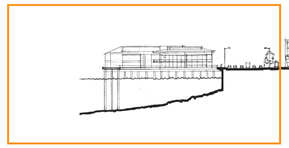
Ecological Environment

Section - Lenora St
SOURCE: WAGDA, accessed October, 2010.



Section - Lenora St
SOURCE: DPD

Open Water Shelf Treatment

Designed to maximize surface area diversity, variation of solar irradiance, water movement, and minimization of predation. These functions combined in one treatment could potentially support rapid colonization by a wide array of marine life at the intertidal zone. This treatment functions as an 'accreting framework', similar to an underwater scaffold or lattice, upon which a range of organisms can attach, crawl over or swim through.

Large Woody Debris (LWD)

The introduction of LWD into the nearshore environement would re-create a naturally occuring environment that is no longer present in Elliot Bay. LWD may be attached to the sea wall directly, or submerged. LWD serves as a substrate on which fish may forage, find refuge and spawn.

Reef Balls

Designed to mimic the natural conditions of a specific location and have been used worldwide (Barber, n.d.). According to Barber (n.d.), life-expectancies are estimated to be up to 500 years, since they are constructed of concrete. Typical concrete is not marine organism friendly because its high pH prevents colonization; however,the concrete used in reef balls incorporates an admixture that reduces the pH so that it is not detrimental to marine life.

"Fish Mix" Gravel Beds

Prearranged mixtures [have the] to start a food chain beneficial to juvenile salmon and other fish. This substrate can be piled along a steep intertidal slope, between +6 and -6 feet MLLW, and is held in place by a collection of riprap or larger rocks at its base. The complicated and porous texture of a gravel pile forms an unexpected "fuzzy" surface, which in actuality is a benthic diatom community. These benthic diatoms attract carpactecoids, tiny crustaceans that happen to be prey of juvenile salmon.

Sea Wall Mitigation Strategies

SOURCE: DPD, "Rethinking the Urban Marine Edge."

Wildlife
Life Over Water

Birds
Birds are among the species most adaptable to living in the highly urbanized environment of downtown Seattle. For further information, a complete bird species list can be found in the DEIS (wsdot.wa.gov).

Terrestrial wildlife
Terrestrial animal species range from domestic dogs, cats and rabbits to bats, ermine and mink. The highly urbanized environment only allows for species that are highly adaptable to the intense urban setting. For further information, a complete discussion of wildlife can be found in the DEIS (wsdot.wa.gov).

Vegetation
The only notable vegetation along the waterfront are mature street trees planted along the length of the project area.

Special Status Species
Bald eagle (Haliaeetus leucocephalus) – protected under the Bald and Golden Eagle Protection Act of 1940 (16 USC 668-668c).
Southern resident killer whale (Orcinus orca): Federally and State listed as endangered.
Marbled murrelet (Brachyramphus marmoratus): Federally and State listed as threatened.
Puget Sound Steelhead (Oncorhynchus mykiss)Distinct Population Segment: Proposed for Federal listing as threatened.

Puget Sound/Outer Elliott Bay - Pelagic Waters
Orcas, gray whales, and Dall's porpoise occasionally pass through this area. Seals and sea lions are more frequently seen here.

Sources:
FHWA. Alaskan Way Viaduct & Seawall Replacement Project: Supplemental Draft Environmental Impact Statement. Appendix R: Fisheries, Wildlife, and Habitat Discipline Report. 2004.

Salmon
Life Under Water

Nearshore Marine Environment
While shady areas are critical for salmon spawning habitat, it is believed to be a less desirable condition during the juvenile and adult life stages.

"Like the habitat use patterns observed in Lake Washington, juvenile Chinook salmon in the marine nearshore and estuary areas of central Puget Sound tend to be closely associated with shallow habitats located close to shore (KCDNR 2001)."

"Because Puget Sound Chinook out migrate as younger and smaller juveniles, they are more dependent on forage in the estuaries and near- shore systems to increase their body weight and condition before moving into more pelagic environments (i.e., deeper Puget Sound waters or the Pacific Ocean) (Levy and Northcote, 1982; Pearce et al., 1982)."

"This is consistent with observations in other regions of the Pacific northwest, where juvenile Chinook are found to be strongly associated with shoreline areas (Levings et al. 1983)."

"Marine nearshore areas and estuaries may be particularly important for juvenile Chinook salmon for migration, feeding, and rearing within the central Puget Sound (KCDNR 2001). Moreover, some of these areas are used by juveniles for the physiological transition from freshwater to saltwater (especially mouths of creeks and Duwamish River). "

"The period of use within estuary and marine nearshore areas of the city may be highly variable among individual juvenile fish. Shepard (1981) found that some individual Chinook may utilize estuarine and nearshore habitats for as few as four days, while other authors have documented that juvenile Chinook use estuary habitats for up to 189 days (Wallace and Collins, 1997; Levy and Northcote, 1982)."

Essential Fish Habitat
Essential Fish Habitat (EFH) is "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). The Magnuson Stevens Act requires proposed projects with a federal nexus to evaluate potential impacts to habitat of commercially managed fish populations. A complete fish species list can be found in the DEIS (wsdot.wa.gov).

Sources:
Toft, et al, 2004. Wetland Ecosystem Team, School of Aquatic and Fishery Sciences, University of Washington Seattle, WA. *Fish Distribution, Abundance, and Behavior at Nearshore Habitats along City of Seattle Marine Shorelines, with an Emphasis on Juvenile Salmonids.*

Pollution
Sources

Point Source Pollution
Point sources, such as combined sewer overflow (CSO) outfalls, are "relatively insignificant source(s) of contaminants" to the Seattle waterfront. Non-point sources, such as small fuel spills, discharges of oily water from vessels, and creosote-treated piles and bulkheads, particularly those in disrepair and potentially decomposing, are a larger threat to the marine environment.

Non-Point source
Non-point source pollution sources include urban runoff (oils and grease from streets) and agricultural runoff (fertilizer, pesticides).

Combined Sewer Overflow (CSO)
4 CSO outfalls owned by Seattle Public Utilities (SPU) are within the project area. Within the project area, existing upstream separated stormwater systems flow through the project area and discharge to Elliott Bay untreated. The AWVSRP does not trigger any codes that require a change of the existing condition, however, SPU could choose to intercept and treat this stormwater to improve water quality.

Buried/Capped Debris Within The Bay
Piles of rubble sit on the bay floor where several piers once stood. These structures are large pieces of debris comprised of steel, wood, and/or concrete that rise several feet off the bottom.

Chemical Pollutants
Concentrations of mercury, PAHs and other hazardous chemicals contaminate the bay.

Sources:
FHWA. Alaskan Way Viaduct & Seawall Replacement Project: Supplemental Draft Environmental Impact Statement. Appendix U: Hazardous Materials Discipline Report. 2006.

Public Spaces Public Life for Seattle's Central Waterfront

image sources: Gehl Architects

Easton Branam
Andrea Gousen
Andrea Slusser
David Tomlinson
Aaron Vandenberg

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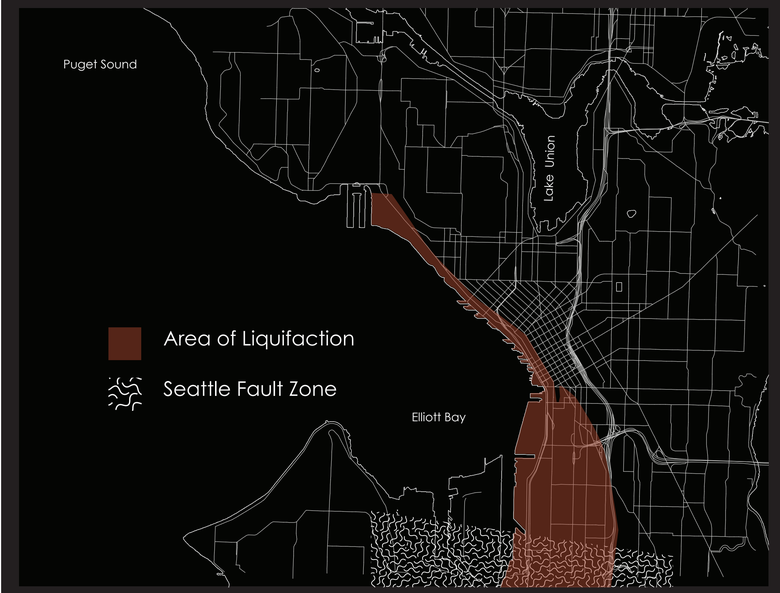
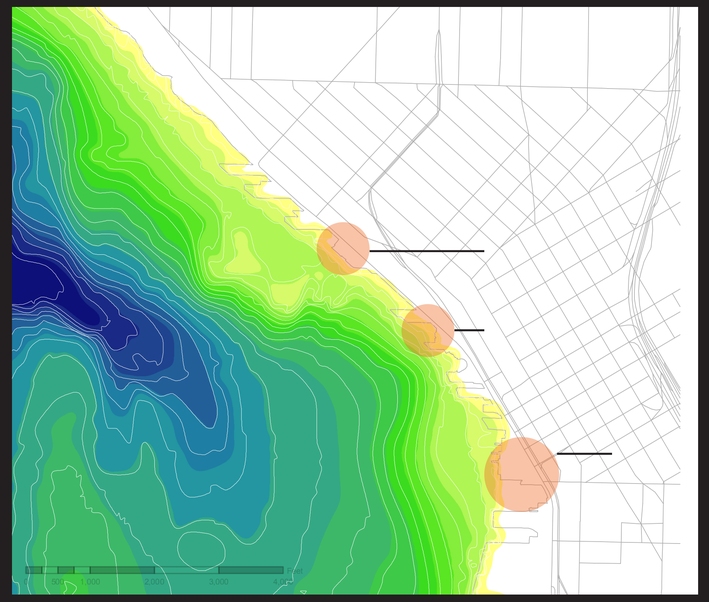
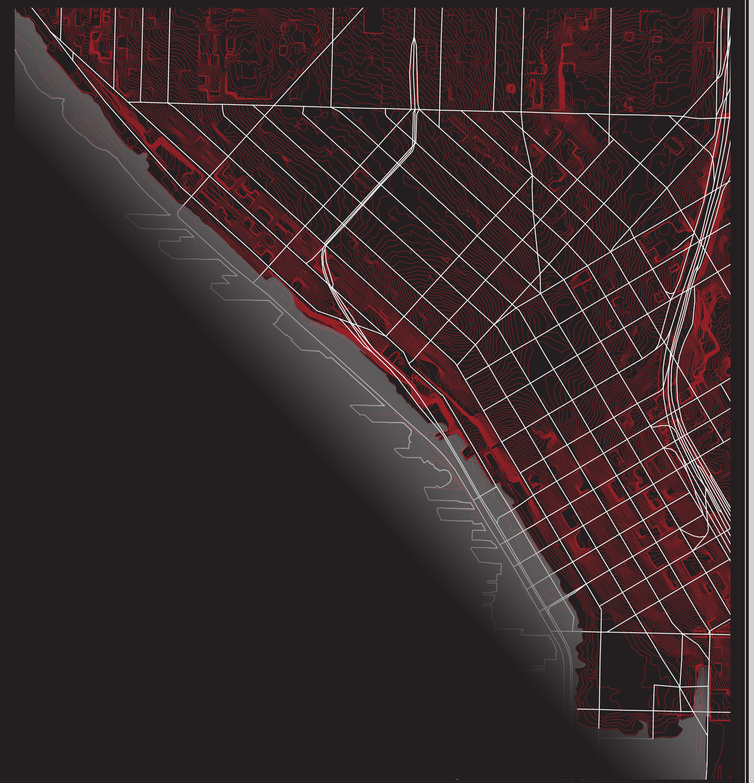
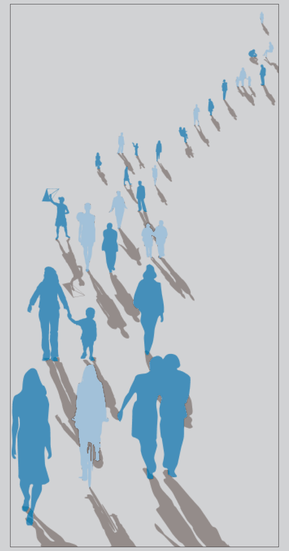
06 October 2010







Public Spaces Public Life for Seattle's Central Waterfront



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GeoHazard
Shake It Up

In 2001, Seattle experienced the Seattle Earthquake in 1965 and the Nisqually Earthquake in 2001, indicating a new era of development, design and planning in an active fault zone. The Pacific Northwest is known for many famous seismic events, however, a large fault line runs East-West across the southern end of the waterfront. This fault zone poses a serious threat as the area also has loose, unconsolidated soils along the entire rim of the waterfront. In large seismic events, this saturated fill acts much like a gelatinous substance and may experience settling from 0-24 inches (Seismic Vulnerability of the AK Way Viaduct). This soil compaction and movement seriously jeopardizes the structural integrity of many of the buildings, piers, and civil infrastructure of the waterfront district. If an earthquake were to occur the fill is expected to move laterally along the entire length of the seawall and hence would move the seawall and the fill towards the water up to 3-4 feet (ibid).

(L) Photo shows repairs by WSDOT being completed after the 2001 Nisqually Quake. (R) The damage becomes apparent months after the quake hits when water seeps through the concrete and disrupts the structure of the Viaduct.

Sources: Kramer, Eberhard. "Seismic Vulnerabilty of the Alaskan Way Viaduct." WSDOT. 1995. www.wsdot.wa.gov/research/reports/fullreports/363.4.pdf
Viaduct Repairs: http://www.wsdot.wa.gov/Projects/Viaduct/Photos/Repairs.htm

Waterfront Bathymetry
Life Under Water

Due to the physical limitations of the bathymetric profile near the waterfront, developing additional infrastructure would be difficult, expensive and may disturb the existing habitat of the surrounding aquatic environment. The nearshore habitat is an important space that has the potential to be the richest area for biodiversity, green infrastructure improvements and public access to the shoreline. Creating a place for people is equally important to creating spaces for other creatures of the natural world.

In a technical memorandum by Parametrix Consulting to the City of Seattle, ecological surveys suggest that the city should restore four main areas along the waterfront. TThese four locations are all publicly held and have shallow shorelines, which makes them good candidates for nearshore habitat restoration. Ideal habitat should include wave attenuation devices, cobble/gravel mix fill and solid substrate that will allow aquatic grasses and algae to proliferate.

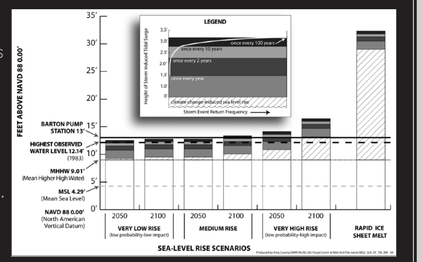
OA major design consideration in this restoring this habitat is the proper angle of beach to create the maximum amount of surface area in relation to the vertical water depth to allow sunlight to permeate the water column along the nearshore areas of the waterfront. The suggested slope of the restored beach areas should be 5:1 to 8:1 graded to a 2:1 rock wall profile to create ideal conditions for nearshore marine habitat. In certain areas it is feasible to construct fill areas to form this angle as deep as -60 feet Mean Low Low Water (MLLW). (Parametrix)

Sources:
Don Weitkamp, Bob Donnely, Kurt Buchanan. SEATTLE SHORELINE HABITAT RESTORATION OPPORTUNITIES. Parametrix Technical Memorandum. April 2003.

Waterfront Brief. http://www.seattle.gov/dpd/planning/central_waterfront/partnerships committee/briefing book/index.htm

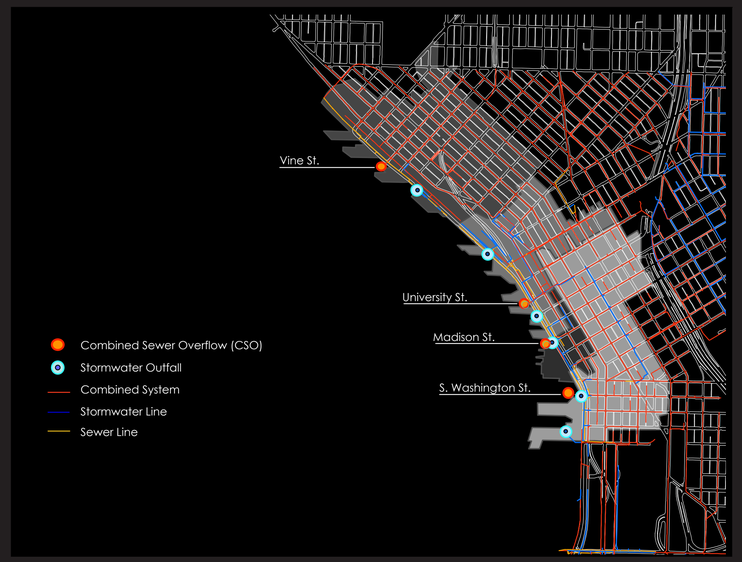
Visualize Climate Change
Rise and Fall

King County officials used climate models to project the vulnerability of civic infrastructure by the increase in sea levels due to climate change by the year 2100. Some models suggest that there may be an increase in sea level on average of 18 feet (MLLW) by 2100 but possibly up to 32 feet. (King County Stormwater Infrastructure Report). Other reports published by the International Panel on Climate Change (IPCC) suggest numbers at least an increase



of 50 inches by the end of the century.
Water levels would inundate much of the new waterfront area and stretch into areas of 1st St. in downtown Seattle. The unconsolidated soils, sea wall and issues regarding liquefaction of soils may undermine the integrity of the proposed infrastructure taking into account this data.

Sources:
Vulnerabilty of Stormwater Facilities to Flooding from Sea-Level Rise. July 2008. King Country Metro. Department of Natural Resources.
Photo: James Corner Operations Waterfront Presentation. September. 2010. DPD.



OUTFALL NUMBER	OVERFLOW OUTFALL LOCATION	RECEIVING WATER BODY	LATITUDE	LONGITUDE
69	Alaskan Way at Vine Street	Elliott Bay	47° 36' 48" N	-122° 21' 08" W
70	Alaskan Way at University Street	Elliott Bay	47° 36' 21" N	-122° 20' 26" W
71	Alaskan Way at Madison Street	Elliott Bay	47° 36' 13" N	-122° 20' 19" W
72	Alaskan Way S. at S. Washington	Elliott Bay	47° 36' 03" N	-122° 20' 13" W

CSOs and Stormwater

Drainage Systems

Ecology regulations require SPU to control CSOs to an average of one untreated overflow event per year per overflow site by 2020. The transportation project provides an opportunity for SPU to upgrade its existing CSO system in the transportation footprint to bring SPU's CSO system into regulatory compliance concurrently with the construction of the transportation project.

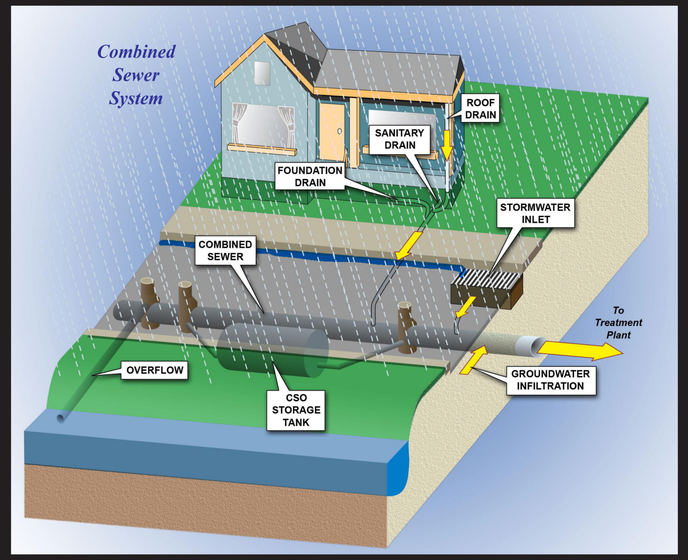
The City of Seattle's Combined Sewer Overflow (CSO) system has 90 outfalls that may discharge a combination of sewage and stormwater during precipitation events. Each CSO is identified by its National Pollutant Discharge Elimination System (NPDES) permit number.

Within the Alaskan Way Viaduct and Seawall Replacement Project (AWVSRP) vicinity, the City of Seattle is responsible for permits that govern performance of **four active CSO outfalls** located at Vine Street (NPDES 69), University Street (NPDES 70), Madison Street (NPDES 71) and Washington Street (NPDES 72), as shown above.

It is also important to consider that surface stormwater does NOT drain into the combined sewer system. **Within the AWVSRP area, existing upstream separated stormwater systems flow through the project area and discharge to Elliott Bay untreated.** The AWVSRP does not trigger any codes that require a change of the existing condition, however, SPU could choose to intercept and treat this stormwater to improve water quality.

Sources:
Major Project Decision for Alaskan Way Viaduct and Seawall Replacement Project. Stormwater and CSO Control for Vine, University, Madison and Washington Basins. Seattle Public Utilities: April 2009

Fact Sheet for NPDES Permit WA-003168-2: City of Seattle's Combined Sewer Overflow System. Department of Ecology DRAFT: August 2010



OUTFALL NUMBER	OVERFLOW OUTFALL LOCATION	AVE ANNUAL OVERFLOW COUNT	AVE ANNUAL OVERFLOW VOLUME (MG)
69	Vine Street	4.4	1.38
70	University Street	0.9	0.15
71	Madison Street	1.3	0.30
72	S. Washington Street	1.2	0.28

Remediation Goals

Storage and Cleaning

The sewer systems in Seattle were designed to carry combined flows of sanitary sewage and stormwater runoff in a common piping system. Overflows may occur at designated outfalls during wet weather events when the volume of sewage and stormwater entering the combined sewer system exceeds the system's capacity. Seattle does not own a wastewater or CSO satellite treatment plant. All sewage collected in Seattle's sewer system is conveyed to King County for regional conveyance and treatment, or is discharged via one of the CSO outfalls.

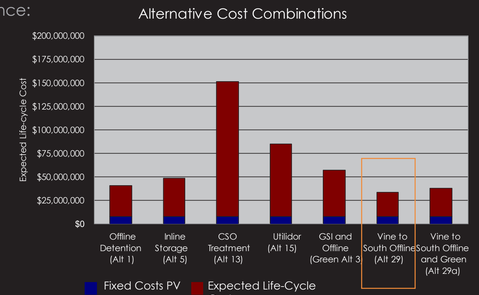
Seven concept-level options for CSO Control in the Central Waterfront AWVSRP project area were evaluated using the triple bottom line analysis. For the triple bottom line economic analysis, capital costs, life-cycle costs, risks and benefits were quantified and compared for each of the seven options. The recommended alternative (29) does not include green mandates but the City of Seattle is open to green remediation strategies.

City Recommended Alternative: Alt. 29

Summary of Major Components:

North Waterfront Conveyance:
54-in-diameter,
3,200 ft long 0.65 MG

S. Area Detention Pipe:
84-in-diameter,
2,260 ft long,
with odor control



COMMON HAZARDOUS MATERIALS FOUND ON LAND
Gasoline
Metals
Solvents
Petroleum-based
PCBs
Combination of these

(Hazardous Materials Discipline Report, 2006)

Contaminants and Toxins

Land and Water

Assorted anthropogenic debris are found along the margin of all piers and sidewalks in the project area. The most contaminated sites are directly offshore.

Piles of rubble cover the open areas where several piers were standing in the past. For example, the same footprint as Pier 61; the open areas between Pier 57 and the Aquarium and between the Aquarium and Piers 62/63 have numerous scattered derelict piles lying horizontal on the seafloor.

Three large structures, one immediately offshore of Piers 62/63 and two adjacent to Pier 57, are present. These structures are large pieces of debris comprised of steel, wood, and/or concrete that rise several feet off the bottom.

Concentrations of mercury, low molecular weight **polycyclic aromatic hydrocarbons (PAHs)**, and high molecular weight PAHs exceeded Ecology's Sediment Quality Standards (SQS), bis(2-ethylhexyl)phthalate, pentachlorophenol, benzoic acid, and benzyl alcohol

Creosote, a wood preservative made from coal tar. The major chemicals associated with creosote that can impair the environment are PAHs, phenols, and creosols
(City of Seattle, Parks and Recreation Department. Final Environmental Impact Statement for the Central Waterfront Master Parks Plan, Aquatic Animals, Vegetation and Wildlife Technical Appendix. 2006)

PUGET SOUND DREDGED DISPOSAL ANALYSIS DISPOSAL AREA The goal of PSDDA is to provide publicly acceptable guidelines for environmentally safe, unconfined, open-water disposal of dredged material, and to provide Puget Sound-wide consistency and predictability in decisions concerning dredged material disposal.

PIER 53 PROJECT In 1992, contractors for the U.S. Army Corps of Engineers placed 22,000 cubic yards of clean sand offshore of Piers 53, 54 and 55 in Elliott Bay on Seattle's downtown waterfront, capping 4.5 acres of chemically contaminated bottom sediments. This action, known as the Pier 53 project, was the culmination of over four years of study and planning by many agencies.
(Parametrix, Inc., 1992.)

Point sources, such as combined sewer overflow (CSO) outfalls, are "relatively insignificant source(s) of contaminants" to the Seattle waterfront. Instead, non-point sources, such as small fuel spills, discharges of oily water from vessels, and creosote-treated piles and bulkheads, particularly those in disrepair and potentially decomposing, may affect sediment chemistry along the waterfront. *(Parametrix, Inc., 1992)*

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