PROPOSED PLAN

Asarco Sediments/Groundwater Operable Unit
Ruston and Tacoma, Washington

Public Comment Period on Cleanup Alternatives
January 26 through February 24, 2000

A Community Meeting is Scheduled For:

7:00 p.m. to 9:00 p.m. on February 10, 2000 at:
Tacoma Yacht Club
5401 North Waterfront Drive
Tacoma, Washington 98407

Oral comments can be provided to EPA at the meeting.

EPA invites you to comment on the Preferred Alternative, other cleanup alternatives, and information in this Proposed Plan. Your comments will help EPA make a decision on the cleanup approach for the Asarco Sediments/Groundwater Operable Unit that is technically sound and addresses the concerns of the community.

Your written comments must be received by February 24, 2000, and mailed to:

Mr. Lee Marshall
Project Manager
U.S. Environmental Protection Agency
Region 10 (ECL-111)
1200 Sixth Avenue
Seattle, WA 98101

1. Introduction

This Proposed Plan identifies the Preferred Alternative for cleanup of contaminated sediments and groundwater at the Asarco Sediments/Groundwater Operable Unit (the Sediments/ Groundwater OU), which is part of the former Asarco Smelter Facility (Facility). The U.S. Environmental Protection Agency (EPA) is the lead agency for the cleanup of the Asarco Facility, including the Sediments/Groundwater OU, and works closely with the State of Washington Department of Ecology (Ecology). Ecology agrees with EPA's Preferred Alternative. The purpose of this Proposed Plan is to describe EPA's proposal for cleaning up sediments and groundwater at the Sediments/Groundwater OU and to ask for public comments. This Proposed Plan is issued in accordance with Section 117(a) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

The Facility is part of the Commencement Bay Nearshore/Tideflats (CB/NT) Superfund Site in Tacoma, Washington. The Facility is divided into four operable units. These include:

- OU 02—Asarco Tacoma Smelter and Slag Peninsula
- OU 04—Asarco Off-Property (Ruston/North Tacoma Study Area)
- OU 06—Asarco Sediments/Groundwater
- OU 07—Asarco Demolition

This Proposed Plan proposes a remedy for Operable Unit 06 - Asarco Sediments/Groundwater, which includes the sediment in the offshore portion of the Facility and the groundwater discharging to Commencement Bay from the upland portion of the Facility.

The area covered by the Sediments/Groundwater OU is located along the Commencement Bay shoreline in Tacoma and Ruston, Washington (Figure 1). It includes the groundwater beneath the Facility and beneath the slag peninsula, the sediments immediately offshore and east of the upland part of the Facility, the slag peninsula, and the Yacht Basin. The slag peninsula and most of the shoreline were created when slag from smelting operations was poured into Commencement Bay.

The Preferred Alternative for the Sediments/Groundwater OU includes the following elements:

Groundwater

- Reduce groundwater flow and related contaminant loading to Commencement Bay by limiting groundwater recharge. This will be accomplished by intercepting groundwater with subsurface drains in selected locations and directing it to a treatment system, diverting surface water and installing a low-permeability cap over the Facility to minimize infiltration, and eliminating leaking underground water and sewer lines (Figure 2).

- Continue to monitor groundwater to evaluate the long-term effects that the smelter cleanup activities will have on future groundwater quality.

- Implement institutional controls to restrict future use of Facility groundwater (this allows for any future need to control or treat groundwater for purposes of protecting human health or the environment).

The first groundwater element listed above is being implemented as part of the Asarco Tacoma Smelter Facility Record of Decision (ROD), but is repeated here to present the entire groundwater remediation plan. This groundwater element is presented again because the sediment cleanup and the groundwater cleanup both impact Commencement Bay. In addition, this Proposed Plan and the subsequent ROD will be written to allow enough flexibility so that future modifications/additions to the groundwater remedy will be possible, should they be necessary (i.e., the concentrations on the Facility after cleanup do not reach the cleanup goals).

Sediment

- Cap contaminated sediments in selected offshore subareas (Northshore, Offshore, and Nearshore areas; Figure 3).

- Use institutional controls to prevent activities that could damage the sediment cap (i.e., shipping activities).

- Dredge contaminated sediments in the Yacht Club basin and place the dredged sediment beneath the low-permeability cap on the upland portion of the Facility. Sediments will be placed in an area known as Crescent Park, in the central part of the upland facility. These sediments will be placed so that no groundwater is or will come in contact with them.

- Monitor the sediment cap to confirm that it remains in place, continues to isolate the contaminated sediment below, becomes recolonized with a healthy biological community, and does not become recontaminated.

- Monitor the dredged area to ensure that it is not becoming recontaminated.

- Monitor the areas outside the capped and dredged areas to confirm the assumptions and conditions on which the decision was made to not require active cleanup and to assist in determining if the cleanup has been successful.

- Based on the long-term monitoring results, determine for all areas whether further action is needed.

This Proposed Plan summarizes information provided in detailed studies (several of which are listed in the following section). All of these documents, in addition to letters and other associated data, are in the Administrative Record for the Facility at EPA's Regional Office in Seattle, the Main Branch of the Tacoma Public Library, and the Ecology office in Olympia. This information is available for public review; addresses for these locations are listed at the end of this Proposed Plan.

Community participation has been, and continues to be, a critical element in designing a cleanup plan for the Sediments/Groundwater OU. EPA will consider community comments when finalizing the cleanup actions for this OU and will address these comments in a Responsiveness Summary, as part of the ROD. EPA has also been working closely with the Natural Resource Trustee agencies, which include National Oceanic and Atmospheric Administration (NOAA), US Fish and Wildlife, Department of Natural Resources (DNR), the Muckleshoot Tribe, and the Puyallup Tribe. Many of their comments were considered in preparation of this document; further comments from the Trustee agencies will be considered during this public comment period.

2. History

From 1890 through 1912, the Facility was used as a lead smelter and refinery. Asarco, Inc. purchased the property in 1905 and converted it in 1912 into a facility to smelt and refine copper from copper-bearing ores and concentrates shipped from other locations. By-products of the smelting operations were further refined to produce other marketable products, such as arsenic, sulfuric acid, and liquid sulfur dioxide. Asarco ended operations in 1985.

Soil, groundwater, surface water, and sediments have been contaminated as a result of the smelting and refining operations at the Facility. Metals, such as arsenic, copper, lead, and zinc, were released into Commencement Bay via spillage from loading/unloading ships, surface water runoff, air emissions, slag fill to extend the shoreline, slag shoreline erosion, and groundwater transport.

The Facility was placed on the Superfund National Priorities List in 1983, and was originally investigated as part of the CB/NT site. Since then, Asarco has conducted numerous investigations and cleanup activities at the Facility under EPA's supervision. The upland cleanup is proceeding ahead of the sediment cleanup, so that the sediments will not become recontaminated. As part of the upland cleanup, which began in 1994, all of the buildings and structures at the Facility have been or will be demolished, and the most contaminated material will be placed in an on-site containment facility (OCF) on the Facility. Construction of the OCF began in 1999. Contaminated soil from nearby residential yards and public rights-of-way is being removed and consolidated for containment under the cap on the Facility.

Additional Sediments/Groundwater OU information is presented in greater detail in the following documents:

(1) Groundwater FS Process Document (December 1999)

(2) Sediment FS Process Document (December 1999)

(3) Draft Refinement of the Proposed Remedy Report (August 1999a)

(4) Group 5 Technical Memorandum, Asarco Sediment/Groundwater Task Force (April 1999b)

(5) Draft Phase 2 Refinement of Options Report—Expanded Remedial Investigation and Feasibility Study (December 1996a)

(6) Ecological Risk Assessment and Seafood Consumption Screening Risk Assessment (October 1996)

(7) Phase 1 Data Evaluation Report—Expanded Remedial Investigation and Feasibility Study (April 1996b)

(8) Phase 2 Data Evaluation Report—Expanded Remedial Investigation and Feasibility Study (March 1996c)

(9) Draft Disposal Site Inventory (March 1995)

(10) Supplemental Feasibility Study—Commencement Bay Nearshore/Tideflats Asarco Sediment Site (October 1993)

Asarco sediments are different from most other sediments in Commencement Bay due to the presence of slag. Slag has high concentrations of metals, but these metals are bound in a rock-like form, which are not necessarily available to the benthic community. Therefore, the chemistry may have high concentrations, yet the biological community could be healthy. This difference between the Asarco Facility and other sites was first noted in the CB/NT ROD, and later in the Upland Smelter Facility ROD. It was further addressed by a group of people from EPA, Ecology, and NOAA (the "Sediment Design Group") as part of the expanded investigations. Based on the above considerations, this group, using best professional judgment, gave greater weight to the benthic evaluation, than to chemical and bioassay data in making cleanup decisions. Where benthic communities were stressed, active remediation (e.g., capping or dredging) was deemed necessary. In the moderate impact area, where benthic communities appear healthy (based on evaluation of community structure), active remedial

State Sediment Management Standards—Sediment Cleanup Criteria

The Washington State Sediment Management Standards (SMS) are used to evaluate contaminated sediments. The long-term goal of the SMS is "to reduce and ultimately eliminate adverse effects on biological resources and significant health threats to humans from surface sediment contamination." To this end, the SMS include numerical standards for chemical and biological effects for the protection of marine animals living in the bottom sediments (the "benthic community").

The SMS define two levels of chemical and biological criteria. The most stringent level, the Sediment Quality Standard (SQS), corresponds to the long-term goal of "no adverse effects" on sediment biological resources; while the less stringent level, the Cleanup Screening Level (CSL), corresponds to "minor adverse effects" on these resources. At contaminant levels above the CSL, more significant effects are predicted, and a sediment cleanup decision is required.

The chemical criteria are based on Puget Sound data, which indicate sediment chemical concentrations above which specific biological effects have always been observed in test sediments. Cleanup areas may be defined using chemical criteria alone; however, the SMS recognize that the chemical data may not accurately predict biological effects for all sediment locations. Biological testing (bioassays and benthic evaluation), allowed under the SMS, can be conducted to determine whether biological effects predicted by the chemical concentrations are actually occurring. The biological testing must include two tests for acute toxicity to marine organisms and one for chronic biological effects. If all three biological criteria are met for a given area, this area is not included in the cleanup area and does not require cleanup under the SMS. Failure to meet the biological criteria, confirms the potential for adverse impacts to the benthic community.

For this Asarco project, the sediment stations failing to meet the biological criteria include the "Contaminant Effects Area" and the "Moderate Impact Area" as shown on Figure 5. In evaluating cleanup action alternatives, the SMS considers net environmental impacts, technical feasibility, and cost (WAC 173-204-580(4)). In light of the unique nature of slag (i.e., metal contamination not necessarily available to the biological community), and as the benthic community is a good measure of the health of the sediment ecosystem, the benthic results were used to identify the most highly impacted areas where remedial action is necessary. The sediment stations showing impacts to the benthic community are identified as the "Contaminant Effects Area." Meanwhile, the presence of relatively healthy benthic communities in areas outside of the Contaminant Effects Area suggests that active cleanup may not be appropriate. Active cleanup might result in greater net negative impacts through destruction of existing habitats than if not remediated. This area is identified as the "Moderate Impact Area." Monitoring was deemed most appropriate for the Moderate Impact Area.

measures may result in net negative environmental impacts. Monitoring was considered appropriate for these "moderately" impacted areas. This evaluation is consistent with the SMS rule, WAC 173-204-580(4). The reader is referred to the Sediment Cleanup Criteria box for further details on this weighted approach to selecting cleanup stations.

3. Groundwater and Sediment Characteristics

Under EPA's oversight, Asarco collected and analyzed the following samples:

- Groundwater (water collected from wells on the upland part of the Facility)
- Sediment (material that is below water all or part of the time)
- Surface water (water on the ground surface in and around the upland portions of the Facility)
- Marine surface water (water from Commencement Bay)
- Porewater (water that is between sediment particles)
- Fish tissue (samples from the flesh of the fish that feed on prey associated with the sediments)
- Benthic tissue samples (tissue samples from marine animals that live in or on the sediment, such as sea stars and sand shrimp)
- Bioassays (laboratory tests where marine animals are placed in sediment from the OU and are watched to see if detrimental impacts occur)
- Benthic community structure (an analysis of what type of animals are living in the sediment, how many animals there are, how many of each type of animal, etc.)

After the completion of the above sampling, there were two outstanding questions. One was if the groundwater from the Facility would negatively impact the sediments. The second was whether a sediment cap would remain stable, since the currents are relatively strong in this part of Commencement Bay. The first question was addressed by the Asarco Sediments Groundwater Task Force (the "Task Force"), who studied the impacts of groundwater on the sediments. The second was addressed by the placement of a pilot cap (a small sediment cap) and subsequent sampling of it to see if it was remaining in place over a two-year period. A summary of the results of all of the above studies is provided below.

3.1 Groundwater

Groundwater conditions at the Asarco Facility were initially characterized in 1993 during the investigation for the upland part of the Facility. Since that time, monitoring of groundwater flow and quality has continued throughout the Facility twice a year (spring and fall). A summary of groundwater conditions at the Facility is provided below.

Groundwater at the Facility flows from the southwest to northeast and ultimately discharges to Commencement Bay. The general groundwater flow direction at the Facility is depicted in Figure 3. Near the shoreline, groundwater levels constantly fluctuate up to several feet in response to the tide in Commencement Bay.

Shallow and deep aquifer systems have been identified at the Facility (Figure 4). The deep aquifer is located approximately 70 to 100 feet below ground surface. The shallow aquifer is located within 10 to 50 feet of the ground surface. The deep and shallow aquifers are separated by a thick layer of low-permeability silt and clay that inhibits groundwater flow between the two systems. Depending on location and depth, the shallow aquifer generally consists of sand and gravel alluvium (in the higher southwestern portions of the upland Facility), slag fill (ranging up to approximately 45 feet thick near the shoreline), and native sands underlying the slag. The shallow aquifer system beneath the Facility is largely recharged by lateral flow of groundwater from the southwest (Ruston area) and infiltration of precipitation and surface water run-on.

Groundwater Chemicals of Concern

Groundwater at the Facility was sampled and analyzed for a wide range of organic compounds and metals. With the exception of dimethylaniline (DMA) and related compounds (e.g., aniline) present in the DMA area, organic constituents were detected infrequently and typically at low concentrations. A risk assessment conducted as part of the investigation indicated that DMA-related compounds do not bioaccumulate in fish and have a negligible contribution to human health risk. [0]Monitoring data collected over the years since the investigation indicate that the concentrations of DMA-related compounds decrease to very low or non-detectable levels before they reach the Bay. Due to their isolated numbers and distribution, low concentrations near the shoreline, and negligible risk, organic constituents are not considered constituents of concern for this OU.

Of the eight metals routinely included in the post-investigation groundwater monitoring program, arsenic and copper have been detected above their respective cleanup goals most frequently (see Section 6 for additional information regarding cleanup goals for groundwater). The concentrations in approximately 90 percent of the groundwater samples collected since the investigation have exceeded the arsenic cleanup level of 6 µg/L. Approximately 60 percent of the samples have exceeded the copper cleanup level of 3.1 µg/L. Other metals exceed applicable marine water or drinking water criteria, but less frequently and usually where arsenic or copper also exceed their respective standards. The Task Force (see Section 5) determined that copper was a potential concern to marine life in Commencement Bay. Arsenic, due to its high frequency of detection and concentrations, is also a metal of concern for groundwater. As such, arsenic and copper are considered the “drivers” and metals of concern for purposes of identifying cleanup goals. These two metals, plus selected other metals, will be included in the post-cleanup groundwater monitoring program to assess cleanup progress.

Groundwater in the shallow aquifer at the Facility is contaminated by elevated concentrations of metals (primarily arsenic and copper; see the box titled “Groundwater Chemicals of Concern”). Metal concentrations are highest in and around the former processing areas. Concentrations tend to decrease approaching the Commencement Bay shoreline. This reduction in metal concentrations is caused by dispersion (the “spreading out”) of the contaminants as they move toward the Bay and their eventual dilution with seawater that mixes with the groundwater near the shoreline. The presence of oxygen in seawater in the aquifer near the shoreline also has a favorable impact by promoting the chemical precipitation (removal by “settling out”) of arsenic. In contrast, seawater invading the face of the slag or in contact with fresh slag surfaces may redissolve and mobilize arsenic to some extent. Compared to arsenic, copper responds differently to the effects of the more highly oxygenated seawater. Copper tends to be more readily mobilized from the slag into the groundwater when dissolved oxygen levels increase. Given the geochemical processes at work within the slag, groundwater, and seawater, it appears there will always be some level of arsenic and copper present in the groundwater near the shore. Thus, the most efficient way to minimize arsenic and copper loading to Commencement Bay is to reduce the volume of groundwater discharge.

In the southeast area of the Facility, the slag was placed over woodwaste left by a former sawmill. Later, Asarco used an organic chemical called dimethylaniline (DMA) in this area for the production of concentrated sulfuric acid and liquid sulfur dioxide. Shallow groundwater in this "DMA area" has some of the lowest pHs and some of the highest copper and arsenic concentrations found at the Facility. DMA-related organic compounds are also present in the shallow groundwater system. However, the DMA, arsenic, and copper in the DMA area do not appear to result in any greater exceedances of surface water criteria in the adjacent Commencement Bay than observed elsewhere at the Facility. For this reason, no special groundwater remedial action is planned for the DMA area. However, groundwater monitoring in the DMA area will be part of the post-remedial action monitoring program.

In comparison to the shallow aquifer, metal contamination in the deep aquifer is limited in extent and concentration. Contamination in the deep aquifer is present near a former supply well that provided water for the Facility. It is believed that metals migrated from the shallow aquifer to the deep aquifer through the well casing. This well was sealed in 1994 to inhibit the movement of contaminants between the shallow and deep groundwater systems.

The Task Force, as part of its two-year study, addressed the following issues: groundwater flow rates and volumes, further screening of the contaminants of concern, impact of groundwater on sediments and the water column, dilution of groundwater from seawater, and geochemical changes in groundwater due to the dissolved oxygen in intruding seawater. The results of these studies were used to propose the Preferred Alternative described in this Plan.

3.2 Sediment

An area extending as far out as ½ mile, and running the entire length of the Facility, was studied offshore of the former smelter. This area included sediments at water depths of over 200 feet. These sediments, seaward of the Asarco Smelter Facility, consist generally of coarse-grained material. Sediments inshore of the slag breakwater, in the Yacht Basin, tend to be more fine-grained. Pieces of slag are mixed in with the sediment in portions of the OU, especially immediately adjacent to the shoreline. Along the slag peninsula, the sediment is composed mostly of granular slag.

Numerous tests were performed as part of the sediment investigation. These included chemical and biological tests: specifically, sediment chemistry, bioassays, benthic community structure analyses, fish tissue analyses, benthic tissue analyses, marine surface water chemistry, and porewater chemistry. The results from all of these tests were compared to state cleanup criteria and were used in selecting the areas that require active cleanup. The "Cleanup Criteria" box explains the state criteria used, and how the biological data were weighted more heavily than the

Sediment Chemicals of Concern

As part of the chemical sampling in the sediment, organic compounds and inorganic analytes were tested. Out of the 24 organics sampled, there were only a few isolated concentrations greater than the state standards (SQSs and CSLs). These compounds included individual PAHs and phthalate esters. Due to the limited exceedances and isolated locations of these concentrations, organic constituents were not considered constituents of concern for this OU.

Out of the 11 inorganics analyzed, the constituents with the greatest frequency and highest concentrations were arsenic, copper, lead, and zinc. Arsenic had concentrations up to 26,000 mg/kg in the Nearshore area. Copper and lead had concentrations up to 9300 mg/kg and 6300 mg/kg, respectively, in the Nearshore area. Zinc had concentrations up to 21,000 mg/kg off the slag peninsula. These four inorganic constituents were therefore selected as the constituents of concern for the Asarco Sediments /Groundwater OU and were used in selecting the cleanup areas. These constituents will also be used post-cleanup to monitor the success of the cleanup activities.

chemical data in the decision process. A brief description of each of these tests and the respective results are provided below.

The following inorganic contaminants had concentrations above the state cleanup screening levels (CSLs) and were found in sediments adjacent to the Facility: arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc. A significant amount of slag was found in sediment samples off the slag peninsula and immediately off the former smelter property. Slag contains high concentrations of metals, including arsenic and lead, in a rock-like form. Concentrations of arsenic found in sediment samples were as high as 26,410 mg/kg (the state CSL is 93 mg/kg).

Bioassays (the laboratory biological tests) were conducted on sediment from 62 stations. These results showed that the majority of exceedances occurred immediately offshore. Similarly, the results from the benthic organism (bottom-dwelling organism) tests confirmed the bioassay results. Since these benthic organisms form the base of the marine food chain, their overall health is an important measure of the health of the sediment.

Fish tissue whole-body results indicated that arsenic, chromium, copper, and lead were at levels higher than the reference sample (a sample collected away from the influences of the Facility). Fillet samples had arsenic and copper at concentrations higher than the reference sample. To assess the impacts of bioaccumulation, benthic tissue was analyzed. The benthic tissue results indicated that arsenic, copper, and lead were detected consistently in the tissue samples from the Sediments/Groundwater OU at levels above the reference sample.

Marine surface water samples were collected from various locations in Commencement Bay off the upland portion of the Facility. Marine surface water samples exceeded EPA's marine chronic criteria (MCC) for copper in all of the samples collected off the shoreline, including locations in the Yacht Basin.

Porewater samples analyzed from sediment collected from 11 stations and 2 reference stations were compared to MCC, for comparison purposes only (since porewater concentrations do not technically apply to these standards). These samples contained arsenic, copper, ammonia, and sulfide above EPA's MCC.

In order to determine what sample stations warranted active cleanup, EPA compared the sediment sample results to the state SMS. In short, EPA followed the SMS criteria that state that two exceedances of SQS standards or one exceedance of a CSL criterion requires a cleanup decision. However, for every station that had results that required a cleanup decision, the entire suite of benthic data were considered. If the benthic data indicated a relatively healthy benthic community, the station was not included in the active cleanup area (i.e., the benthic data were weighted more heavily than the chemistry and bioassay data). The summation of these sample results was then used to select the active cleanup area. This area is called the Contaminant Effects Area and is the area proposed for active remediation (i.e., dredging and/or capping) (Figure 5). This evaluation is summarized in the "Cleanup Criteria" box.

Overall, the data showed that the greatest impacts to the environment are posed by the contaminated sediments that are immediately offshore of the former smelter area and in the Yacht Basin. These areas have the greatest biological impacts, due to a combination of high chemical concentrations of metals, impacts from Facility surface water outfalls, erosion of contaminated material, and spillage of contaminated material during loading/off-loading activities.

Some concentrations of metals and/or biological impacts (as measured with bioassays) exceeded the CSL outside of the Contaminant Effects Area in what is depicted as the "Moderate Impact Area" (Figure 5). The benthic communities in the Moderate Impact Area appear healthy. Because active cleanup might result in greater net negative impacts through destruction of existing habitats than if not remediated, long-term monitoring is proposed in these areas to verify that the overall health of the ecosystem (after the upland and offshore cleanup activities are done) is remaining the same or improving.

4. Scope and Role of Operable Units

As mentioned above, the Facility has four OUs:

- OU 02—Asarco Tacoma Smelter and Slag Peninsula
- OU 04—Asarco Off-Property (Ruston/North Tacoma Study Area)
- OU 06—Asarco Sediments/Groundwater
- OU 07—Asarco Demolition

This Proposed Plan addresses the cleanup of OU 06, Asarco Sediments/Groundwater. Cleanup of the other OUs has already been started and is anticipated to be substantially complete in 2003. Although there are four separate OUs, the cleanup of these OUs is integrated. Specifically, the cleanup of the Asarco Sediments/Groundwater OU (OU 06) will begin once the source control actions for OU 02, OU 04, and OU 07 are mostly complete. These source control actions include the cleanup of metal-contaminated soils and slag, the removal of arsenic- and lead-contaminated soils from residential yards and public rights-of-way, the demolition of Facility structures, and surface water controls. These source controls will lead to reduced metals concentrations in the groundwater, which in turn will reduce contaminant discharges to the Bay. This reduction is due to less contact between the groundwater and contaminated soil and less surface water in contact with contaminated soil, as the surface water infiltrates down through the soil. An estimated 75 to 95 percent reduction in groundwater flow is expected, based on calculations that take into account the low-permeability cap and groundwater diversions. (Captured groundwater will be diverted to the surface water treatment system being constructed as part of OU 02 before being discharged to Commencement Bay.) Another example of the integration of OUs at this Facility is the fact that a portion of the upland capped area (OU 02) will be left available for the Yacht Basin sediment (OU 06).

5. Summary of Risks

This section presents the human health and ecological risks associated with the Sediments/Groundwater OU. For human health risks, risk assessments are based on the toxicity of the contaminants and assumptions regarding the extent to which people may be exposed to the contaminants. For ecological risks, risk assessments are based on the toxicity of the contaminants and assumptions regarding the extent to which organisms may be exposed.

Human health and ecological risk assessments also take into consideration the future uses of the OU. For this OU, the upland area land uses were assumed to be a commercial zone and a park, and the offshore area will be a recreational area. Actual future land uses will be determined at a later date, and may include residential uses, if measures are taken to preclude exposure to slag or contaminated soils remaining at the Facility.

5.1 Human Health Screening Risk Assessment

Groundwater

A baseline human health risk assessment was completed in 1993 as part of the investigation. The risk assessment identified “chemicals of concern” (COCs) in groundwater that potentially present risk to human health under two scenarios. For groundwater used as drinking water, the COCs were antimony, arsenic, beryllium, cadmium, chromium, copper, lead, manganese, nickel, and silver. For groundwater not suitable for drinking because of saltwater intrusion, COCs were selected based on the potential for groundwater to enter the Bay and impact humans who might consume seafood from the Bay (i.e., chemicals that have possibly migrated to the marine environment via groundwater discharge). Five metals (arsenic, beryllium, lead, manganese, and mercury) and aniline (a class of organic compounds) were selected as COCs for groundwater not suitable for drinking.

Potential human health impacts were estimated assuming several possible land-use scenarios, including a residential scenario, which represents a worst-case assumption for assessing risk to human health. Results showed that estimated cancer risks and noncancer health effects from the Facility are the highest under a residential-use scenario where future residents may drink groundwater from the Facility. Arsenic exposure is responsible for most of the estimated cancer risk.

Sediment

Samples of rock sole were collected from five areas near the Asarco shoreline as well as from one reference area near Brown's Point; all were analyzed for several metals. Because fish can contain metals as a result of the background levels of metals in the environment, the sample from Brown's Point was taken to determine if concentrations of metals in the fish from the water offshore of Asarco are above background levels. The inorganic arsenic level in the Brown's Point sample (0.034 mg/kg) was below the average of the five samples (0.056, range of 0.022 to 0.083 mg/kg) taken off the shore of the Asarco Facility, but was higher than and /or close to the level found in two of the five individual Asarco samples (0.022 and 0.038 mg/kg). Arsenic was the only contaminant in all of these fish samples that was above the risk-based screening concentration developed by Region 10 EPA. Arsenic was, therefore, selected as a Contaminant of Potential Concern for the Facility and analyzed in more detail in a risk assessment.

The ingestion exposure pathway was assessed for this OU (i.e., it was assumed that people eating fish would be the most likely exposure route to the contaminated sediment; contact through the skin and lungs was not considered likely for saturated sediments). Although the amount and type of fishing at the Asarco Facility in the future are difficult to predict, it was assumed for the risk assessment that fishing for finfish (fish that feed on the bottom and live near the Asarco Facility) would be unlimited, similar to that at the pier south of the Asarco Facility. Salmon were not addressed as these fish only move past the OU briefly and do not stay for extended periods of time. For the risk assessment, cancer risks and noncancer health impacts from inorganic arsenic were estimated using the maximum fish concentration found in the five samples collected near Asarco, with a range of fish ingestion rates. The low end of this range (1 gram per day of fish) was selected to represent the consumption of an infrequent sports fisherperson, who might eat fish from the waters off the Facility a few times a year, while the high end (292 grams per day of fish) was selected to represent the consumption of a subsistence fisherperson, who might eat fish from the waters off the Facility every day.

The potential cancer risks estimated for the sports fisherperson from eating fish from offshore of the Facility was about 6 in 10 million ($6 X 10^{-6}$, in scientific notation), while a subsistence fisherperson was estimated to be about 2 in 10,000 ($2 X 10^{-4}$). These risks are probabilities and indicate that the subsistence fisherperson is estimated to have about a 2 in 10,000 chance of developing cancer if he/she were to eat 292 grams (about a half pound) a day of fish from the water off the Asarco Facility. EPA's general acceptable risk range for site-related exposures is between 10^{-4} to 10^{-6}.

A risk assessment was also done using the Brown's Point reference sample. The estimated cancer risk for a subsistence fisherperson for this reference sample was about 7 in 100,000 ($7 X 10^{-5}$). Therefore, the cancer risks from consuming fish from near the Asarco Facility appear to be slightly higher than that from consuming fish from the reference area. This conclusion, however, is not definitive because of the limited sampling done in the reference area. The site risks presented above are at or below the EPA's acceptable risk. It is uncertain if the elevated contamination in fish tissue is due to the fish's exposure to contaminated sediments and/or contamination from other sources, such as stormwater. The range of cleanup activities, for the upland and sediments, are expected to reduce the risk to within EPA's and Ecology's acceptable risk range.

The potential noncancer health impacts were evaluated. It was concluded that noncancer health impacts from eating finfish are unlikely.

In any risk assessment, there are uncertainties. EPA believes that conservative assumptions were used in the above risk assessments, and therefore the above risks would tend to be over-estimates rather than underestimates

5.2 Ecological Risk Assessment

Groundwater

As addressed in Section 3.1, groundwater beneath the Facility ultimately discharges to Commencement Bay. As such, the ecological risks associated with contaminated groundwater were evaluated with respect to their potential impact on aquatic life in the waters and marine sediments of Commencement Bay. To address this, a baseline ecological risk assessment for the sediments was performed as part of the sediment risk investigation (EPA, 1996). In 1996, the Task Force was formed to conduct additional evaluations related to groundwater and its impact on the aquatic life in Commencement Bay. The Task Force, which consisted of personnel from EPA, Ecology, NOAA, and other Trustee agencies, evaluated the possible impacts of groundwater discharging to the aquatic environment. It also studied the associated metals loading on the quality of marine sediments and bay waters under both pre- and post-remediation conditions at the upland part of the Facility.

The findings of the Task Force regarding the impact of groundwater on the sediments and waters of Commencement Bay indicate the following:

- The amount of metals currently being discharged (pre-remediation conditions) by groundwater and surface water discharges to Commencement Bay results in the exceedance of applicable water standards for certain metals (e.g., arsenic and copper) within a few feet of the shoreline. The metals load discharged to Commencement Bay by groundwater is expected to decrease after remediation because the most highly contaminated source materials will have been removed and groundwater flow to Commencement Bay will be reduced.

- Contaminants found today offshore of the Facility are primarily associated with historic contaminant sources other than groundwater. These other sources include discharge of contaminated surface water from the Facility, direct placement of slag into the Bay, contaminated surface water particulates, and spillage of materials during the loading and off-loading of ships.

- Current groundwater discharge to the Bay, and the associated metals load, are expected to be reduced by 75 to 95 percent after source control and remediation are complete (due to less surface water infiltration, less groundwater flow through the Facility, etc).

Sediment

EPA developed an ecological risk assessment based on 62 stations located in a grid off the Facility. The sample results from these stations allowed EPA to assess the impacts of contamination on aquatic organisms. The identification of current and future risks to aquatic organisms used both biological and chemical data, but placed more emphasis on the biological data. Based on this analysis, each station was delineated as either a nonminimally impacted station, moderately impacted station, or a severely-impacted station. These stations are discussed below.

Non-Impacted/Minimally Impacted Stations

The non-impacted and minimally impacted stations fall under three categories:

- Stations that are considered to be currently unimpacted and pose no potential future risks to the aquatic organisms (e.g., fish and other bottom-dwelling animals) because contaminant concentrations were below the state standards (SQS).

- Stations that are considered to have no current impacts, but *may* have impacts in the future (i.e., these stations have chemical concentrations greater than the state standards but biological testing showed no adverse impacts).

- Stations that have a current minimal impact and *may* have impacts in the future (i.e., these stations had minor biological CSL exceedances, but no chemical CSL exceedances).

Approximately 61 percent of the stations are in these categories (Figure 5).

Moderately Impacted Stations

Moderately impacted stations are those that have a limited number of adverse biological impacts (i.e., a bioassay result indicated an impact or benthic abundance in a sediment sample was significantly different from a reference sample), but the overall health of the biological communities did not appear to be substantially impacted. For example, there were stations that had chemical and bioassay exceedances, but a healthy biological community. These stations included approximately 28 percent of the locations off the former smelter (Figure 5). These stations will be monitored after cleanup.

Severely Impacted Stations

Stations are severely impacted when sediment chemical concentrations exceeded the higher state cleanup standard (CSL) chemical criteria and multiple biological impacts were observed. In addition, every station that had a benthic community structure that indicated a stressed environment was included in this category. Approximately 11 percent of the stations (170,000 yd^2; approximately 35 acres) had these characteristics. These stations are included in the Contaminant Effects Area, which is the area to be cleaned up.

5.3 Basis for Taking Action

Based on the contamination and effects observed in the sediment and groundwater described in Section 3 and the risks described in Section 5, it is EPA's judgment that the Sediments/Groundwater OU requires cleanup. This means that measures need to be taken to reduce the discharge of metals to Commencement Bay via groundwater and the contaminated sediment needs to be addressed. This Proposed Plan describes several cleanup alternatives, plus EPA's Preferred Alternative.

6. Remedial Action Objectives

EPA's objectives for the cleanup are presented below.

6.1 Groundwater Cleanup Objectives

EPA's remedial action objectives (RAOs) for groundwater are as follows:

- Prevent ingestion of, or direct contact with, groundwater containing contaminants.
- Prevent discharge (to Commencement Bay) of groundwater that exceeds applicable marine surface water quality standards or background concentrations (if background concentrations are higher than the standards).

Currently, the groundwater discharging to Commencement Bay will exceed human health risk based levels for fish consumption (0.14 µg/L for arsenic) (National Toxics Rule; CFR 40, § 131.36). However, past fish tissue sampling indicates low risk from Facility contaminants even to people consuming large quantities of fish from the Facility.

The groundwater cleanup goals selected for groundwater discharging from the Facility are 6 µg/L for arsenic and 3.1 µg/L for copper. The established local background (uncontaminated) concentrations for arsenic and copper in groundwater are 6 µg/L and 40 µg/L, respectively.

In setting the arsenic cleanup goal at 6 µg/L, it is acknowledged that this concentration is higher than the National Toxics Rule standard of 0.14 µg/L deemed to be protective of human health for fish consumption. However, the 0.14 µg/L standard is below the normal laboratory detection limit for arsenic and also below the local background concentration for groundwater (6 µg/L). As such, the cleanup goal for arsenic is being set at the background concentration of 6 µg/L. This is well below the 36 µg/L marine chronic criteria for arsenic and is therefore protective of marine life in Commencement Bay.

The cleanup goal of 3.1 µg/L for copper is protective of human health and marine life in Commencement Bay. It is acknowledged, however, that the background concentration for copper in the vicinity of the Facility is 40 µg/L, and it may not be possible to achieve the 3.1 µg/L cleanup goal. If not, copper in groundwater will be managed to the 40 µg/L background concentration.

Neither the Maximum Contaminant Limits (MCLs) promulgated under the Federal Clean Water Act nor the State of Washington Model Toxics Cleanup Act (MTCA) groundwater cleanup levels are considered Applicable or Relevant and Appropriate Requirements (ARARs) for the shallow groundwater system at the Facility. These standards are not considered ARARs because the shallow groundwater system is not currently used as a drinking water source, and future use of the shallow aquifer system for drinking water purposes is unlikely. Future use of the shallow aquifer system as a drinking water source is considered unlikely because groundwater within several hundred feet of the Commencement Bay shoreline is typically saline or brackish (total dissolved solids greater than 10,000 mg/L) and therefore unsuitable for drinking. Shallow groundwater farther from the shoreline (e.g., southwestern side of the Facility), while having lower total dissolved solids concentrations, is present in subsurface water-bearing zones of limited permeability and thickness such that well yields would likely be inadequate. Regardless, sustained pumping from shallow water-supply wells in this area may induce saltwater intrusion that could, over time, make the water unsuitable for drinking. In addition, the shallow groundwater lies immediately below, or in direct contact with, soil and slag material with high metals concentrations. Although the most contaminated material will be excavated and placed in the OCF, some contaminated materials will still remain in place in accordance with the 1995 ROD, making it difficult to achieve groundwater quality that is safe for drinking water purposes. Human health risks associated with ingestion of shallow groundwater will be addressed by institutional controls restricting any future use of site groundwater.

The above-referenced federal and state standards (MCLs and MTCA values) for groundwater are considered ARARs for the deep aquifer system beneath the site. At present, metals concentrations exceed these standards in limited areas. However, the source of contamination has recently been eliminated and the metals concentrations are expected to gradually decline and achieve background levels in the years following remedial action.

The above-referenced groundwater objectives are expected to be achieved by the remedial actions already selected for the Asarco Tacoma Smelter and Slag Peninsula and are repeated in this Proposed Plan for completeness of the Facility remedy. These actions include:

- Removal of source materials (i.e., contaminated soil and slag) that appear to be related to the greatest groundwater contamination.
- Limiting groundwater recharge by:
  - intercepting groundwater flowing onto the Facility at selected locations (Figure 2) and redirecting the captured water to a treatment facility prior to its release to Commencement Bay, and
  - reducing infiltration of surface water by constructing surface water controls and installing a low-permeability cap over the Facility.
- Institutional controls (i.e., restricting future use of Facility groundwater).
- Long-term monitoring.

6.2 Sediment Cleanup Objectives

EPA's cleanup objective for sediments is the following:

- Restore and preserve aquatic habitats by limiting and/or preventing the exposure of environmental receptors to sediments with contaminants above Washington State Sediment Management Standards (SMS; WAC 173-204).

This objective will be partly achieved by dredging in the Yacht Basin. Cleanup values will be presented in the ROD and will be consistent with the state sediment management standards. These values will be protective of the biological community. The above objective will be further achieved by capping in the Northshore, Nearshore, and Offshore areas. The cap will be constructed of clean material.

7. Summary of Cleanup Alternatives

The various feasibility study documents prepared by Asarco and EPA identify a range of alternatives to achieve the cleanup objectives for the Sediments/Groundwater OU. These alternatives include active cleanup options (e.g., capping and dredging) and institutional controls (e.g., limiting access). EPA, with public input, decides among the range of choices in order to select a final remedy for this OU, which will be presented in the Sediments/Groundwater ROD.

A consistent and reliable operation, maintenance, and monitoring plan (OMMP) is necessary to ensure the continued effectiveness of any remedy. Important components of the OMMP include maintaining the integrity of the remedy (e.g., ensuring the sediment cap stays in place) and monitoring the sediments to ensure they are not becoming recontaminated. Details of this long-term monitoring are summarized in Section 9 of this document; a detailed OMMP will be written as part of the design of the cleanup of the Facility.

7.1 Groundwater

The remedial action alternatives assembled for addressing groundwater are listed below. This list is based on alternatives that were first identified in the Asarco Plant Feasibility Study (Hydrometrics, 1993) and as later refined in the Asarco Feasibility Study Update, (Hydrometrics 1999). These previously developed individual alternatives have been combined into comprehensive groundwater remedies for the Facility as shown in Table 7-1.

The active construction associated with the Preferred Alternative would be completed by 2003.

Table 7-1—Groundwater Alternatives

Alternative	Description	Present Worth (in millions)
GW-A: No Action	No actions are taken.	Capital Costs: $0 Annual O&M Costs: $0 Present Worth Cost: $0
GW-B: Soil Capping, Groundwater Interception/Treatment, Replacements of Leaking Subsurface Water Lines, Institutional Controls and Monitoring *(Preferred Alternative). This alternative includes the remedy items from the Smelter ROD, plus allows flexibility for future actions, should they be necessary.*	Reduce groundwater discharge to Commencement Bay by 1) limiting infiltration of precipitation and surface water, 2) intercepting groundwater at selected locations before it enters the Facility and treating* that groundwater prior to discharge to Commencement Bay, and 3) abandoning or replacing leaking underground sewer and water lines. Continued groundwater monitoring and implementation of institutional controls (e.g., restricting future use of Facility groundwater) will also occur. If groundwater cleanup goals are not achieved, contingency actions such as additional diversion, may be constructed. *Captured groundwater will be directed to the on-site stormwater treatment system being constructed as part of the upland remedy. This treatment system includes particulates removal enhanced by the use of coagulants and flocculants.	Capital Costs: $35.9 O&M Costs: $0.2 Present Worth Cost: $38.4
GW-C: Pump/Treat and Discharge to Outfalls	Actively remove contaminated groundwater by a series of extraction wells. The groundwater would be treated and discharged to Commencement Bay. Candidate areas for the pump/treat alternative are downgradient of the Arsenic Kitchen, Southeast Plant (DMA) area, Copper Refinery, and Fine Ore Bins. All elements of Alternative GW-B (above) would be included to reduce groundwater discharge to Commencement Bay, protect the deep aquifer, and provide institutional controls.	Capital Costs: $64.6 O&M Costs: $0.6 Present Worth Cost: $74.4
GW-D: *In situ* Groundwater Treatment	*In situ* oxidation of groundwater by air injection to enhance chemical precipitation of arsenic. Nutrient injection would stimulate biological degradation of DMA-related compounds in the Southeast Plant Area. All elements of Alternative GW-B (above) would be included to reduce groundwater discharge to Commencement Bay, protect the deep aquifer, and provide institutional controls.	Capital Costs: $37.9 O&M Costs: $0.2 Present Worth Cost: $41
GW-E: *In situ* Treatment by Seawater Injection	Injection of seawater to raise pH and provide a more oxygenated subsurface environment conducive to chemical precipitation of arsenic. Candidate areas for seawater injection are the Arsenic Kitchen, Southeast Plant (DMA) area, and Fine Ore Bins. All elements of Alternative GW-B (above) would be included to reduce groundwater discharge to Commencement Bay, protect the deep aquifer, and provide institutional controls.	Capital Costs: $38 O&M Costs: $0.2 Present Worth Cost: $41

Notes:

1) Alternatives GW-1B and GW-3D from the 1993 FS are not included in this Proposed Plan because soil remedial actions selected previously by EPA have eliminated these alternatives as options. Alternative GW-A, "no action," is retained only for comparative analysis purposes.

2) Discount costs are not included in the above table since the costs in the table are applicable primarily to the next 5 years. Discount costs become important for long-term (i.e., greater than 5 years) cost estimates.

7.2 Sediment

The following tables summarize the cleanup alternatives for each sediment subarea (Figure 3).

Table 7-2—Sediment Remedial Alternatives for the Nearshore/Offshore Area (88,000 yd^2 or 18 acres)

Alternative	Description	Estimated Cost
S-1A: No Action	No actions are taken.	Capital Costs: $0 Annual O&M Costs: $0 Present Worth Cost: $0
S-1B: Natural Recovery	Natural recovery does not involve any active work, but typically includes long-term monitoring to ensure that sediment quality is naturally improving over time (e.g., new clean sediment is covering up the contaminated sediment).	Capital Costs: $0 O&M Costs: $240,000 Present Worth Cost: $240,000
S-1C: Capping *(Preferred Alternative)*	Cover 88,000 yd^2 (18 acres) of contaminated sediment with a minimum of 1.0 m of clean sand and gravel. In general, the purpose of a cap is to prevent the direct contact of people and marine organisms with contaminated sediment.	Capital Costs: $10.3 million O&M Costs: $1.3 million Present Worth Cost: $11.6 million
S-1D: Dredging and Nearshore Confinement	Dredge contaminated sediment and place in nearshore confined aquatic disposal (CAD) facility, which is an underwater cell that keeps the contaminated sediment covered with a cap and isolated from the overlying water. This alternative would require dredging of a minimum of 70,000 yd^3 of contaminated sediment with a dredge depth of approximately 1 yd (some of the 88,000 yd^2 or 18 acres of contaminated sediment would be covered by the nearshore facility), placement of the dredged sediment within a berm along the shoreline of the Facility, and placement of a clean sediment cap over the dredged material. The cap and containment berm of the nearshore CAD would be armored to minimize erosion.	Capital Costs: $11.8 million O&M Costs: $1 million Present Worth Cost: $12.8 million
S-1E: Dredging and Upland Disposal	Dredge contaminated sediment and place beneath the upland cap. This alternative would require dredging of a minimum of 88,000 yd^3 of contaminated sediment with a dredge depth of approximately 1 yd; placement of the dredged sediment on the upland portion of the Asarco Facility; and construction of an upland cap over the dredged sediment.	Capital Costs: $26 million O&M Costs: $240,000 Present Worth Cost: $26.2 million

Table 7-3—Sediment Remedial Alternatives for the Yacht Basin (75,000 yd^2; 15.5 acres)

Alternative	Description	Estimated Cost
S-2A: No Action	No actions are taken.	Capital Costs: $0 O&M Costs: $0 Present Worth Cost: $0
S-2B: Natural Recovery	Natural recovery does not involve any active work, but typically includes long-term monitoring to ensure that sediment quality is naturally improving over time (e.g., new clean sediment is covering up the contaminated sediment).	Capital Costs: $0 O&M Costs: $270,000 Present Worth Cost: $270,000
S-2C: Dredging and Nearshore Confinement	Dredge contaminated sediment and place in nearshore CAD. This alternative would require dredging of approximately 55,000 yd^3 of contaminated sediment, with a dredge depth of approximately 2 feet.	Capital Costs: $4.9 million O&M Costs: $210,000 Present Worth Cost: $5.1 million
S-2D: Dredging and Upland Disposal (*Preferred Alternative)*	Dredge an area of 75,000 yd^2 (15.5 acres) of contaminated sediment to a depth of 2 feet and place beneath the upland cap in the central portion of the upland part of the Facility. This alternative would require dredging of approximately 55,000 yd^3 of contaminated sediment. (Note: As a contingency, if all the contaminated material cannot be removed from the Yacht Basin, dredging in the Basin followed by placement of clean material may occur).	Capital Costs: $3.4 million O&M Costs: $210,000 Present Worth Cost: $3.6 million

Table 7-4—Sediment Remedial Alternatives for the Northshore Area (7000 yd^2; 1.5 acres)

Alternative	Description	Estimated Cost
S-3A: No Action	No actions are taken.	Capital Costs: $0 O&M Costs: $0 Present Worth Cost: $0
S-3B: Natural Recovery	Natural recovery would not involve any active work at the Facility, but would include monitoring to ensure that sediment quality is naturally improving over time (e.g., new clean sediment is covering up the contaminated sediment).	Capital Costs: $0 O&M Costs: $200,000 Present Worth Cost: $200,000
S-3C: Capping (*Preferred Alternative)*	Cover 7,000 yd^2 (1.5 acres) of contaminated sediment with a minimum of 1.0 m of clean sand and gravel. In general, the purpose of a cap is to prevent the direct contact of people and marine organisms with contaminated sediment.	Capital Costs: $540,000 O&M Costs: $200,000 Present Worth Cost: $740,000
S-3D: Dredging and Nearshore Confinement	Dredge contaminated sediment and place in nearshore CAD. This alternative would require dredging of approximately 4,500 yd^3 of contaminated sediment (7000 yd^2 dredged to a depth of 2 feet).	Capital Costs: $660,000 O&M Costs: $200,000 Present Worth Cost: $860,000
S-3E: Dredging and Upland Disposal	Dredge contaminated sediment and place beneath the upland cap. This alternative would require dredging of approximately 4,500 yd^3 of contaminated sediment (7000 yd^2 dredged to a depth of 2 feet).	Capital Costs: $500,000 O&M Costs: $200,000 Present Worth Cost: $700,000

Notes:

1) Discount costs are not included in the above table since the costs in the table are applicable to the next 5 years. Discount costs become important for longer term estimates (i.e., greater than 5 years).

2) Operations and Maintenance (O&M) costs are for 30 years.

The above Preferred Alternatives would be completed before the end of 2003. A cap is expected to be successful because it can be designed to remain stable (i.e., the correct particle size can be engineered so that the cap will not wash away) and maintain its thickness so that the contamination remains covered. The results of the two-year pilot cap indicated that a cap will work with appropriately sized material; and long-term monitoring will occur to ensure that this is true over time (i.e., the cap is functioning as planned).

No remedial action is planned for the Slag Peninsula area (approximately 85,000 yd^2 or 17.5 acres) because the water depths and steep slopes make capping or dredging technically impracticable. The sediment depth off the Slag Peninsula in some areas is almost 100 feet deep at only 200 feet from shore. Similarly, the slope can be up to 50 percent in some areas. The stability of a cap on a slope such as this is questionable, and the construction of a nearshore facility on a slope such as this would be very difficult (e.g., making a berm stable, etc.). In addition, dredging is not possible because the entire peninsula would need to be removed (since it is constructed entirely of slag, up to 110 feet deep in the center of the peninsula). Although capping or dredging of the Slag Peninsula is not feasible, shoreline armoring will be placed in the intertidal areas where possible. This will greatly reduce the erosion of slag in this high-energy area.

The Yacht Basin will be dredged. If all the contaminated material cannot be removed (specifically, if slag is encountered), an option that may be considered is capping the remaining contamination in the Basin. If this occurs, the cap must be placed so that it does not interfere with navigation.

Dredging in the Nearshore/Offshore area is possible, but not practical. First, the depth of dredging is unknown in some areas, but is expected to be deep. This could lead to large volumes of material to be removed. Second, the shoreline was constructed of poured slag in some locations, thereby creating a steep slag face, which would be easy to undercut by dredging activities. This could cause unstable slopes and not allow all of the contaminated material to be removed.

Natural recovery was assessed at the Facility and it was determined that recovery of the sediments to concentrations lower than the state standards would not occur within a reasonable time frame (i.e., less than 10 years). This is because there is not sufficient sedimentation in this area that would cover the existing contaminated sediment.

8. Evaluation of Alternatives

Nine criteria are used to evaluate the different remediation alternatives individually and against each other in order to select a cleanup remedy. To be selected, an alternative must meet the first two “threshold” criteria. EPA uses the next five criteria as “balancing” criteria for comparing alternatives and selecting a Preferred Alternative. After public comment, EPA may alter its preference on the basis of the last two “modifying” criteria. The first seven criteria are addressed below with respect to the alternatives listed in Section 7.

Evaluation Criteria for Superfund Remedial Alternatives

Threshold Criteria:

Overall protection of human health and the environment—How well does the alternative protect human health and the environment, both during and after construction?

Compliance with applicable or relevant and appropriate requirements (ARARs)—Does the alternative meet all ARARs from state and federal laws? Does the alternative qualify for an ARAR waiver?

Alternatives that are not protective or do not attain ARARs are not evaluated further under the remaining criteria.

Balancing Criteria:

Long-term effectiveness and permanence—How well does the alternative protect human health and the environment after completion of cleanup? What, if any, risks will remain at the site?

Reduction of toxicity, mobility, or volume through treatment—Does the alternative effectively treat the contamination to significantly reduce the toxicity, mobility, and volume of the hazardous substance?

Short-term effectiveness—Are there potential adverse effects to either human health or the environment during construction or implementation of the alternative? How fast does the alternative reach the cleanup goals?

Implementability—Is the alternative both technically and administratively feasible? Has the technology been used successfully on other similar sites?

Cost—What are the estimated costs of the alternatives?

Modifying Criteria:

State/Tribal acceptance—What are the state's and tribes' comments or concerns about the alternatives considered and about EPA's Preferred Alternative? Do the State and tribes support or oppose the preferred alternative?

Community acceptance—What are the community's comments or concerns about the Preferred Alternative? Does the community generally support or oppose the Preferred Alternative?

8.1 Overall Protection of Human Health and the Environment

Groundwater

All of the groundwater alternatives, except the no-action alternative, are protective of human health to the degree that institutional controls will prohibit the use of contaminated groundwater at the Facility. The groundwater discharging to Commencement Bay may exceed human health risk based levels for fish consumption (0.14 µg/L for arsenic). However, a risk assessment based on data from past fish tissue sampling indicates acceptable risks from Facility contaminants even to people consuming large quantities of fish from the Facility. This risk assessment information is based on pre-remediation conditions where groundwater samples collected from wells near the shore indicate the arsenic concentration is higher than the 6 µg/L cleanup goal. Thus, any human health risk is expected to decline further after remediation is complete. In addition, contaminant concentrations are expected to be reduced by the cleanup activities on the Facility. The remedial alternatives involving active groundwater treatment would likely be more protective than capping and groundwater interception (where groundwater is pumped/treated or treated *in situ*) since groundwater contaminant levels will be further reduced. The no-action alternative is not protective of human health and thus is not evaluated further in this section of the Proposed Plan.

Sediment

All of the sediment alternatives, including the no-action alternative, are protective of human health since the baseline risk for sediments did not exceed EPA's risk management threshold. However, the no action alternative is not protective of the environment and thus is not further evaluated under the nine criteria. The natural recovery alternative for the sediments would also not be protective of the environment because it would not prevent aquatic organisms from coming into contact with the contaminants for many years, and possibly indefinitely. The alternatives discussed below, however, are expected to achieve EPA's and Ecology's acceptable risk criteria.

Protectiveness is based on how clean the remaining surface sediments will be following cleanup. The assumption that lower contaminant concentrations result in higher sediment quality was primarily used to rank the alternatives for overall protection. Capping is more protective in the Nearshore area, where the depth of contamination is unknown in some areas or is very deep because the shoreline is constructed of slag. In this area, slag was placed directly into the water and used to build pier-like structures. Dredging of this would be very difficult due to the problems of slope stability; and the chance of removing all of the contaminated material is low. Therefore, the highest degree of protectiveness would be provided by capping the contaminated sediments in the Nearshore, Offshore, and Northshore areas with clean sediment imported from another location. The Yacht Basin cannot be capped (without dredging first) since additional sediment in the Yacht Basin would interfere with boat navigation. Therefore, dredging in the Yacht Basin to concentrations less than the state criteria is the Preferred Alternative. If all of the sediment with concentrations above state criteria cannot be feasibly removed from the Basin, a cap of clean material would be considered post-dredging, which would cover any remaining sediments that exceed criteria and would be thick enough to not allow recontamination due to bioturbation (organisms digging down into the contaminated sediment and bringing it to the surface of the sediment cap).

8.2 Compliance with Federal and State Environmental Standards

Groundwater

Modeling performed by the Task Force indicates that state and federal laws applicable to protection of marine water quality may not be currently achieved within a few feet of the shoreline for all metals. Samples of Commencement Bay water collected at the shoreline confirm that current laws for marine water quality are not currently met at all locations and at all times. However, metals concentrations in groundwater flowing toward the shoreline are expected to decrease in future years in response to the site-wide changes (i.e., reduced groundwater discharge) affected by the cleanup. These changes are expected to allow state and federal laws to be met at the end of the remedy. Lastly, Asarco has demonstrated that intercepting additional groundwater at the southwest (uphill) side of the Facility could only be done at a cost that is disproportionately high compared to the small incremental environmental benefit expected.

Sediment

For sediments, it is important to attain sediment concentrations between the sediment quality standards and cleanup screening levels in the state's law. Based on modeling and site-specific rates of sedimentation, the natural recovery alternative would not meet the state's criteria within an adequate time frame (i.e., 10 years). Therefore, natural recovery does not meet the requirements of this law. An isolating cap, meanwhile, would achieve the standards, as long as it stayed in place as a physical barrier and does not become recontaminated. Institutional controls would help ensure that the integrity of the cap is maintained. The dredging/nearshore confinement and dredging/upland disposal alternatives would also meet the standards if all of the contaminated sediments could be removed. Dredging in the Nearshore/Offshore area would be less likely to meet ARARs than dredging in the Yacht Basin, since it is estimated that removal of all contaminated material in this area would be difficult.

The Clean Water Act Section 404 criteria will be met, including any potential need for mitigation. This will be addressed in the ROD.

8.3 Long-Term Effectiveness and Permanence

Groundwater

All of the alternatives will minimize generation of contaminated groundwater by reducing groundwater recharge, flow through contaminated source areas, and ultimately the discharge of contaminants to Commencement Bay. The remedial alternatives involving active groundwater treatment would further lower groundwater contaminant concentrations and, therefore, have the lowest residual risk. However, this benefit is not permanent as it would occur only as long as the treatment systems were operating. Since most of the on-site slag will not be removed by any of the upland cleanup activities, it will continue to contribute contaminants to groundwater indefinitely. Therefore, reduction of surface water infiltration and groundwater flow to Commencement Bay are critical to making the Preferred Alternative long-term protective of human health and environment. The *in situ* groundwater treatment and seawater injection alternatives may be less reliable than the pump and treat alternative because these treatment technologies are generally less proven. These latter treatment methods may not be necessary if effectiveness can be achieved with groundwater and surface water flow reductions combined with selected contaminant source removals. If the diversion of groundwater from the OCF and Stack Hill areas (Figure 2) does not provide adequate reduction of groundwater flow through the Facility, additional groundwater diversions may be required in the future (e.g., in the Cooling and East Stack Hill drainages and along Ruston Way).

Sediment

Removing contaminated sediment and consolidating it upland is considered more reliable than capping in place because removal and placement results in a smaller and more controlled area of contaminated sediments. In addition, an engineered *upland* disposal facility is easier to inspect, monitor, and maintain than a larger aquatic capped area or aquatic disposal site. Therefore, the greatest degree of long-term effectiveness is provided by dredging the contaminated sediments (assuming all contamination can be removed) and placing them on the upland facility. In those areas where all contaminated material cannot be removed (i.e., the Nearshore area), *in situ* capping is best. In these areas, a cap can be designed with appropriately sized material such that it provides long-term isolation of the contamination (i.e., it remains in place and does not wash away with wave action or ship traffic and does not become recontaminated), while providing acceptable aquatic habitat. The cap would also be monitored regularly to ensure it is being effective.

8.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Groundwater

All of the groundwater alternatives, including GW-B (the Preferred Alternative), would reduce the toxicity, mobility, and volume of contaminants through treatment. Groundwater intercepted at the OCF and Stack Hill/tunnels areas would be routed through the surface water treatment system before being discharged to Commencement Bay. The *in situ* treatment and seawater injection treatment alternatives would promote chemical precipitation (i.e., “settling out”) of arsenic from groundwater, thereby reducing the arsenic load reaching Commencement Bay.

Sediment

None of the alternatives, including the Preferred Alternative, involves treatment of the sediments, although there is limited reduction in contaminant mobility for the Yacht Basin sediments that would be placed under an upland cap. Treatment is not proposed for the sediments for several reasons. First, in order to treat the sediments, they must be removed. This is difficult in the Nearshore/Offshore area of this OU since the contamination is known to be very deep. Therefore, the chance of leaving contamination behind is very high. In addition, since slag was poured to create the shoreline in portions of the Nearshore area, dredging in this area would be difficult due to slope stability issues. In addition, costs associated with treatment of the Yacht Basin sediments would be disproportionate to the costs associated with the current upland disposal plan.

8.5 Short-Term Effectiveness

Groundwater

All of the alternatives present minimal risks to the community and workers during cleanup. Similarly, all of the alternatives have minimal short-term environmental impacts, as Best Management Practices (BMPs) would be implemented during construction. To limit the short-term impacts, implementation of any of the groundwater alternatives must be coordinated with the other upland cleanup actions. All of the alternatives therefore require several years to construct, and several years are expected for there to be a noticeable improvement in groundwater quality.

Sediment

Short-term environmental impacts include water quality impacts, exposure of marine life to contaminants, and habitat loss (i.e., fisheries impacts) during the implementation of the remedial alternative. Remedial alternatives that involve dredging contaminated sediments would result in a potential for water quality and fisheries impacts (due to disturbance of contaminated sediment), human exposure to contaminants, and possible worker injury/exposure resulting from the use of dredging equipment. Remedial alternatives that involve capping contaminated sediments and constructing a confined aquatic disposal area would result in short-term loss of aquatic habitat due to covering the currently existing benthic community. These alternatives also have a potential to suspend contaminated sediment. Overall, capping has the greatest short-term effectiveness (e.g., the least short-term impact) because it has the least amount of in-water work, and the contaminated material is not disturbed much. Dredging and construction of a nearshore facility would have the greatest short-term impacts due to the extensive in-water work required.

Although all these alternatives have short-term impacts, much of the short-term risk associated with both dredging and capping can be significantly reduced by carefully choosing methodology and monitoring (i.e., controlling the dredge depth and speed of dredging, controlling the rate of placement of cap material, etc.).

8.6 Implementability

Groundwater

The Preferred Alternative is most easily implemented. The pump and treat alternative would be the most difficult to construct and operate since very large quantities of groundwater would require pumping and treatment (i.e., many hundreds of gallons per minute would be required due to the incidental capture of seawater by the extraction system). Although a pump and treat technology may be difficult to operate, it is reliable and available. The remedial alternatives involving *in situ* groundwater treatment would be easier to construct and operate but are less proven and reliable technologies than pump and treat. The *in situ* treatment alternatives would require pilot testing to confirm their efficacy at the Facility. All of the alternatives would require long-term operation, maintenance, and monitoring.

Sediment

Capping or dredging are feasible with appropriate design and monitoring during construction. A nearshore CAD facility is also feasible but would require more engineering controls. Confined upland disposal of sediment at the Asarco Facility would be more easily implemented than the nearshore confinement alternative because the upland work is already underway and space has been made available under the Facility cap.

8.7 Cost

Cost estimates presented in this Proposed Plan are intended to be accurate within a range of +50 to -30 percent. (See Tables 7-1 through 7-4).

Groundwater

Alternative GW-B (the Preferred Alternative) is the least costly. The *in situ* groundwater treatment alternatives are similar to each other in cost. The pump and treat alternative is most expensive.

Note that additional groundwater interception is technically possible under Alternative GW-B. However, Asarco has demonstrated that intercepting additional groundwater at the southwest (uphill) side of the Facility could only be done at a cost that is disproportionately high compared to the small incremental environmental benefit expected. If it is determined that more groundwater needs to be captured and diverted around the Facility to achieve the cleanup goals, additional groundwater diversions may be required in the future (e.g., in the Cooling and East Stack Hill drainages and along Ruston Way).

Sediment

For the Nearshore, Offshore, and Northshore areas, capping is less costly than dredging and nearshore confinement/upland disposal. For all sediment areas, upland disposal is less costly than nearshore confinement.

8.8 State/Tribal Acceptance

Ecology is continuing to review the Proposed Plan for compliance with state regulation. Ecology generally agrees with the Preferred Alternative.

The Native American tribes participated in the review of the major Facility documents, and it is EPA’s understanding that they are in general agreement with the Preferred Alternatives in this Proposed Plan. The Tribes will be providing comments to EPA on this Proposed Plan.

8.9 Community Acceptance

Community acceptance of the Preferred Alternative will be evaluated after the public comment period ends and will be described in the ROD for the Sediments/Groundwater OU.

9. EPA’s Preferred Alternative

9.1 Groundwater

EPA’s Preferred Alternative for groundwater is Alternative GW-B: Capping, Groundwater Interception, Treatment of Intercepted Groundwater, Replacement of Leaking Subsurface Water Lines, Institutional Controls and Monitoring. This alternative is currently being implemented as part of the ROD for OU 02, but is reiterated here for completeness and to allow further modifications, should they be necessary, to occur in the future (i.e., if the cleanup goals are not achieved within a reasonable time frame). The Preferred Alternative for groundwater is a combination of several alternatives modified from the 1993 FS prepared by Asarco and is the Preferred Alternative because it greatly reduces groundwater flow through the Facility and surface water infiltration. Since the slag will remain in place on the Facility, the best way to limit groundwater contamination is to limit groundwater contact with the slag. The preferred groundwater alternative is discussed below.

9.1.1 Interception Trenches/Drains Upgradient of Source Areas with Discharge to Existing Outfalls

Subsurface trenches or drains will be installed upgradient of the proposed OCF and railroad tunnel as part of the remedial action for Operable Unit 02. Additional subsurface drainage could be installed along Ruston Way depending on the results of hydrologic analyses that are in progress. This additional drainage would be performed pursuant to this Proposed Plan and subsequent ROD. These subsurface drainage systems will intercept and capture groundwater that would otherwise enter the Facility, contact slag and possibly other contaminated materials, and ultimately transport contaminants to Commencement Bay. Water from the interception trenches and drains will be treated prior to discharge to the Bay.

Source Control

Before the preferred remedy can be implemented, source control must be achieved. This is being accomplished by the following:

- The Facility is no longer active
- Groundwater flow is estimated to be reduced by 75 to 95 percent
- The upland area will be capped to inhibit surface water infiltration
- Shoreline stabilization will be constructed to reduce the breaking off of slag into the marine water
- Soil source areas will be removed
- Surface water flow will be treated prior to discharge to the marine water
- Leaking underground pipes will be removed
- Buildings will be demolished and removed from the Facility

Some of the above source control measures have already been completed; the remainder will be done by 2003.

9.1.2 Reduction of Groundwater Recharge by Facility Capping and Surface Water Controls

A large percentage of groundwater currently discharged to Commencement Bay originates from on-site recharge by precipitation and surface water run-on. As part of the remedial action for Operable Unit 02, an extensive system of surface water controls will be constructed to capture surface water that would otherwise run onto the Facility from uphill locations (e.g., from Ruston, Stack Hill, Cooling Pond area, etc.) and infiltrate into the shallow groundwater system. The captured surface water will be treated as necessary and then discharged to Commencement Bay. A low-permeability soil cap will be constructed over the Facility (including the Breakwater Peninsula) to inhibit infiltration of precipitation into the shallow groundwater system. Run-off from precipitation falling on the cap will be captured in on-site surface water drainage systems and discharged to Commencement Bay. Reduction of infiltration by surface water controls and site capping is expected to reduce groundwater discharge to Commencement Bay by approximately 75 to 95 percent (Parametrix 1999b). Additional groundwater interception is being considered at the Facility, and may also be considered by EPA at a later date. The need for additional groundwater interception would be based on the results of ongoing groundwater sampling.

9.1.3 Elimination of Leaking Subsurface Water and Sewer Lines

Leakage from underground stormwater, sewer, water, and fire protection lines is believed to contribute a significant volume of recharge to the shallow on-site groundwater system. These underground lines will be either abandoned (sealed) or removed and then replaced with new piping as needed. Some of this work has already been completed. Additional abandonment and replacements of underground piping can occur as part of the remedial action for Operable Unit 02 or as part of this OU (OU 06).

9.1.4 Institutional Controls and Continued Monitoring

Institutional controls will be implemented to prohibit the use of groundwater for any purpose other than cleanup or monitoring.

Groundwater monitoring will be conducted two times a year. The details of the groundwater monitoring plan will be developed as part of the operation and maintenance plans for the Facility. At a minimum, monitoring wells at the downgradient perimeter of the Facility (along the shoreline) will be monitored, including wells near source areas. The objectives and methods for groundwater monitoring will be designed to complement the marine surface water and sediment monitoring programs and may be altered in the future. In addition, should the groundwater indicate high concentrations of metals, contingency actions, such as additional groundwater diversions, may be considered.

9.2 Sediment

EPA's preferred sediment alternative is a combination of capping in the Nearshore, Offshore, and Northshore areas, and dredging of the Yacht Basin with on-site upland disposal of the dredged sediments (Figure 5). Rationale for these Preferred Alternatives is provided below. In addition, the upland source control activities discussed above are necessary prior to sediment remediation, to limit the chances of sediment recontamination.

9.2.1 *In situ* Sediment Capping

In situ capping is the Preferred Alternative for the Nearshore/Offshore area and Northshore area. Approximately 88,000 yd^2 (18 acres) of existing contaminated sediments in the Nearshore/ Offshore area will be capped with a minimum of 1 meter of clean sediment from an upland source, and approximately 7,000 yd^2 (1.5 acres) of existing contaminated sediments in the Northshore area will be capped with a minimum of 1 meter of clean sediment. The cap thickness will be designed such that it provides chemical isolation, is stable, and provides a cap surface that will allow recolonization of benthic communities. In order to achieve this, the design will assess the geotechnical aspects of the area, as well as the erosional nature, depth of bioturbation, future use of the area, and other design considerations.

The capping material will come from an upland source, and the cap can be designed to be stable. The results of the pilot cap study will be used to design an appropriate cap, including the results from the small armored sections of the pilot cap. The cap will be thick enough to be protective of human health and the environment, and will be designed to be stable (so it will be long-term effective). Placement of a cap is also relatively easy to implement, as this type of work is done regularly, and much was learned as part of the pilot cap study.

9.2.2 Yacht Basin

The Preferred Alternative for the Yacht Basin is Alternative 2D, Dredging and Upland Disposal. An area approximately 75,000 yd^2 (15.5 acres) will be dredged in the Yacht Basin. At this point, approximately 1 to 2 feet of material is estimated to be removed and placed beneath a portion of the upland cap that will be kept available during the upland cleanup activities. If all of the contaminated sediments in the Yacht Basin cannot be practicably dredged or slag is discovered, then, as a contingency, the remaining contaminated sediment areas may be capped.

Dredging in the marina is the preferred remedy because it would remove the contaminated material (which tends to be a more permanent remedy than covering up the contaminated material). Further, capping in the marina (without first dredging) is not possible as the cap would interfere with the boat activity.

For the dredging alternative, the material would be dewatered, and then placed in a controlled, upland location (known as Crescent Park, in the central part of the upland Facility), that will be monitored for many years. This allows for the long-term effectiveness of the remedy to be monitored. Further, the mobility of the contaminants would be reduced, as the sediment would be in a location that does not have contact with water. There will also be contingency plans should the upland cap begin to fail (i.e., get cracks in it).

9.2.3 Institutional Controls

The preferred sediment alternative may include institutional controls to prevent damage to the sediment cap. For example, boat activity over the cap may need to be limited. In addition, the upland cap that covers the sediment from the Yacht Basin will have some institutional controls, such as no drilling or digging through the cap.

9.2.4 Long-term Monitoring

Long-term monitoring will occur post-cleanup in the sediments to check the performance of each remediated area and the adjacent areas. Specifically, long-term monitoring of the sediment cap will be necessary to confirm that the cap is isolating the contaminated sediments from marine life. The cap’s physical integrity, particularly its thickness, will be verified on a regular basis. In addition, chemical analysis to verify that concentrations of contaminants are not accumulating in the upper part of the cap, where the marine organisms live, is needed. Because some of the processes that can recontaminate the cap are slow, long-term monitoring must occur over decades, not just years.

Long-term monitoring must occur in the area that cannot be remediated due to technical impracticability (i.e., off the slag peninsula). Long-term monitoring must also occur in the area not falling in the active remediation area, which has exceedances of the SMS biological criteria (i.e., the Moderate Impact area, just outside the Contaminant Effects Area). Monitoring is necessary to determine whether there is overall long-term biological improvement in these areas, or that, at a minimum, the areas are not worsening with time. Again, these measurements must be made over a long duration so that trends are apparent.

If long-term monitoring indicates recontamination of an area, or that the cap is eroding, several contingencies may be applied. For example, more material may be added to the sediment cap, or additional armoring might be added to reduce erosion. In addition, more source control measures might be instituted upland to reduce the chances of recontamination of the cap (i.e., additional groundwater diversion measures).

9.2.5 No Action

No remedial action is planned for the Slag Peninsula area (approximately 85,000 yd^2 or 17.5 acres) because the water depths and steep slopes make capping or dredging technically impracticable (Figure 3). The sediment depth off the Slag Peninsula in some areas is almost 100 feet at only 200 feet from shore. Similarly, the slope can be up to 50 percent in some areas. The stability of a cap on a slope such as this is questionable, and the construction of a Nearshore facility on a slope such as this would be very difficult. In addition, dredging is not possible because the entire peninsula would need to be removed (since it is constructed of slag, up to 110 feet deep in the center).

The peninsula is therefore technically impracticable to remediate.

9.3 Summary

The combination of the elements of the Preferred Alternatives for groundwater and sediments provides the best balance of tradeoffs among the alternatives with respect to the balancing and modifying criteria and it complies with statutory requirements under the Superfund law. EPA believes the Preferred Alternative would protect human health and the environment, comply with ARARs, be cost-effective, and utilize permanent solutions to the maximum extent practicable.

The Preferred Alternative can change in response to public comment or new information.

10. Community Participation

One of EPA’s objectives in issuing this Proposed Plan is to enable the public to review all alternatives and participate in the selection of alternatives. Specifically, EPA solicits public comment on whether EPA has made good choices in proposing that certain alternatives become elements of the cleanup, and whether the choices made will attain community objectives for the Asarco Sediments/Groundwater OU. After consideration of all comments, EPA will make its final decision on the cleanup remedy for the Asarco Sediments/Groundwater OU in a ROD. Also, EPA will respond in writing to all comments submitted during the public comment period in a document called a “Responsiveness Summary.” The Responsiveness Summary will be part of the ROD, which will be available for public review at the local information repositories.

You can review copies of the investigation and study documents related to the Asarco Sediments/Groundwater OU at the information repositories listed below. You can also view this Proposed Plan on EPA’s web page at **http://www.epa.gov/r10earth.** Scroll down to “calendar” at the bottom of the page, scroll to "Public Comment Opportunities," and click on any of the underlined titles to view the information.

In Tacoma:

Tacoma Public Library
1102 Tacoma Avenue, NW Room

In Seattle:

U.S. Environmental Protection Agency
1200 Sixth Avenue
7th Floor, Records Center

In Olympia:

Washington Dept. of Ecology
300 Desmond Drive, S.E.

In addition, copies of this Proposed Plan will be at the following locations:

(1) City of Tacoma
Environmental Commission
747 Market Street, Suite 1120

(2) Tacoma Pierce County Health Dept
3629 South D Street

(3) Ruston Town Hall
5117 Winnifred

(4) Asarco Information Center
5311 North Commercial

(5) Citizens for a Healthy Bay
917 Pacific Avenue, Suite 406

If you have questions about the Asarco Sediments/Groundwater OU, contact **Lee Marshall**, the EPA Project Manager, toll free in Seattle at 1-800-424-4EPA, or at **206-553-2723**.

If the information repositories do not have the document you need or if you would like more information about the Asarco Sediments/Groundwater OU, contact **Jeanne O'Dell**, the EPA Community Relations Coordinator, toll free in Seattle at 1-800-424-4EPA, or at **206-553-6919**.

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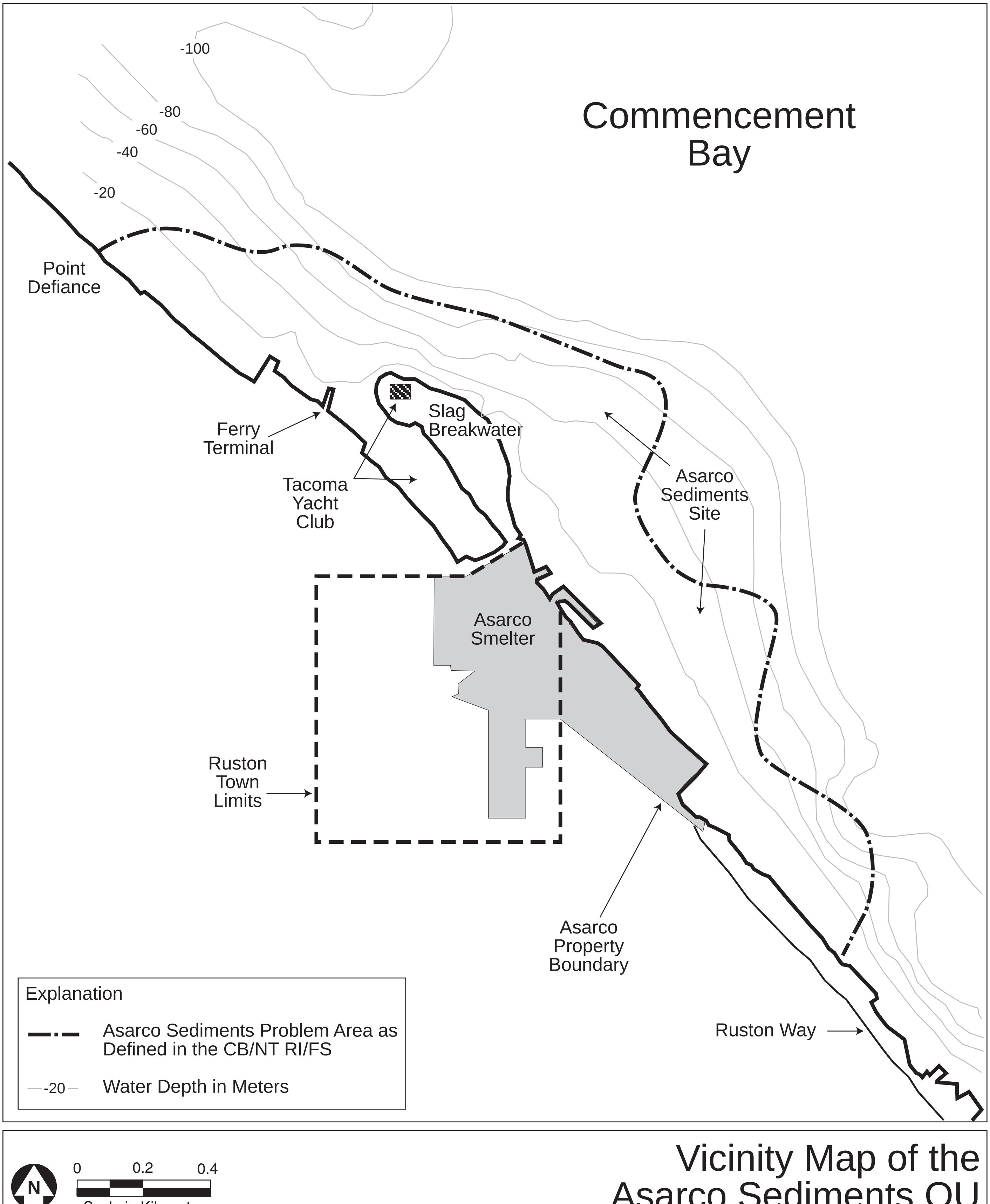
LIST OF FIGURES



Vicinity Map of the Asarco Sediments OU

Figure 1

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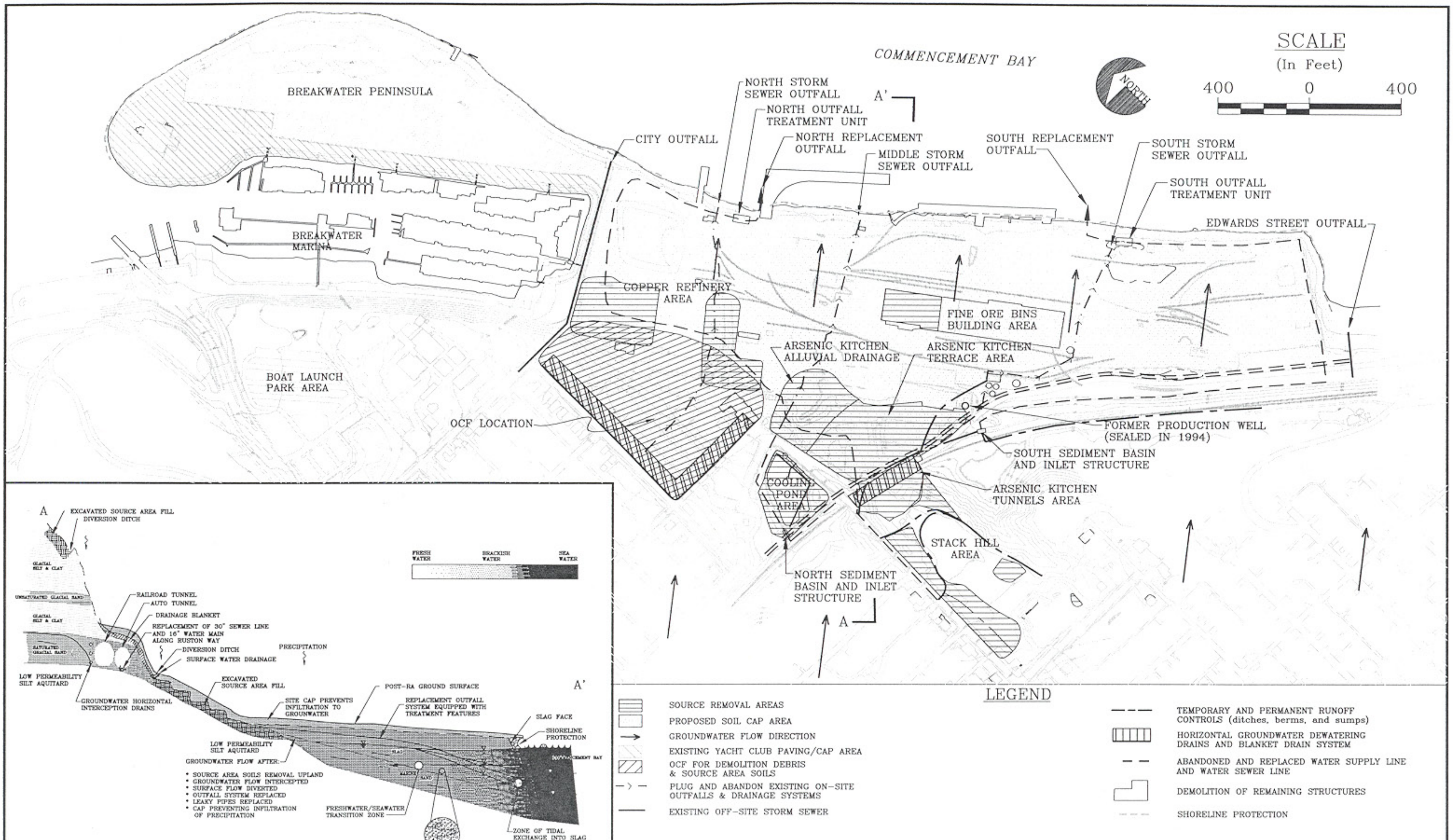

PREFERED GROUNDWATER ALTERNATIVE
ASARCO SEDIMENT/GROUNDWATER OU

FIGURE
2

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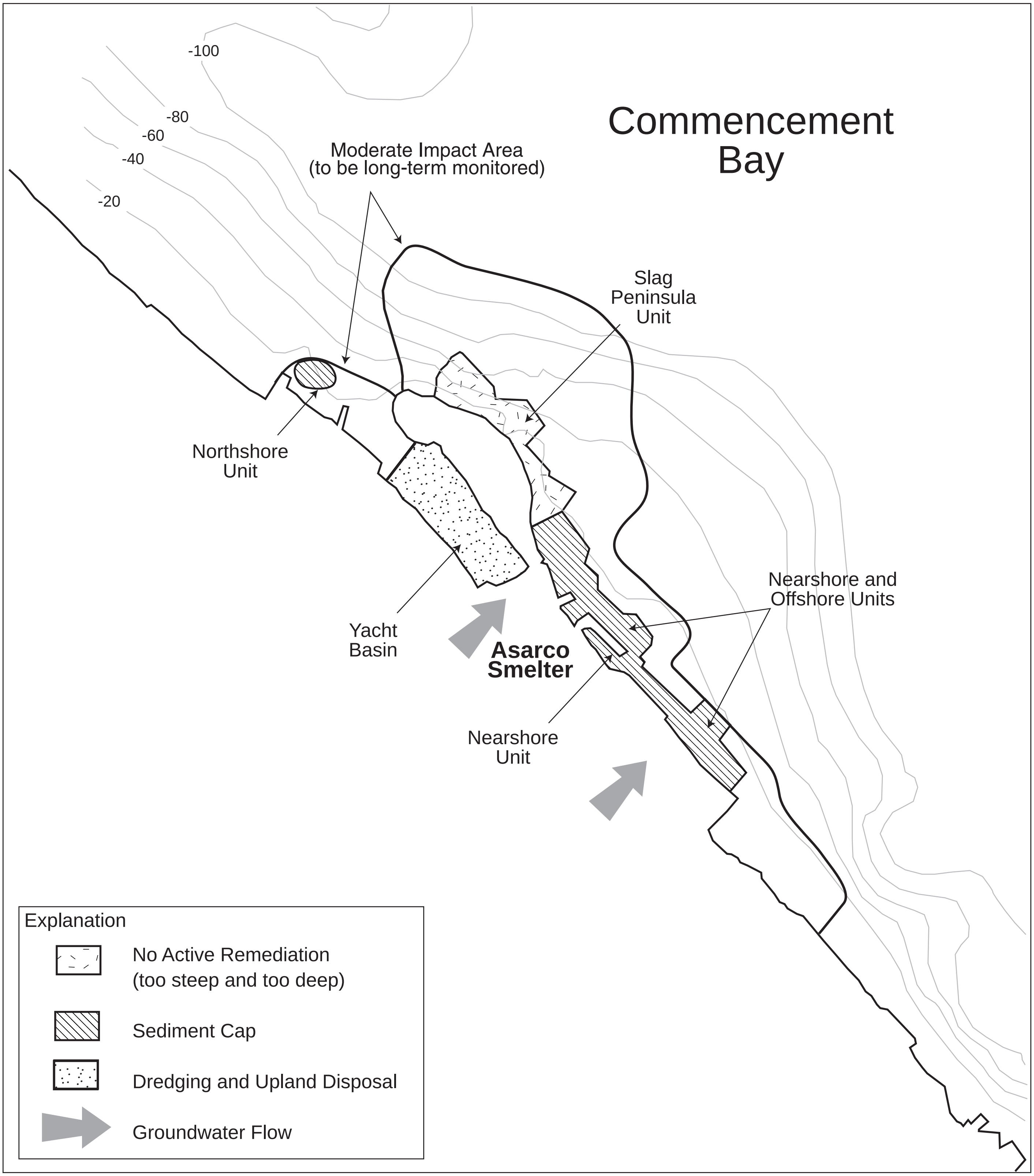

Source: Parametrix 1999

0 500 1000
Scale in Feet

Preferred Sediments Alternative
Asarco Sediments/Groundwater OU

WESTON
MANAGERS DESIGNERS/CONSULTANTS

Figure
3

99-0109 Fig3.ai

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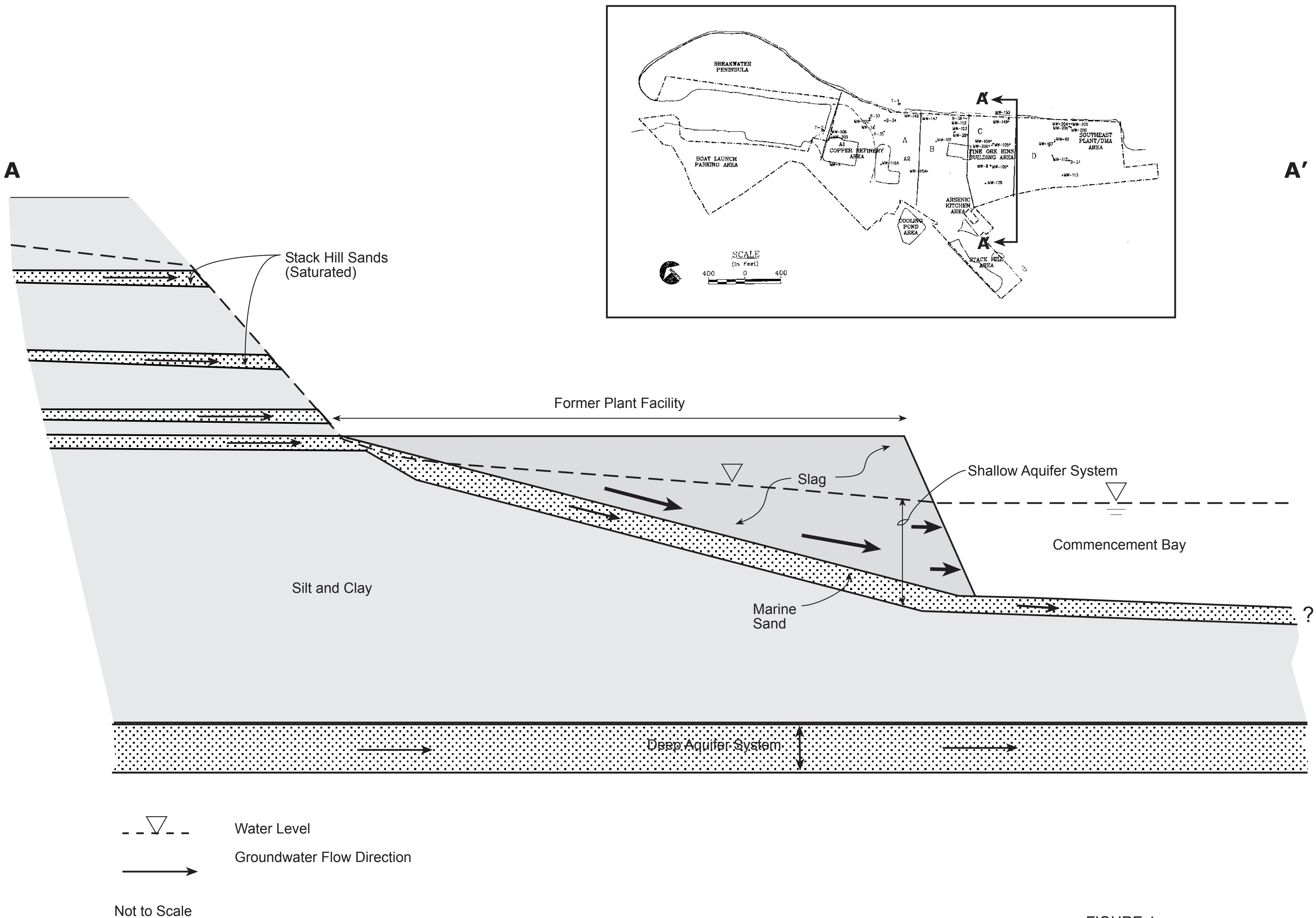

FIGURE 4
Conceptual Cross-Section
ASARCO Sediments/Groundwater OU

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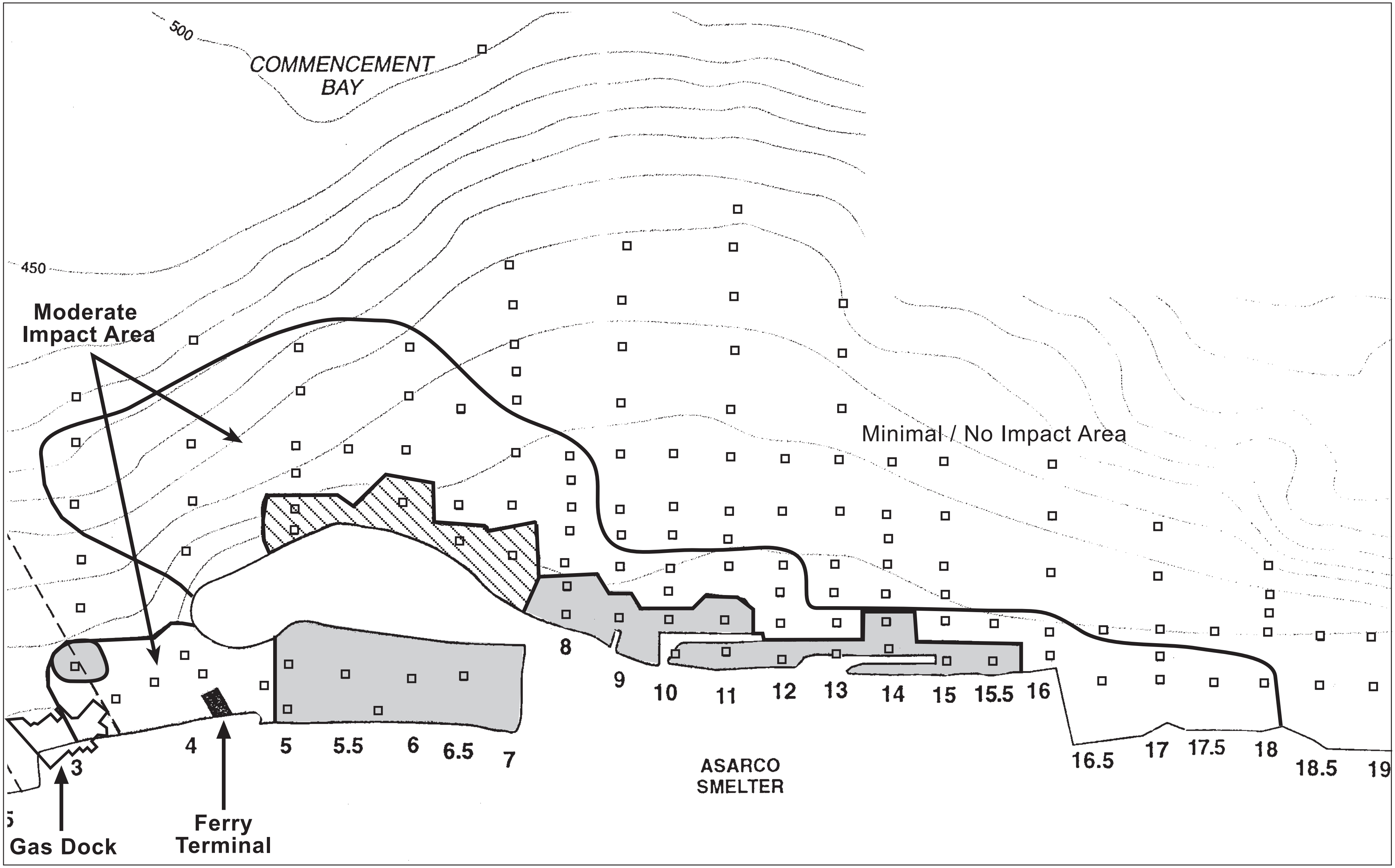

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Scale in Feet

EXPLANATION

50	Depth (in feet)
3	Transect Numbers
□	Stations
	Contaminant Effects Area
	Area Too Steep for Active Remediation

WESTON
MANAGERS DESIGNERS/CONSULTANTS

Note: Figure adapted from Parametrix, 1995.

Contaminant Effects Area
Asarco Sediments/Groundwater OU

Figure
5

99-0109 Fig5.fh8