listed species and other aquatic species that use similar habitats in the Portland Harbor Superfund Site. Although HEA can be used to evaluate impacts and benefits to a variety of aquatic species, the approach will not be used for evaluating potential impacts to all species or associated with other aspects of the human environment evaluated as part of the CWA Section 404(b)(1) Analysis, such as those related to aesthetics and other human uses. Individual species or resource categories that are not suited for evaluation using the means and methods described in this document will be addressed separately in the CWA Section 404(b)(1) Analysis.

2 Species Occurrence and Habitat Preferences in Portland Harbor

Within Portland Harbor, shallow water habitat with sand and gravel or smaller substrates and shoreline habitat complexity is both spatially limited and important to salmonids and native and non-native resident fish species. All aquatic species require specific ecological conditions or functions to survive and progress through their life cycles, including reproduction, rearing, and migrating or moving from one habitat type to another. In addition, anadromous species require specific conditions for transitioning from freshwater to saltwater and from saltwater to freshwater environments as they migrate out of their natal streams to the ocean and back again to spawn. These key ecological functions must be available to allow aquatic species, including salmonids, to progress from one life stage to the next.

Because of the ecological importance of salmonids in the Willamette and Columbia River systems, habitat that supports healthy salmonid populations will also benefit other species that prey upon salmonids both in the water and in the upland. Subyearling and juvenile life stages of many species, including salmonids, preferentially use shallow water habitat, which is limited in the Lower Willamette River and Portland Harbor compared to historical conditions prior to industrial and municipal development. As these fish species grow into adults, they utilize a variety of aquatic habitats, including both shallow and deep water. Subyearling and juvenile life stages of fish are more sensitive than the adult life stage, which increases the importance of shallow water habitat along with its scarcity in the river system.

This section provides a brief overview of the different species likely to occur within Portland Harbor, including the ESA-listed species that have critical habitat in Portland Harbor and their habitat preferences.

2.1 Salmonids

A variety of ESA-listed salmonid species use the Lower Willamette River corridor for upstream and downstream migration and for some life history stage-specific rearing activities. Salmonid species that may be present in the vicinity of the Gasco Site, although in lower numbers during summer/fall in-water work window, include the Lower Columbia River (LCR) and Upper Willamette River (UWR) evolutionarily significant units (ESUs) of Chinook salmon (*Oncorhynchus tshawytscha*), the Columbia River ESU chum salmon (*O. keta*), the LCR distinct population segment (DPS) of steelhead (*O. mykiss*), the LCR ESU of coho salmon (*O. kisutch*), and the UWR DPS steelhead. The Lower Willamette River is designated critical habitat for these species. Bull trout (*Salvelinus confluentus*) occur in the UWR, but their occurrence in the lower river is unlikely, and no critical habitat is designated for bull trout in the Lower Willamette River.

Juvenile salmonids emerging from spawning areas in the Lower Willamette River and its tributaries use the Portland Harbor for rearing and migration to the ocean. Literature suggests that juvenile salmonids require a variety of habitat types and features to grow and survive to entry in the ocean. Juvenile salmonids are known to be most abundant where depth is shallow, velocity is low, and substrate particle size is small, such as sand and gravel (Bjornn and Reiser 1991; Everest and Chapman 1972).

Although the Oregon Department of Fish and Wildlife (ODFW) found that Chinook salmon and steelhead did not show a depth preference in the Lower Willamette River based on radio telemetry information, sites that were relatively deep (26.5 to greater than 33 feet deep) were found to have a significantly lower median catch per unit effort than sites where the average depth was 7 to 10 feet deep for catches of unmarked Chinook salmon based on sampling in different habitat types (ODFW 2005). Furthermore, ODFW observed that many subyearling Chinook salmon were captured in beach seines, indicating that beaches were an important habitat type for small Chinook salmon.

Based on this information, the most important water depth for juvenile salmonids for rearing and migration is less than 15 feet deep. The subyearlings are expected to use the shallower depths, and juvenile fish are expected to move to deeper water as they grow.

2.2 Lamprey and Sturgeon

Adult Pacific lamprey (*Entosphenus tridentatus*) are briefly present in the Lower Willamette River and potentially Portland Harbor from April to July during their upstream spawning migration, but there are no known spawning habitats for lamprey within these areas.

After hatching, young lamprey ammocoetes migrate downstream to areas of low flow, where they burrow into the sediment. Juvenile lamprey remain burrowed in the mud for about 4 to 6 years, rarely moving to new areas. Lamprey ammocoetes are present in the Lower Willamette River, but the duration of their residence is unknown. Based on an extensive sampling effort by the LWG, juvenile lamprey appear to be scarce in Portland Harbor (Windward 2011). For a 2017 study by the U.S. Fish and Wildlife Service, sampling detection of juvenile lamprey near the Gasco Site was low, with only two individuals detected in 50 quadrats (Silver et al. 2016).

Little information exists about lamprey migration rates in the Willamette River system, the amount of time they rear within the lower river, or the seasonality of their presence. There is also limited information available about lamprey's use of specific habitat types. Although not known for sure, a substrate type thought to be important for larval lamprey is soft silt with high organic content in low-velocity areas (Graham and Brun 2004; Kostow 2002; Pirtle et al. 2003). It appears that adult lamprey change their habitat preference to larger cobble-sized substrate and faster water before outmigration (Beamish 1980).

White sturgeon (*Acipenser transmontanus*) are known to be present in the Willamette River during their juvenile (pre-breeding) life stage. Juvenile sturgeon were found at depths of 6.6 to 190 feet over substrates of hard clay, mud and silt, sand, gravel, cobble, boulder, and bedrock (Parsley et al. 1993). The ESA-listed Southern DPS of North American Green sturgeon is unlikely to be found in the Lower Willamette River.

2.3 Native Resident Fish Species

The Lower Willamette River supports several species of native resident fish. Habitat requirements for these fish include the following:

- **Largescale sucker (*Catostomus macrocheilus*):** This fish species is often abundant at the mouths of streams or rivers but can also be found in backwater areas. Suckers live on the bottom, generally in shallow water, but sometimes in water as deep as 80 feet. Largescale sucker fry inhabit shallow pools and backwaters with mud and cobble substrate. The fry move into shallow areas during the day and into deeper water at night. Yearling largescale sucker on the Columbia River are most abundant in backwaters in water less than 3.3 feet deep (Wydoski and Whitney 2003).
- **Northern pikeminnow (*Ptychocheilus oregonensis*):** This species inhabits lakes and areas of slow to moderate currents in streams and rivers. In summer, the fish are found in the shallows, and in winter, they occupy benthic habitats in deep water. Young pikeminnow are found in shallow water (less than 1 foot deep) over mud, sand, rubble, and gravel substrates (Wydoski and Whitney 2003).
- **Peamouth (*Mylocheilus caurinus*):** Young peamouth inhabit very shallow water in spring, summer, and fall. In the winter, peamouth are typically found in deep water and move inshore during spring and summer. These fish are typically associated with the river bottom (Wydoski and Whitney 2003).
- **Redside shiner (*Richardsonius balteatus*):** This fish species is found in a variety of habitats where the current is slow to moderate in large rivers, streams, springs, sloughs, irrigation ditches, ponds, and lakes. The fish move around in schools and tend to occupy habitats with aquatic vegetation when in shallow areas. The fish move to nearshore areas in the spring and remain there until July, at which time they move to deeper water. They also occupy shallow water during the day and move to deeper water at night (Wydoski and Whitney 2003).
- **Speckled dace (*Rhinichthys osculus*):** This species is found in shallow, colder waters less than 3 feet deep. Speckled dace are associated with the river bottom and feed primarily on benthic organisms (Wydoski and Whitney 2003).
- **Three-spined stickleback (*Gasterosteus aculeatus*):** This species is found in marine and freshwater habitat and is abundant in the slow, brackish water of shallow sloughs and estuaries; they also tend to be associated with aquatic vegetation (Wydoski and Whitney 2003).

Native resident fish species require shallow water habitat with sand and gravel or smaller substrates and habitat complexity for sensitive life stages, generally similar to salmonids.

2.4 Wildlife Species

Key terrestrial wildlife species also utilize habitat within Portland Harbor for a variety of life cycle processes. Mammals, including mink (*Mustela vison*), have been observed in Portland Harbor, using the area for foraging in the river and in shoreline habitats (Stratus 2010). Mink use the shoreline of the Lower Willamette River for rearing young, along with the open water and nearshore habitats for foraging (PHNRTC 2007). Riparian areas adjacent to the nearshore habitat are important for mink as well, as woody debris serves as crucial denning habitat and thick vegetation provides cover for hunting (NOAA 2017).

Locally important migratory bald eagles (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and great blue herons (*Ardea herodias)* have the potential to use the Gasco Site. These species are piscivorous and forage within the open water and nearshore habitats of the Lower Willamette River. These species may also use the beach and shoreline habitat for nesting, foraging, or other life cycle processes. Bald eagles usually prefer large riparian habitat buffers between foraging habitat and human disturbance (NOAA 2017).

While the HEA does not address these terrestrial species specifically, the crucial foraging and riparian habitats in the river and along the shoreline discussed previously are included in the evaluation.

2.5 Common Habitat Characteristics

Aquatic habitats, such as rivers, provide varying levels of service to different species assemblages (e.g., benthic communities [including aquatic plants], fish, birds, and mammals as described in the prior sections). Throughout the Lower Willamette River, salmonids and other aquatic species (e.g., native resident fish species, lamprey, and sturgeon) require specific ecological characteristics or functions to survive and progress through their life cycles, including reproduction, rearing, and migrating or moving from one habitat type to another.

In the Lower Willamette River, evaluations conducted by the Portland Harbor Natural Resources Trustees Council (PHNRTC) for the NRDA process (PHNRTC 2010) determined that shallow water habitat with sand and gravel substrate adjacent to the shoreline and, preferably, shallow off-channel backwater habitat provide the highest level of service to juvenile Chinook salmon, and PHNRTC acknowledged as part of its Restoration Plan that this habitat also supports other assemblages of species. As described in Sections 3.1 through 3.4, shallow water habitat with sand and gravel or smaller substrate are not only important for salmonids but also native resident fish species and wildlife species that rely on prey that live in this type of habitat. In contrast, deeper water habitat may provide a similar or lower level of service to some of these receptor groups. These deeper habitats are more abundant in the Lower Willamette River and provide some additional services to the local benthic community and some fish resources; the combination of shallow and deeper waters in turn provides a spectrum of services. However, deeper water habitat is not limiting in the Lower Willamette River and is less productive habitat than the shallow water habitat, especially for birds and mammals. See Section 3.4.2.3 for further discussion on deep water habitat.

3 Mitigation Evaluation Method

Due to the nature of this cleanup Project, there may be instances where completely avoiding impacts to aquatic habitat will not be possible and compensatory mitigation will be required. The following subsections summarize the evaluation method proposed for determining compensatory mitigation for the Project, considering the proposed cleanup activities, species presence, and use of Portland Harbor, and incorporation of design-based avoidance and minimization measures. Overall, the mitigation evaluation steps include the following:

- Establish baseline conditions.
- Establish post-construction conditions.
- Determine input parameters and conduct HEA comparing pre- and post-cleanup habitat conditions.
- Use HEA results to identify mitigation requirements.

3.1 Establish Baseline Conditions

To determine baseline conditions in the Final Project Area, a habitat survey was performed by Anchor QEA on May 17 and 18, 2012 (Anchor QEA 2012), and visual observations of the shoreline were collected on September 18, 2017 (Anchor QEA 2017). Baseline habitat conditions resulting from 2012 and 2017 habitat surveys are shown in Figures 2a through 2d. Other data sources used in this evaluation, including bathymetry, topography, sediment percent fines, and aerial imagery, are summarized in Table 1. In addition, during the design phase, the CWA 404(b)(1) and ESA documentation will include photographs of existing shoreline habitat conditions to demonstrate the baseline habitat condition.

3.1.1 Habitat Data Collection

On May 17 and May 18, 2012, Anchor QEA biologists collected shoreline habitat data at the Final Project Area between the top of bank and +10.9 feet City of Portland Datum (COP; Anchor QEA 2012). Water levels during the data collection were approximately +12.9 feet COP. Transects perpendicular to the shoreline were established every 100 feet from the top of bank to the water's edge. Substrate and vegetation data were collected at three data points (high, middle, and low) along each transect. The middle data point was located approximately midway between the water's edge and the top of bank. The high and low data points were located halfway between the middle data point and the top of bank and halfway between the middle data point and water, respectively. At each data point (high, middle, and low), the presence of large woody debris, overhanging vegetation, pilings, shoreline complexity, and type of substrate were observed and documented using a differential global positioning system (DGPS) unit.

Table 1
Existing Habitat Data to Be Used as Inputs to the HEA

HEA Inputs		Sources of Habitat Data					
Category	**Characteristics**	**Shoreline Visual Observations[1]**	**Bathymetry/ Topography[2]**	**Habitat Evaluation Transects[1]**	**Sediment Percent Fines[3]**	**Google Earth Aerial Imagery[4]**	**Notes**
Riparian (above OHW)	Vegetation	x		x		x	
	Substrate	x					
	Paved areas, buildings	x				x	
	Elevation		x				
ACM (between OHW and OLW)	Vegetation	x		x			
	Substrate	x		x			
	Shoreline slope		x				
	Structures[6]	x					Map base layer includes existing structures[5]
	Elevation		x				
Shallow Water (0–15 feet of water depth as measured from OLW)	Natural substrate[7]	x			x		
	Artificial substrate[8]	x			x		
	Structures[6]	x					Map base layer includes existing structures[5]
	Water Depth		x				
Deep Water (deeper than 15 feet of water depth as measured from OLW)	Natural substrate[7]				x		
	Artificial substrate[8]						
	Water Depth		x				

Notes:
1. Anchor QEA 2012, 2017
2. eTrac 2019
3. AECOM and Geosyntec 2019 and EPA Record of Decision database
4. City of Portland 2022
5. LWG 2008
6. "Structures" includes suspended or floating structures, pilings, sheetpile walls, or seawalls.
7. "Natural substrate" includes rounded gravel and finer substrates and natural rock outcrop.
8. "Artificial substrate" includes angular rock, riprap, or anthropogenic debris.

On September 18, 2017, Anchor QEA biologists collected additional shoreline habitat data continuously across the Final Project Area between the top of bank and approximately +3.9 feet COP (Anchor QEA 2017). Water levels during the data collection were approximately +3.9 feet COP. Prior to collecting shoreline habitat data below +10.9 feet COP, Anchor QEA confirmed the 2012 shoreline habitat observations across the Final Project Area adjacent to the Gasco property by walking along the top of slope and the shoreline while noting habitat type within the previously defined and mapped habitat categories that were established along 100-foot transects during the 2012 shoreline. Any observed changes to the previously characterized habitat types, including to slope, substrate, and vegetation data, were noted on field maps and in digital data collection equipment.

Due to site access restrictions in 2017, the 2012 shoreline habitat results between +10.9 feet COP and the top of bank at the Final Project Area adjacent to the Siltronic property were not confirmed and were assumed to be unchanged from the original habitat survey. In 2017, habitat conditions adjacent to the Siltronic property between +10.9 feet COP and +3.9 feet COP were observed from the Gasco/Siltronic property boundary to consist entirely of riprap with no vegetation.

3.2 Establish Post-Construction Conditions

Post-construction habitat categories will be established based on the remedy design and final expected elevations, substrate composition, and shoreline conditions (e.g., slope, presence of vegetation, substrate). These conditions will be determined based on the preferred design alternative and avoidance and minimization measures that are expected to be implemented.

The design alternative that fully achieves all of EPA's design objectives and prevents sediment recontamination is the Full Dredge and In Situ Stabilization and Solidification (ISS) Design. This design consists of full dredging to the depth of contamination based on remedial action level (RAL) exceedances and principal threat waste (PTW; including PTW-nonaqueous phase liquid, PTW-not reliably contained, and PTW-highly toxic threshold exceedances) in the Navigation Channel Region followed by placement of cover materials for dredge residual management. This activity will change the baseline water depths and could change substrate composition, and shoreline conditions. Additionally, the remedy also includes ISS to the depth of contamination throughout the Intermediate, Shallow, and Riverbank Regions to treat 100% of the RAL exceedances and PTW in situ. Both of these remedial technologies may positively or negatively impact aquatic habitat by changing water depths, substrate composition, and/or shoreline conditions. These changes will be determined during remedial design, and RHVs will be assigned for post-construction conditions. Overall, the alterations associated with these remedial activities are intended to reduce sources of contamination and improve overall conditions for aquatic species.

Avoidance and minimization measures will be incorporated into the remedial design and implemented to minimize the impact of the Project on aquatic species and their habitats.
CWA Section 404 (40 Code of Federal Regulations [CFR] 230.10) establishes procedures for the sequence of mitigation measures that should be considered before compensatory mitigation for the discharge of fill material into waters of the United States. According to the Council on Environmental Quality (CEQ), which coordinates all federal environmental policies, including the CWA, mitigation incorporates all steps taken to avoid and minimize impacts of an action on the environment, as well as compensation of unavoidable impacts. The components to mitigation are summarized into the following three hierarchical categories: 1) avoid; 2) minimize; and 3) compensate. Specifically, mitigation includes the following actions:

1. Avoid the impact altogether by not taking a certain action or parts of an action.
2. Minimize impacts by limiting the degree or magnitude of the action and its implementation.
3. Rectify the impact by repairing, rehabilitating, or restoring the affected environment.
4. Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action.
5. Compensate for the impact by replacing or providing substitute resources or environments (40 CFR 1508.20).

The guidelines set out for the CWA in 40 CFR 230.10 are based upon the overarching mitigation hierarchy established by CEQ and establish that appropriate and practicable changes to the Project must be considered to avoid (e.g., select another site or alternative that would have no impact on aquatic resources) and then minimize the environmental impact before considering compensatory mitigation.

The following are a few examples of potential measures that might be incorporated into the remedial design to avoid and minimize adverse effects to the aquatic environment that could influence post-construction conditions; however, final measures will be developed during the Project remedial design:

- In the navigation channel, multiple residual management cover layers consisting of sand (with amendments, as necessary) will prevent benthic exposure to dredge residuals.
- The post-construction riverbank elevation profile using ISS is flexible and would be designed and constructed to ensure habitat improvements are optimally designed as well as meeting the Federal Emergency Management Agency no-rise threshold criteria.
- Habitat material could be added to ISS surfaces to improve substrate conditions and increase post-construction habitat function where it is expected to remain in place. Habitat material is defined as 2-to-6-inch rounded rock. The size of the habitat material to be placed will depend on the forces acting on the area and the ability of the material to stay in place. NW Natural will conduct an evaluation of forces along the shoreline, including propwash modeling and

wave and vessel wake analysis, during remedial design to inform where habitat material will and will not be expected to remain in place. The 2-inch minus rounded rock material will be used to the extent possible and up to 6-inch rounded rock could be used in areas subject to propwash, wind waves or other forces that could move the smaller 2-inch minus material. This will be evaluated during remedial design and more specific habitat material sizes and gradations will be determined and included in the Technical Specifications.

3.3 Data Processing and Mapping

All available data sources shown in Table 1, including habitat survey results, bathymetry, topography, sediment percent fines, and aerial imagery, have been imported to ArcGIS software. The elevation (bathymetry and topography) data were processed to derive slope categories defined as a change in horizontal distance over a vertical distance (i.e., greater than or less than a 5-to-1 [11%] slope). Along with habitat conditions, elevations and slopes are used to assign the HEA habitat categories described in Section 3.4.2.2 and the RHVs described in Section 3.4.2.3. Baseline HEA-based habitat categories are shown in Figure 3.

Remedy design details, including final expected elevations, substrate composition, and shoreline conditions (e.g., slope, presence of vegetation, substrate), will be provided by the design engineer and imported to GIS when available. Spatial analysis tools will then be used to intersect baseline habitat conditions polygons with remedial design areas to create post-construction habitat conditions polygons. Post-construction habitat conditions polygons will then be assigned HEA habitat categories and RHVs, as described in Sections 3.4.2.2 and 3.4.23, for use in the mitigation evaluation.

3.4 Habitat Equivalency Analysis

3.4.1 Overview

NW Natural proposes to determine mitigation for the Project using an HEA to determine if a habitat credit or debit results. The HEA is performed by evaluating the existing habitat function compared to the proposed habitat function after implementing a remedial activity that involves a discharge of dredge or fill material to the aquatic environment.

HEA is an accounting technique for calculating the replacement of lost ecological services (defined as functions and values that a habitat provides) resulting from an impact (NOAA 1995; Ray 2009). It is a generalized method that can be used in any type of habitat, including freshwater rivers and streams, salt marshes, seagrass beds, and coral reefs. An estimate of how much habitat to restore to replace lost ecological services is based on balancing the total amount of services lost with those supplied by restored habitat, including services lost while the restored habitat is maturing and while the damaged habitat is recovering. The main assumption associated with HEA is that a one-to-one tradeoff between services lost and gained is acceptable rather than a one-to-one tradeoff in resources (NOAA 2000). The metric used in the HEA model is discounted service acre-years (dSAYs), which is a measure of the resource service flows provided by various habitats. The HEA model quantifies the reduction or gain in resource service flows in various habitats over time because of impacts or benefits to habitats used by aquatic resources. An HEA workbook template that will provide the basis for this evaluation is provided in Attachment A. It will likely be necessary to modify the HEA workbook to be consistent with the remediation design. For example, the duration of construction will need to be incorporated once construction sequencing is determined. The inputs to the HEA model are described in the following sections.

3.4.2 Input Parameters

Input parameters for HEA include the area of impact and pre- and post-construction RHVs. HEA also accounts for the project start date, expected time to recover to full function, and project life and assigns a discount rate to future habitat conditions.

3.4.2.1 Area of Impact

For this analysis, the area of impact will include the Final Project Area where the sediment remedy will be implemented.

3.4.2.2 Habitat Categories

Habitat categories defined by elevations that will be used in the mitigation evaluation include the following:

- Riparian Habitat—within 400 feet above OHW
- Active channel margin (ACM)—between OHW and OLW
- Shallow Water—between 0 and 15 feet below OLW
- Deep Water—deeper than 15 feet below OLW

These habitat categories were taken from Appendix D of *Portland Harbor Permitting Assistance Tools*[1] (DEQ et al. 2016) and are provided in Attachment B of this document.

3.4.2.3 Relative Habitat Values

Habitats provide varying levels of service to different natural resources. Typically, natural resources are loosely grouped into four main categories: benthic communities (including aquatic plants), fish, birds, and mammals. In the Lower Willamette River, it is generally accepted that shallow water habitat adjacent to the shoreline and, preferably, shallow off-channel backwater habitat provides the highest level of service to these four main resource groups. Deeper water habitat generally

[1] Appendix D of *Portland Harbor Permitting Assistance Tools* defines all habitat below OLW (Shallow Water and Deep Water) as Main Channel habitat. No Off Channel habitat occurs in the Final Project Area.

provides a lower level of service to these receptor groups. These deeper habitats still provide some services to the local benthic community and some fish resources; these fish resources, in turn, may provide some services to birds and mammals. However, on a relative scale it is less productive habitat in terms of ecological service flow than the shallow water habitat. The use of RHVs allows service losses from different habitat types to be normalized to the most valuable habitat type in the Lower Willamette River (i.e., shallow water with gravel or finer substrates or rock outcrop or shallow sloped ACM with native vegetation and no armoring). This normalization technique also allows for a comparative analysis of different restoration opportunities that may involve different habitat types.

For this Project, NW Natural proposes to use an HEA that includes RHVs developed by PHNRTC for the NRDA process (PHNRTC 2010) that NMFS updated for ESA species (Attachment B). If there are any habitat conditions that are not captured by these values, additional values will be developed in coordination with EPA and NMFS. Where discrepancies exist between the PHNRTC values and NMFS values, NMFS values will be the default used in the HEA.

RHVs for the HEA will be determined using the sources of information summarized in Table 2. In addition, photographs of existing shoreline habitat conditions will be used to determine baseline RHVs. As described in Sections 3.2 and 3.3, post-construction habitat conditions will be determined based on the remedy design and final expected elevations, substrate composition, and shoreline conditions (e.g., slope, presence of vegetation, substrate).

Table 2
Summary of Habitat Categories and Relative Habitat Values

Habitat Category	Baseline Habitat Information for Characteristic	Habitat Characteristic for RHV Assignment	RHV
Riparian (above OHW)	3-to 9-inch angular rock, 1 or 2 layers of trees and shrubs	Vegetated riprap	0.05
	3- to 9-inch angular rock, non-native		
	Riprap/Debris (boulder; large stone – 9 inch), 1 or 2 layers of trees and shrubs		
	Riprap/Debris (boulder; large stone – 9 inch), non-native		
	Riprap/Debris (Boulder; Large Stone – 9 inch), No Vegetation	Unvegetated/paved/buildings/riprap	0

Habitat Category	Baseline Habitat Information for Characteristic	Habitat Characteristic for RHV Assignment	RHV
ACM (between OHW and OLW)	Unarmored, no vegetation with <5:1 slope	Sloped (<5:1), unarmored and unvegetated[1]	0.8
	Unarmored, no vegetation with >5:1 slope	Sloped (>5:1), unarmored and unvegetated[1]	0.1
	<3-inch angular rock, no vegetation with <5:1 slope	Sloped (<5:1), unarmored and unvegetated[1]	0.8
	<3-inch angular rock, no vegetation with >5:1 slope	Sloped (>5:1), unarmored and unvegetated[1]	0.1
	3- to 9-inch angular rock, 1 or 2 layers of trees and shrubs	Riprapped	0
	3- to 9-inch angular rock, non-native		
	3- to 9-inch angular rock, no vegetation		
	Riprap/Debris (boulder; large stone – 9 inch), 1 or 2 layers of trees and shrubs		
	Riprap/Debris (boulder; large stone – 9 inch), non-native		
	Riprap/Debris (boulder; barge stone – 9 inch), no vegetation		
	Suspended structures over channel margins	Suspended structures over channel margins	0.1
Main Channel (below OLW), Shallow Water	Unarmored, no vegetation	Shallow water, gravel and finer substrates	1
	<3-inch angular rock, no vegetation		
	3- to 9-inch angular rock, no vegetation	Shallow water with riprap/concrete/seawall in adjacent shoreline	0.1
	Riprap/Debris (boulder; large stone – 9 inch), no vegetation		
	Substrate with suspended structures	Shallow water with suspended structures	0.1
	Substrate with floating structures	Shallow water with floating structures	0
Main Channel (below OLW), Deep Water	Deep water with gravel and finer substrates	Deep water with natural substrates	0.1

Note:
1. Within the ACM, where pilings are present, RHV is 1/2 the value of the margin type.

3.4.2.4 Timing and Time Intervals

Base Year

The base year is the year the impact is expected to occur. The base year for the Final Project Area will be determined during remedial design based on the expected year of remedial construction.

For active remediation construction areas, the HEA evaluation will incorporate the number of in-water work seasons at each specific location. When construction activities are occurring in an active remediation area, the HEA will assume 100% service loss for that area for the year of active construction (e.g., dredging and ISS) in that area. For example, if dredging occurs for 2 months in 2021 and capping occurs for 1 month in 2022, the duration of active construction would be 2 years (2021 and 2022). Construction of the full remedy is estimated to take several years to complete, although some areas may be completed within a single work season. Construction sequencing will be defined during remedial design, and the HEA assumptions and worksheets (Attachment A) will be adjusted at that time to reflect the approved sequencing approach.

Recovery to Full Function

Recovery of the habitat to full function is the amount of time it takes for the habitat to recover from remedial construction and attain its full habitat function. This post-cleanup value will use the years to the full function RHV defined for a particular habitat type by PHNRTC and NMFS, as shown in Attachment B. For vegetation, it is assumed to take 10 years to reach 80% of full function and 40 years to reach 100% function. Other habitat types, such as unarmored and unvegetated areas of ACM, are assumed to return to 100% function after 1 year.

Project Life

As requested by EPA, the Project life will be set at 100 years in the HEA model to represent that the Project life is in perpetuity.

Discount Rate

A standard discount rate of 3% will be used to compound past changes and discount future changes to a net present value. This discount rate is typically assumed in HEA (NOAA 2000).

3.5 Results and Next Steps

The HEA results will be reported in dSAYs. A dSAY represents the present value of all ecosystem services provided by 1 acre of habitat in 1 year. The evaluation will compare the total number of dSAYs provided by the aquatic habitat in the Project Area, assuming no cleanup activities during the Project life (existing conditions), to the total number of dSAYs associated with the changes made to aquatic habitat resulting from the Project, including the construction period. The existing conditions and RHVs will be developed based on the habitat data summarized in Table 2 and photographs. The post-cleanup habitat condition and relative habitat values will be determined based on the design and final expected elevations, substrate composition, and shoreline conditions (e.g., slope, presence of vegetation, substrate). A net positive dSAY result indicates that the post-cleanup habitat provides higher function than pre-cleanup, even accounting for temporary impacts to habitats resulting from cleanup activities. This also indicates that there is a habitat credit and no need for compensatory mitigation. A negative dSAY result indicates that the post-cleanup habitat is degraded compared to pre-cleanup and that compensatory mitigation is needed. The total amount of compensatory mitigation required (if needed) will depend on the type of mitigation proposed and the amount of dSAYs that can be generated per acre. If compensatory mitigation is necessary, a mitigation project type will be proposed, and the size of the Project will be scaled to match the dSAYs required to offset the habitat impacts.

The HEA will be completed as part of the CWA Section 404(b)(1) Analysis for the final remedial design, and any mitigation identified through this evaluation will be considered part of the Project and evaluated in the ESA documentation. Because the HEA is intended to address ESA-listed species, further evaluation of impacts on other CWA Section 404 functions and values will be completed as part of the CWA Section 404 (b)(1) Analysis. Any species or resource categories not sufficiently covered by the HEA will be evaluated separately in the CWA Section 404(b)(1) Analysis and considered in the final determination of required mitigation for the Project. If it is determined that compensatory mitigation is required and a project-based action is proposed, rather than the purchase of credits from a mitigation bank or payment into an in-lieu fee program, a mitigation plan would be developed that would include a long-term stewardship or monitoring component.

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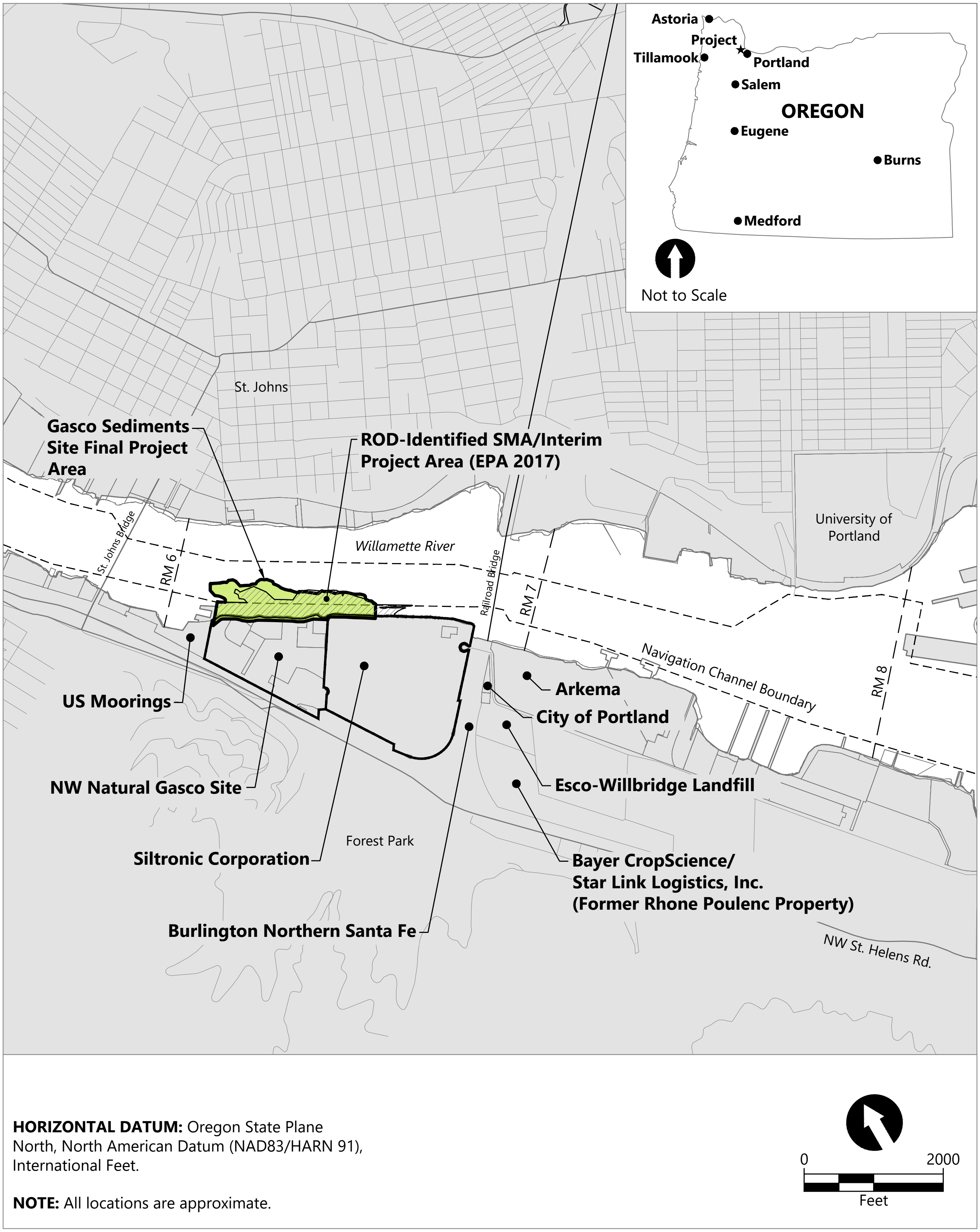
Figures



HORIZONTAL DATUM: Oregon State Plane North, North American Datum (NAD83/HARN 91), International Feet.

NOTE: All locations are approximate.

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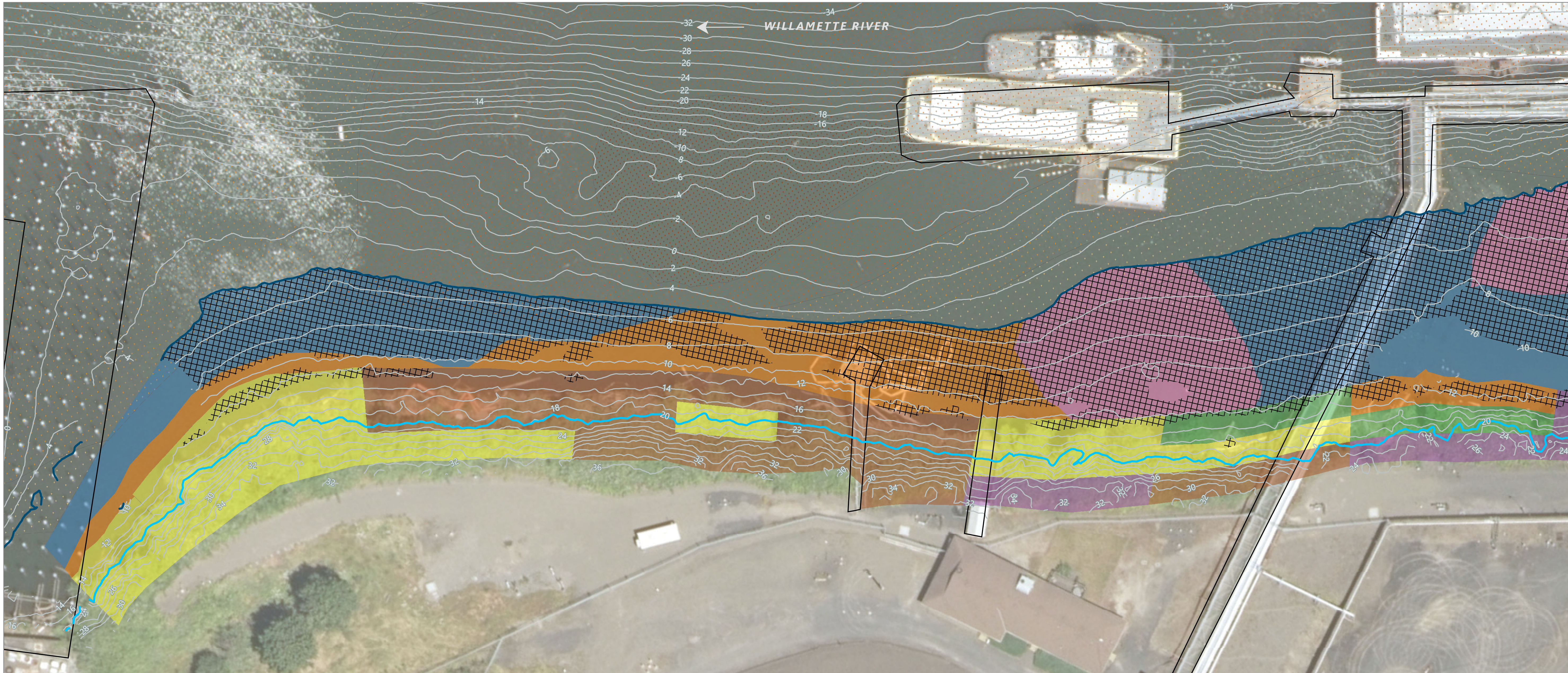
Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Sediments_Pre-Remedial Design_Report Drafting\0029-RP-018 (Vicinity Map MEWP).dwg Figure 1

ANCHOR QEA

Figure 1
Vicinity Map

Mitigation Evaluation Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Ordinary High Water (+18 feet COP)
- Ordinary Low Water (+3.0 feet COP)
- 2-foot Bathymetry Contours (2019)
- Slope Shallower Than 5:1
- Structures

Percent Fines

- 0 – 20%
- 20 – 40%
- 40 – 60%
- 60 – 80%
- 80 – 100%

- <3-inch Angular Rock, No Vegetation
- 3- to 9-inch Angular Rock, No Vegetation
- 3- to 9-inch Angular Rock, 1 or 2 Layers of Trees and Shrubs
- 3- to 9-inch Angular Rock, Non-Native Vegetation
- Riprap/Debris (Boulder; Large Stone -- 9-inch), No Vegetation
- Riprap/Debris (Boulder; Large Stone -- 9-inch), 1 or 2 Layers of Trees and Shrubs
- Riprap/Debris (Boulder; Large Stone -- 9-inch), Non-Native Vegetation
- Unarmored, No Vegetation

NOTES:

1. Areas where slopes are shallower than 5:1 are only shown for the active channel margin (ACM) which is located between OHW (+18 feet COP) and OLW (+3.0 feet COP).
2. Within the ACM, areas that are not shown as shallower than 5:1 slopes contain slopes that are steeper than 5:1 except where contour data is lacking (i.e., slope data not available).
3. Bathymetric survey from eTrack 2019.
4. Arrow indicates direction of flow of river.
5. Horizontal datum is NAD83 Oregon State Plane North, International Feet.
6. Aerial imagery from City of Portland 2022.

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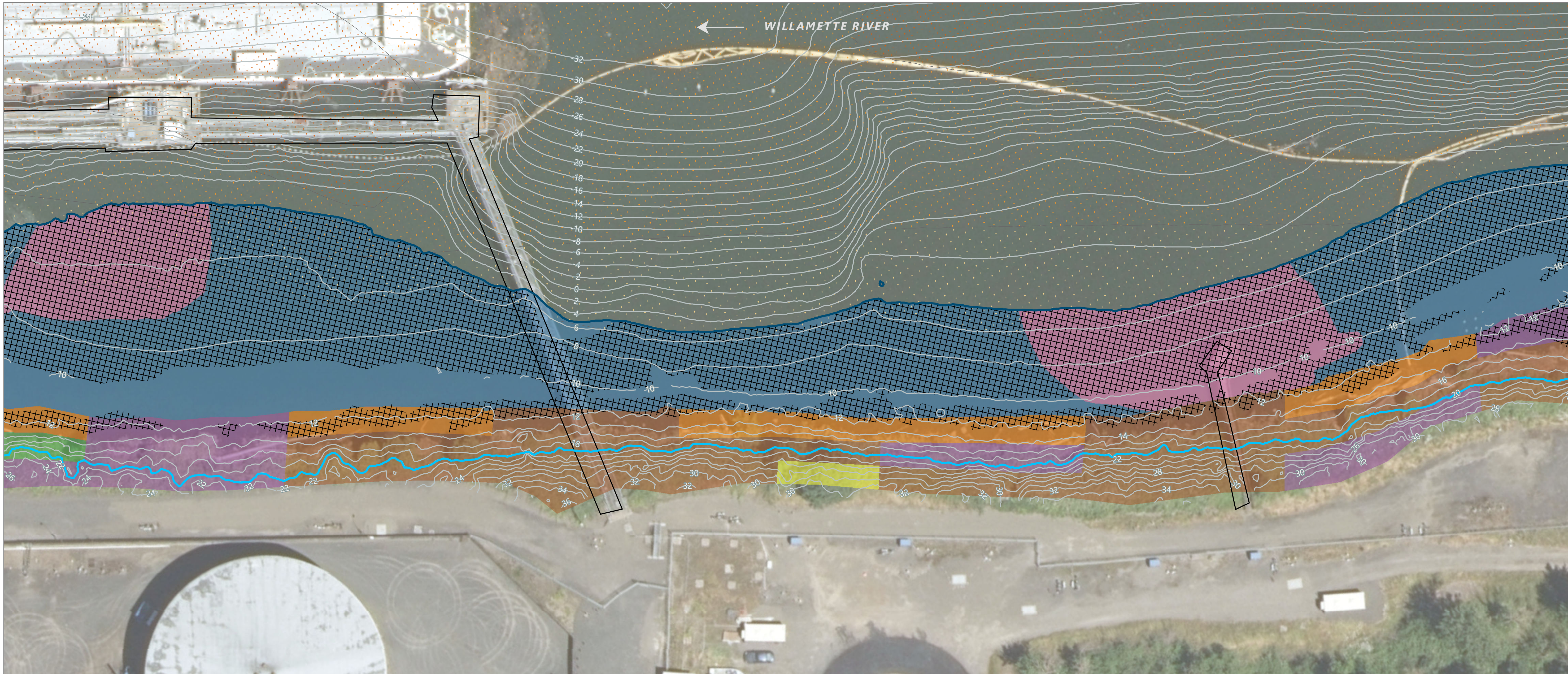
Figure 2a
Gasco 2017 Shoreline Habitat Survey Results
Mitigation Evaluation Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Ordinary High Water (+18 feet COP)
- Ordinary Low Water (+3.0 feet COP)
- 2-foot Bathymetry Contours (2019)
- Slope Shallower Than 5:1
- Structures

Percent Fines

- 0 – 20%
- 20 – 40%
- 40 – 60%
- 60 – 80%
- 80 – 100%

- <3-inch Angular Rock, No Vegetation
- 3- to 9-inch Angular Rock, No Vegetation
- 3- to 9-inch Angular Rock, 1 or 2 Layers of Trees and Shrubs
- 3- to 9-inch Angular Rock, Non-Native Vegetation
- Riprap/Debris (Boulder; Large Stone -- 9-inch), No Vegetation
- Riprap/Debris (Boulder; Large Stone -- 9-inch), 1 or 2 Layers of Trees and Shrubs
- Riprap/Debris (Boulder; Large Stone -- 9-inch), Non-Native Vegetation
- Unarmored, No Vegetation

NOTES:

1. Areas where slopes are shallower than 5:1 are only shown for the active channel margin (ACM) which is located between OHW (+18 feet COP) and OLW (+3.0 feet COP).
2. Within the ACM, areas that are not shown as shallower than 5:1 slopes contain slopes that are steeper than 5:1 except where contour data is lacking (i.e., slope data not available).
3. Bathymetric survey from eTrack 2019.
4. Arrow indicates direction of flow of river.
5. Horizontal datum is NAD83 Oregon State Plane North, International Feet.
6. Aerial imagery from City of Portland 2022.

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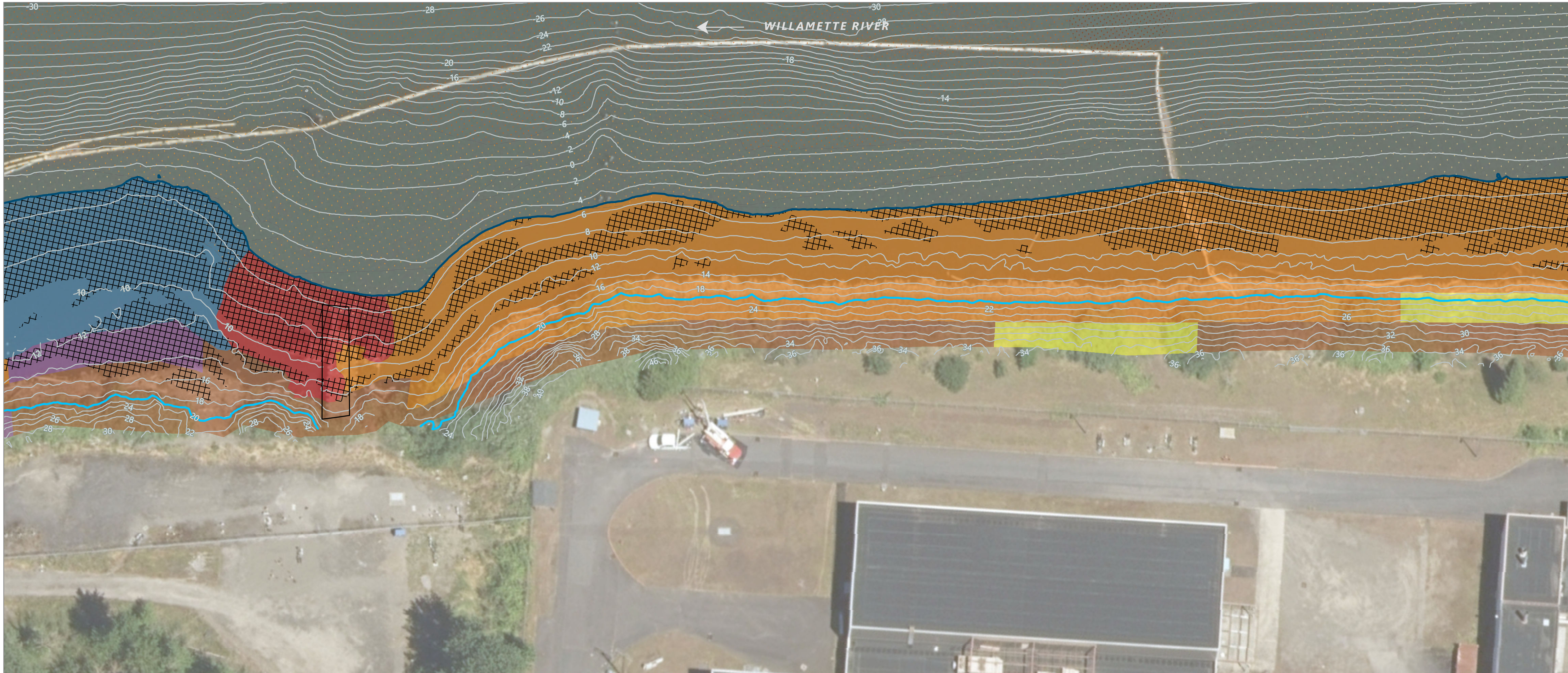
Figure 2b
Gasco 2017 Shoreline Habitat Survey Results
Mitigation Evaluation Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Ordinary High Water (+18 feet COP)
- Ordinary Low Water (+3.0 feet COP)
- 2-foot Bathymetry Contours (2019)
- Slope Shallower Than 5:1
- Structures

Percent Fines

- 0 – 20%
- 20 – 40%
- 40 – 60%
- 60 – 80%
- 80 – 100%

- <3-inch Angular Rock, No Vegetation
- 3- to 9-inch Angular Rock, No Vegetation
- 3- to 9-inch Angular Rock, 1 or 2 Layers of Trees and Shrubs
- 3- to 9-inch Angular Rock, Non-Native Vegetation
- Riprap/Debris (Boulder; Large Stone -- 9-inch), No Vegetation
- Riprap/Debris (Boulder; Large Stone -- 9-inch), 1 or 2 Layers of Trees and Shrubs
- Riprap/Debris (Boulder; Large Stone -- 9-inch), Non-Native Vegetation
- Unarmored, No Vegetation

NOTES:

1. Areas where slopes are shallower than 5:1 are only shown for the active channel margin (ACM) which is located between OHW (+18 feet COP) and OLW (+3.0 feet COP).
2. Within the ACM, areas that are not shown as shallower than 5:1 slopes contain slopes that are steeper than 5:1 except where contour data is lacking (i.e., slope data not available).
3. Bathymetric survey from eTrack 2019.
4. Arrow indicates direction of flow of river.
5. Horizontal datum is NAD83 Oregon State Plane North, International Feet.
6. Aerial imagery from City of Portland 2022.

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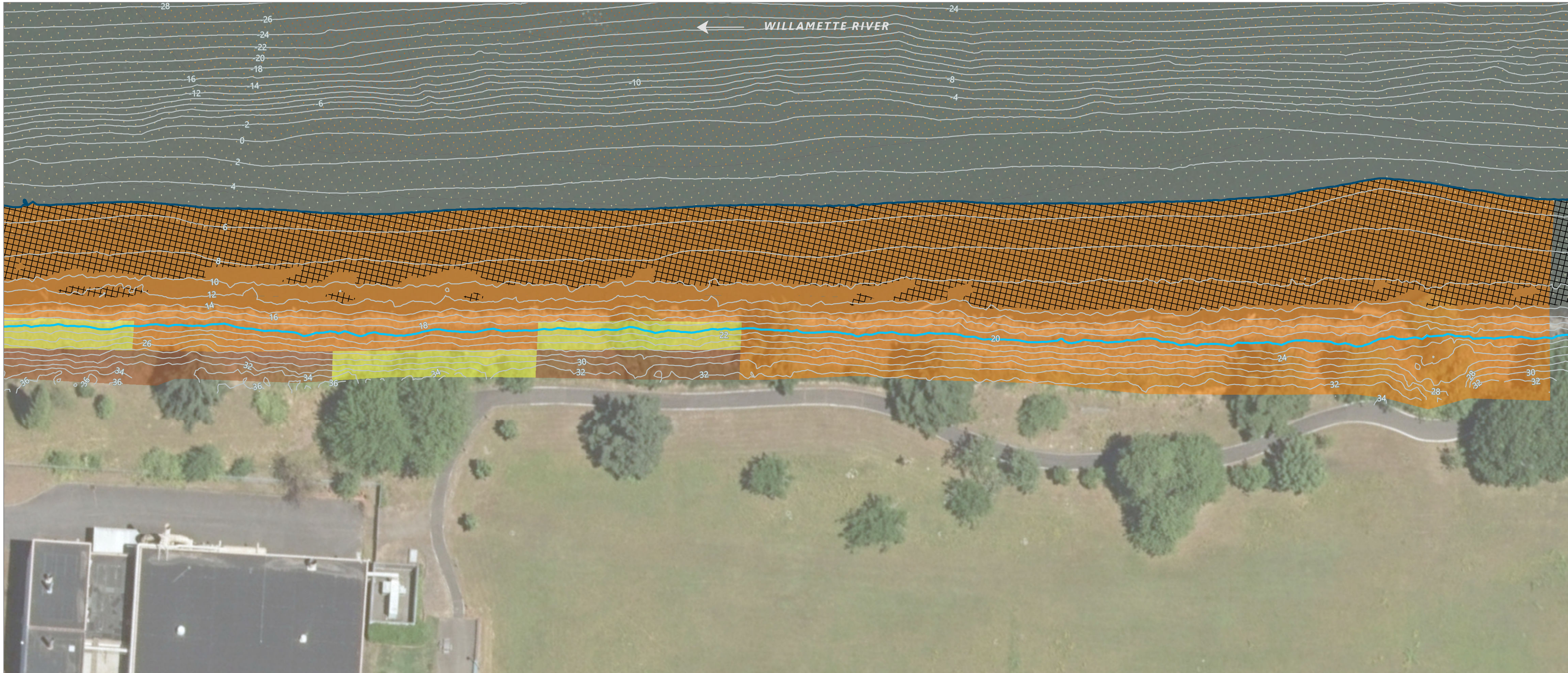
Figure 2c
Gasco 2017 Shoreline Habitat Survey Results
Mitigation Evaluation Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Ordinary High Water (+18 feet COP)
- Ordinary Low Water (+3.0 feet COP)
- 2-foot Bathymetry Contours (2019)
- Slope Shallower Than 5:1
- Structures

Percent Fines

- 0 – 20%
- 20 – 40%
- 40 – 60%
- 60 – 80%
- 80 – 100%

- <3-inch Angular Rock, No Vegetation
- 3- to 9-inch Angular Rock, No Vegetation
- 3- to 9-inch Angular Rock, 1 or 2 Layers of Trees and Shrubs
- 3- to 9-inch Angular Rock, Non-Native Vegetation
- Riprap/Debris (Boulder; Large Stone -- 9-inch), No Vegetation
- Riprap/Debris (Boulder; Large Stone -- 9-inch), 1 or 2 Layers of Trees and Shrubs
- Riprap/Debris (Boulder; Large Stone -- 9-inch), Non-Native Vegetation
- Unarmored, No Vegetation

NOTES:

1. Areas where slopes are shallower than 5:1 are only shown for the active channel margin (ACM) which is located between OHW (+18 feet COP) and OLW (+3.0 feet COP).
2. Within the ACM, areas that are not shown as shallower than 5:1 slopes contain slopes that are steeper than 5:1 except where contour data is lacking (i.e., slope data not available).
3. Bathymetric survey from eTrack 2019.
4. Arrow indicates direction of flow of river.
5. Horizontal datum is NAD83 Oregon State Plane North, International Feet.
6. Aerial imagery from City of Portland 2022.

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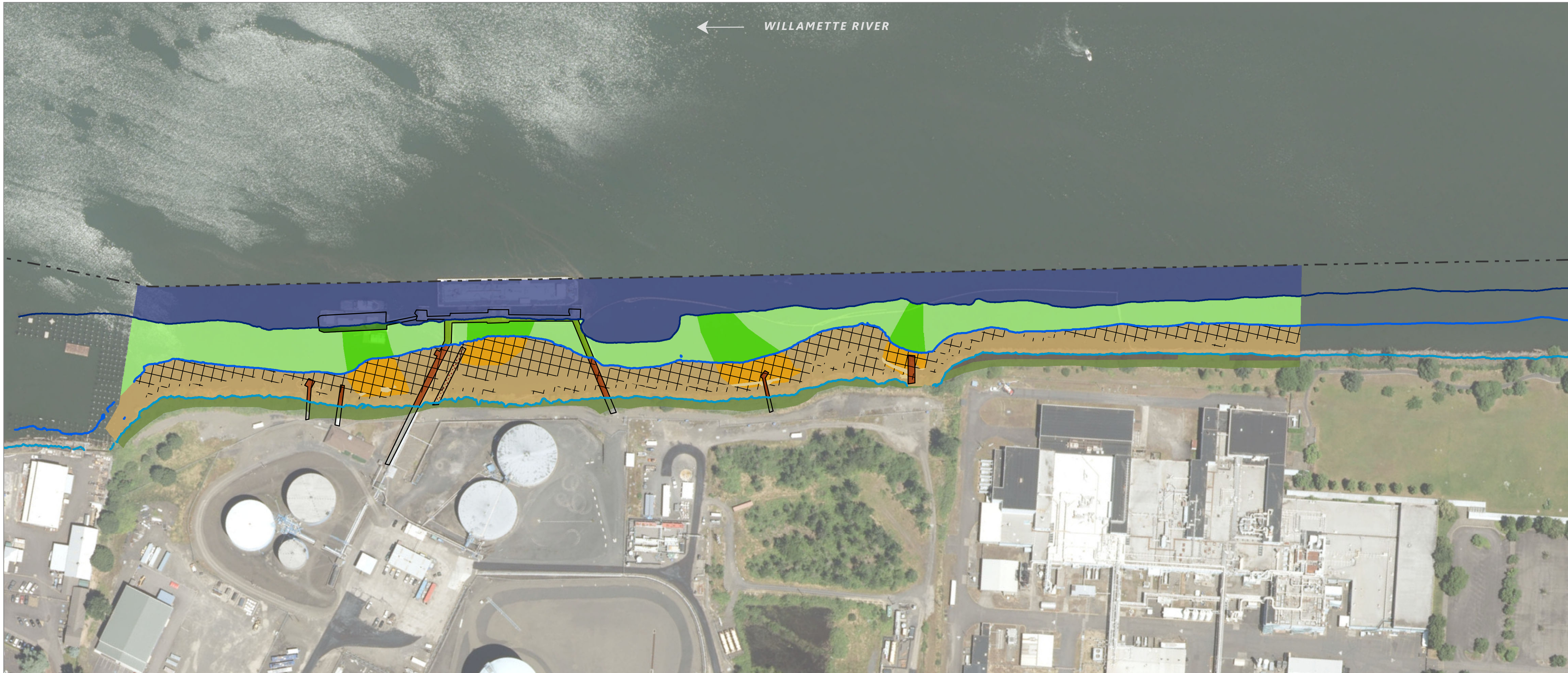
Figure 2d
Gasco 2017 Shoreline Habitat Survey Results
Mitigation Evaluation Work Plan
Gasco Sediments Cleanup Action



LEGEND:

Navigation Channel
Slope Shallower Than 5:1
Structures
Pilings
Ordinary High Water (+18 feet COP)
Ordinary Low Water (+3.0 feet COP)
-12 ft COP

Riparian (Above OHW)

unvegetated/paved/buildings/riprap
vegetated riprap

Active Channel Margin (Between OHW and OLW)

sloped (<5:1), unarmored and unvegetated
sloped (>5:1), unarmored and unvegetated
riprapped and 3 to 9-inch angular rock
suspended structures over channel margins

Main Channel (Below OLW), Shallow Water

shallow water, gravel and finer substrates
shallow water with riprap/concrete/seawall in adjacent shoreline
shallow water with suspended structures
shallow water with floating structures

Main Channel (Below OLW), Deep Water

deep water with natural substrates

NOTES:

1. Areas where slopes are shallower than 5:1 are only shown for the active channel margin (ACM) which is located between OHW (+18 feet COP) and OLW (+3.0 feet COP).
2. Within the ACM, areas that are not shown as shallower than 5:1 slopes contain slopes that are steeper than 5:1 except where contour data is lacking (i.e., slope data not available).
3. Bathymetric survey from eTrac 2019.
4. Arrow indicates direction of flow of river.
5. Horizontal datum is NAD83 Oregon State Plane North, International Feet.
6. Aerial imagery from City of Portland 2022.

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Figure 3
Shoreline Baseline Habitat Characteristics and Categories, Before Remedial Action
Mitigation Evaluation Work Plan
Gasco Sediments Cleanup Action

Attachment A
Habitat Equivalency Analysis Workbook Template

This attachment is being submitted as a separate Excel file.

Attachment B
Habitat Categories and Values

HABITAT EQUIVALENCY ANALYSIS MODEL

There are many aspects to the analysis of a project in a biological opinion from National Marine Fisheries Service, or NMFS. Habitat Equivalency Analysis, or HEA, is often used for one part of an evaluation. HEA is a model that allows NMFS to assess the value of habitat for species at a site listed under the processes of the Endangered Species Act, or ESA. Using HEA, NMFS compares habitat value at a site before a project is implemented with the habitat value after a project is complete. Value is measured in discounted service acre years, or DSAYs. HEA can also account for the time it takes habitats like trees in a riparian area to become fully functional by discounting the value, generally at a rate of 3% per year.

For a HEA analysis, each habitat type is assigned a value ranging from 0 to 1, with 1 being the highest and 0 being the lowest value habitat for ESA-listed species. Inputting the acreages and values associated with each habitat type present at a site before construction, the model can generate the total present habitat value of that site in DSAYs. Similarly, inputting the acreages and values associated with all habitat types planned for after project construction, the model can generate the total habitat value of the site after the project is completed. The pre-project and post-project habitat value of the site can then be compared to see if the project has resulted in a credit (post-project site has a higher habitat value than pre-project site) or debit (pre-project site has a higher value than post-project site). If construction of a project leads to a situation where the pre-project site had a higher value than the post-project site, then the debit from the HEA model can help inform the amount of mitigation that may be necessary. The HEA model can also be used to determine the habitat credit generated by a proposed mitigation project. Credits from a proposed mitigation project are compared to a project debit to see if they balance or result in additional credit, either of which indicates that the mitigation is adequate. Mitigation credits must come from the same habitat category, except that off-channel habitat credits can be applied to debits in any category because this is the primary limiting factor for salmonids in Portland Harbor. Alternatively, a project debit can be mitigated for by purchasing the equivalent DSAY credits from an approved mitigation bank.

Habitat Survey and Values Guide

NMFS will run the HEA model for each project and any proposed mitigation. A pre-project survey must be completed to determine the habitat types and acreages present at the site. This can be done by laying out transects or delineating vertical and horizontal segments of a given size and identifying dominant habitat types along the transects or within each segment. The segments should be small enough so that habitat type does not vary much within a single segment, and one habitat type is easily identifiable as dominant. Clear photographs of each segment or area are helpful as a reference and should be submitted with the habitat survey. Habitat types are listed in the attached table. If habitats are degraded or disconnected from adjacent habitats, these conditions should be documented in the survey. Projected post-project habitat types and their associated acreages can be calculated using project designs.

Note that the attached table contains values for use only in Portland Harbor. While not all habitat types have assigned values, additional values may be assigned as necessary on a project-by-project basis. In addition, pre- and post- project habitat values may be adjusted for a given project based on: the presence or absence of contaminants; the quality of adjacent habitats; or the species and life stages present and the stream where any proposed mitigation is located. "Shallow water habitat" means less than 20 feet of water depth as measured at the ordinary low water level. Shallow water habitat values listed in the table are for depths of 0-10 feet, with a second value in parentheses for depths of 10-20 feet. "Bioengineered" means the use of living and nonliving plant materials in combination with natural and synthetic support materials for slope stabilization, erosion reduction, and vegetative establishment. Treatments must fundamentally rely on riparian plants to provide long term strength to the bank, though grading and inert materials may be used to assist establishment of planted live material.

Please contact Ms. Genevieve Angle at (503) 231-2223 or at Genevieve.Angle@noaa.gov with any questions regarding the HEA process or to request the HEA spreadsheet to experiment with the model for a pre-application stage project.

Draft HEA Habitat Values for ESA Consultation in Portland Harbor

Habitat	Habitat Characteristics	Yrs Until Full Function	Salmonid Value
RIPARIAN (above ordinary high water)	naturally vegetated forest, <400 ft from active channel margin	40 [1]	0.5
	and in the historic floodplain	40 [1]	0.65
	naturally vegetated, grass/shrub	5	0.2
	and associated with historic floodplain	5	0.35
	invasive species (e.g. Himalayan blackberry)	NA	0.1
	vegetated riprap	NA	0.05
	unvegetated/paved/buildings/riprap	NA	0
ACTIVE CHANNEL MARGIN (between ordinary high water and ordinary low water)	sloped (<5:1 or 11°), unarmored and vegetated (native)	3	1
	sloped (<5:1 or 11°), unarmored and vegetated (invasive)	3	0.5
	sloped (>5:1 or 11°), unarmored and vegetated (native)	3	0.8
	sloped (>5:1 or 11°), unarmored and vegetated (invasive)	3	0.4
	sloped (<5:1), unarmored and unvegetated	1	0.8
	sloped (>5:1), unarmored and unvegetated	1	0.1
	sloped (<5:1), bio-engineered	3	0.2
	sloped (>5:1), bio-engineered	3	0.2
	Riprapped	NA	0
	sheetpile/seawall	NA	0
	Pilings	NA	1/2 value of margin type
	suspended structures over channel margins (e.g. docks)	NA	0.1
	floating structures (e.g. docks)	NA	0
MAIN CHANNEL (below ordinary low water)	shallow water, gravel and finer substrates	1	1 (0.9)
	shallow water, natural rock outcrop	NA [2]	1 (0.9)
	shallow water w. riprap/concrete/seawall in adjacent shoreline	NA	0.1 (0.1)
	shallow water with suspended structures	NA	0.1 (0.1)
	shallow water with floating structures	NA	0
	shallow water with pilings	NA	1/2 value of channel type
	deep water with natural substrates	1	0.1
	deep water with artificial substrates	NA	0.05
OFF CHANNEL	"cold" water tributary	1	1
	"warm" water tributary	1	0.9
	side channel	1	1
	alcove or slough with tributary	1	1
	alcove or slough with tributary ("warm")	1	0.9
	alcove or slough without tributary	1	0.8
	embayment (cove) with tributary	1	1
	embayment (cove) with tributary ("warm")	1	0.9
	embayment (cove) without tributary	1	0.8

NOTES: [1] achieves 80% of full function within 10 years; this time is adequate because of flood protection
[2] cannot be created
Credit for simply removing pilings is limited to 0.1 and for removing covering structures is limited to 0.5.

Portland Harbor Natural Resource Trustee Council
"Expert Panel" Discussion of Habitat Restoration for Chinook Salmon

Executive Summary

On November 30 and December 1, 2009, a panel of experts was convened by the Portland Harbor Natural Resource Trustee Council to develop a scientific foundation for restoration planning being conducted under the Natural Resource Damage and Assessment program (NRDA) for the Portland Harbor Superfund site. The Trustees have been engaged in the early phases of restoration planning since 2007, and have developed some preliminary approaches and priorities for restoration of natural resources and habitats that may have been injured by releases of hazardous substances in Portland Harbor. Before moving into a more formal phase of restoration planning and closer to settlements with Potentially Responsible Parties (PRPs), the Trustees paused to invite the review and input of recognized experts on salmon and salmon habitat in the Lower Willamette River, in order to identify a scientific framework and priorities to guide the development of a restoration plan.

The purposes of the two-day expert panel session were to:

- identify the most relevant scientific literature and technical resources to guide restoration planning;
- understand the primary habitat requirements and limiting factors for juvenile Chinook salmon in the Lower Willamette River; and
- identify the types, characteristics and geographic locations of habitat restoration actions that would provide the greatest benefit for juvenile Chinook salmon.

The expert panel was comprised of the following members:

- Tom Friesen, Fish Biologist, Oregon Department of Fish and Wildlife's Corvallis Research Lab
- Stan Gregory, PhD, Professor of Fisheries, Oregon State University
- Nancy Munn, PhD, Aquatic Ecologist and Policy Analyst, National Marine Fisheries Service, Habitat Division
- Chris Prescott, Watershed Ecologist, City of Portland's Bureau of Environmental Services

Other participants included:

- Charles "Pete" Peterson, PhD, Interdisciplinary Marine Conservation Ecologist, University of North Carolina

- Erin Madden, Chair, Portland Harbor Natural Resource Trustee Council, representative of Nez Perce Tribe
- Robert Wolotira, NOAA Restoration Center, Habitat Equivalency Analyst
- Megan Callahan Grant, NOAA Restoration Center, Restoration Planning Coordinator for Portland Harbor Natural Resource Trustee Council (facilitator)
- Megan Hilgart, NOAA Restoration Center (recorder)

Erin Madden provided an overview of the Portland Harbor Natural Resource Trustee Council, its authorities under CERCLA and NRDA, and its phased plan for making the public whole for losses of natural resources, habitats and services in Portland Harbor. Nancy Munn presented background information on Endangered Species Act listings of salmonids that utilize habitat in the Harbor area, and factors that have been identified as limiting recovery of these species. Robert Wolotira provided an overview of Habitat Equivalency Analysis, using a Puget Sound site as an example. Tom Friesen described the findings of his research on juvenile Chinook diet and habitat utilization in the Lower Willamette River. Stan Gregory and Chris Prescott provided relevant information on their biological and ecological research and monitoring of the Upper and Lower Willamette River.

The expert panel reached consensus in the following areas:

1. Juvenile Chinook salmon utilize the Lower Willamette River for feeding and rearing before entering the Columbia River Estuary to a greater extent than previously believed. Chinook salmon are present almost year-round in the Lower Willamette.

2. Both yearling and subyearling (young-of-the-year) juvenile Chinook are found in the Lower Willamette. Although migration rates for subyearlings have not been directly evaluated, studies have shown that Chinook migration rate increases with fish size. Therefore, subyearlings may spend more substantial amounts of time than yearlings (more than two weeks) feeding and developing in the lower Willamette.

3. The area of the Lower Willamette that is most important for juvenile Chinook extends from Willamette Falls to the mouth of the Willamette (the broadest definition of the mouth or confluence with the Columbia includes the Lower Columbia mainstem from the Sandy River confluence upstream to the Lewis River confluence downstream), including the confluence areas of the major tributaries (Clackamas, Johnson, Kellogg and Tryon creeks), and Multnomah Channel.

4. The most limited or scarce habitat types within this area include any refuge from mainstem Willamette flows (alcoves and off-channel habitats, tributary mouths); shallow water and beach habitats with or without large wood assemblages; and undulating, natural shorelines. Other important potential limiting factors include temperature and toxics, as well competition and predation by non-native species that are more tolerant of high temperatures and toxics.

5. The extreme scarcity of key habitat types within the Portland Harbor study area (RM 1-11.8) makes it the expert panel's highest priority for restoration actions. Additional justification for this priority was provided by the panel
   - The study area contains the most impaired habitat in the river; the river is almost completely disconnected from its floodplain in this reach, with many ecosystem processes severely impaired. Further, physical alterations to the channel's edge severely limit availability of nearshore shallow water habitats.
   - The Lower Willamette is the first (lowermost) major tributary junction in the Columbia River basin.
   - A significant number of threatened and endangered (Columbia River and Willamette River) species use the area; all Willamette River stocks must pass through the study area twice during their life cycle.
   - The area's history of toxic contamination poses growth and survival challenges for juvenile salmonids, reducing their resiliency to other stressors.
   - The Lower Willamette contains the largest number of invasive/non-native species in the Willamette system, posing a further survival challenge to native salmonids.
   - There is an important opportunity for public education and outreach in the urban area.
   - Habitats within the study area are underserved by exsiting, non-NRDA sources of funding for restoration, compared to the mainstem Lower Columbia River, and tributaries such as the Clackamas River.

6. The expert panel developed a set of values for existing and potentially restorable types of habitat. The habitat types were evaluated based on their relative importance to juvenile Chinook, with the most important habitat types valued at 1.0, and all other habitat types valued relative to those "ideal" habitat types. These values will be used by the Trustees to identify the current, as well as potential future, value of specific habitats at specific locations as part of the Habitat Equivalency Analysis (HEA) model, and to calculate the increased habitat value or "lift" generated by restoration projects. The table of HEA values generated by the expert panel is attached to this summary.

7. The expert panel identified several characteristics that could increase the value of a restoration project. These include:
   - Restoration actions that would result in high quality habitat along both banks of a stretch of river
   - Projects that provide off-channel habitats or flow refuges at regular intervals ("stepping stones"), especially along the same side of the river
   - Restoration actions that provide a connection to a cold water tributary
   - Projects that provide cumulative ecosystem services (carbon sequestration, non-structural flood storage, wetland, wildlife benefits)
   - Projects of substantial size (expert panel noted that these are rare within the study area) so that ecosystem functions and processes are able to maintain habitats with minimal human manipulation or maintenance
   - Projects that restore multiple functional habitat types
   - Projects that protect existing, high-quality habitats
   - Projects that reconnect portions of the historic flood plain

Recommendations:

The expert panel recommended a strong emphasis on restoration of habitats within the Portland Harbor study area, but also noted the importance of habitats upstream and downstream of the study area. For upstream habitats (upstream of the study area to Willamette Falls), the panel recommended a focus on protecting intact habitats along the mainstem Willamette and tributary mouths that are currently developable and in private ownership. For downstream habitats (Multnomah Channel and Willamette River mouth and environs), the focus should be restoration of forested, complex and undulating shorelines, and the restoration of off-channel habitats.

Although the panel developed a table of initial relative values for each existing and potentially restorable habitat type (for habitat equivalency analysis), the panel members recommended that the Trustees contract out for an independent literature review, and that values be adjusted based on the results of that review.

The panel suggested that Potentially Responsible Parties should be required to direct a minimum of one third to one half of their total liability to restoration projects inside the study area. The panelists identified conservation banking as one possible mechanism to ensure timely and efficient implementation of high-priority restoration actions. The panel also stressed the importance of long-term monitoring, management and stewardship of restoration projects in order to ensure the highest possible degree of scientific learning and the greatest chance of success, and encouraged the Trustees to account for these functions when estimating cost and value of restoration actions.

Table 1. Relative Chinook Salmon Lower Willamette Habitat Values

Habitat	Habitat Characteristics	Function Hab. Val	Yrs Until Full Function
Upland	forested, in hist. floodplain, >200 ft from ACM*	0.65	50
	forested, outside historic floodplain	0.15	40 (80% in 10 yrs)
	vegetated, grass/shrub outside floodplain	0.1	5
	vegetated, invasive spp. outside floodplain	0.05	--
	forested along tributary into Willamette	0.15	40
	forested and part of the historic floodplain	0.3	40
	vegetated, grass/shrub in historic floodplain	0.2	5
	vegetated, invasive spp in historic floodplain	0.1	--
	unvegetated/paved/buildings	0	--
Riparian	naturally vegetated forest, <200 ft from ACM	0.5	40** (80% in 10 yrs)
	and in the historic floodplain	0.65	50
	naturally vegetated, grass/shrub	0.2	5
	and associated with historic flood plain	0.35	5
	invasive species	0.1	3
Active channel margin	Sloped (<5:1 or 11°), unarmored and vegetated	1	3
	Sloped (>5:1 or 11°), unarmored and vegetated	0.2	3
	sloped (<5:1), unarmored and unvegetated	0.8	3
	sloped (<5:1), bio-engineered	0.4	3
	sloped (>5:1), bio-engineered	0.2	3
	riprapped	0.1	1
	sheetpile	0	--
	pilings (1 per 100 sq ft)	half value of margin type	
	covered structures over channel margins	max of 0.1	--
Main Channel	shallow water, gravel and finer substrates	1	1
	shallow water, natural rock outcrop	1	1
	shallow water with riprap or concrete	0.1	1
	shallow water with covering structures	0.1	--
	shallow water with pilings (1 per 100 sq ft)	0.5	1
	deep water with natural substrates	0.1	1
	deep water with artificial substrates	0.05	1
Off Channel	"Cold" water tributary	1	1
	"Warm" water tributary	0.9	1
	side channel	1	1
	alcove or slough with tributary	1	1
	alcove or slough without tributary	0.8	1
	embayment (cove) with tributary	1	1
	embayment (cove) without tributary	0.8***	1

*--ACM = Active Channel Margin

**--this time adequate for juvenile chinook because of flood protection.

***--around 0.6 further upstream