EXHIBIT B
CLEANUP ACTION PLAN (CAP)

ARCO TERMINAL 21T

HARBOR ISLAND SITE - SEATTLE, WASHINGTON

ISSUED BY

WASHINGTON STATE DEPARTMENT OF ECOLOGY

NORTHWEST REGIONAL OFFICE, BELLEVUE

NOVEMBER 19, 1999

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1.0 INTRODUCTION

This Cleanup Action Plan (CAP) is provided to describe the proposed remediation at the ARCO Products Company (ARCO) Harbor Island Terminal 21T Plants 1 and 2 (Terminal 21T) in Seattle, Washington. It has been prepared to satisfy the requirements of the Model Toxics Control Act (MTCA) Agreed Order No. DE 92 TC-N-158, cooperatively entered into between ARCO and the Washington State Department of Ecology (Ecology).

The purposes of this CAP are to: 1) describe the site, including a summary of its history and extent of contamination; 2) identify the site-specific cleanup standards, 3) summarize the remedial cleanup action alternatives presented in the Focused Feasibility Studies (FFS); 4) identify and describe selected remedial action alternative for the site; and 5) discuss the implementation schedule. Detailed information regarding site history, characterization, and the evaluation of alternative cleanup actions is contained in the final RI and final FFS reports by Geraghty & Miller 1994, 1997.

The remedial actions selected for the site are to occur under the legal framework of a consent decree between ARCO and Ecology.

2.0 SUMMARY OF SITE CONDITIONS AND INTERIM REMEDIATION SYSTEM

This section provides a summary of site conditions, including the nature and extent of impacts and a description of the interim remediation system. In addition, the exposure pathways identified for the site are briefly described.

2.1 SITE CONDITIONS

The ARCO Harbor Island Terminal 21T consists of Plant 1 which is adjacent to the West Waterway of the Duwamish River, and Plant 2 which is located inland of the waterfront in the north-central part of Harbor Island (Figure 1). Groundwater flows in a radial pattern outward from the center of Harbor Island and enters the marine surface water at the Island's edge. The site is

zoned industrial and meets the industrial criteria established under WAC 173-340-745. In addition, the site will likely remain an industrial facility in the foreseeable future because of the site zoning, and, perhaps more importantly, because of the substantial industrial improvements to Harbor Island (e.g., construction of cargo handling facilities and construction of major petroleum distribution pipelines for the Island). Ecology and EPA has determined that there is no current or planned future use of groundwater beneath Harbor Island for drinking water purposes but to protect the adjacent surface water and its ecosystem.

2.1.1 Nature and Extent

The following section summarizes the nature and extent of contamination at the site based on the results of the RI. A general discussion of the contaminants detected at the site is presented first. A summary of the free-phase product (product) plume beneath the warehouse next to the shoreline is presented next since this is the primary area of concern at the site. A summary of other localized areas of hydrocarbon-related impacts located inland from the warehouse area in Plants 1 and 2 is then presented as the secondary areas of concern at the site. This section is followed by a summary of minor impacts by metals in soil and groundwater at the site, and the results of surface water and marine sediment sampling.

The results of the site characterization activities conducted during the RI indicate that contaminants present in groundwater and soil at the site are primarily highly-weathered total petroleum hydrocarbons as diesel (TPH-D) with lesser amounts of weathered gasoline (TPH-G) and heavier oil (TPH-O), carcinogenic aromatic polynuclear hydrocarbons (cPAHs), and a few inorganic metals (copper and lead). The weathered TPH is most likely the result of historic spills at the site and there is no evidence of either recent or on-going releases. The inorganic metals are present at low concentrations at a few locations in groundwater and shallow soils, and are most likely due primarily to historic lead smelter activities. Other secondary sources including historical burial of tank bottom sludge, and shipbuilding activities conducted elsewhere on Harbor Island.

The results of the RI show that the primary area of impact at the site is the product plume located beneath the warehouse adjacent to the Duwamish River in Plant 1. The floating product is trapped behind the subsurface warehouse foundation and Island bulkhead that form a partial barrier to groundwater flow to the river. These structures act as a “hanging wall” which allows groundwater and possibly some dissolved petroleum hydrocarbons to flow beneath the foundation while trapping the floating product. The water table elevations fluctuate seasonally due to rainfall, and in response to tidal influence from the Duwamish River; however, the water table elevation does not drop below the base of the subsurface barriers.

Although the warehouse foundation and Island bulkhead retard the transport of floating product to the Duwamish River, a sheen occasionally appears on the Duwamish River and may be due to areas of discontinuity in the hanging wall (e.g., small cracks in the warehouse foundation or island bulkhead). The sheen is contained using sorbing booms except for the dissolved part of the petroleum hydrocarbons. In addition, an interim product recovery system has been in operation under the warehouse since 1992 (Figure 2). This system has been effective in removing product

and reducing the frequency and extent of hydrocarbon sheen in the Duwamish River based on field observations since the system began operating.

Due to the dampening effect of the warehouse foundation and Island bulkhead on the shallow groundwater, water table fluctuations in response to tidal influence are only 1 to 2 feet near the Duwamish River. Seasonal fluctuations in water table elevations due to rainfall are similarly only 1 to 2 feet. The resulting "smear" zone of product in soil beneath the product plume is less than 4 feet thick. The extent of the smear zone was confirmed during the RI soil sampling activities. Elevated TPH concentrations in soil were detected below the water table but it is limited within the zone of tidal fluctuation and does not extend below the seasonal low-lower tide water table elevation.

The results of the RI also indicate that localized areas of soil with elevated concentrations of TPH are present within the tank farms of Plants 1 and 2 inland of the waterfront and warehouse area. These soils have been undergoing intrinsic bioremediation/natural attenuation and appear to be in equilibrium with groundwater at the site (i.e., the soils are not causing an increase in hydrocarbon concentrations in groundwater). Concentrations of TPH-G and TPH-D have been detected in groundwater above cleanup levels within or in close proximity to areas where the historical spills occurred. Groundwater monitoring results indicated no exceedance of the cleanup level for TPH-O. Benzene and cPAHs have also been detected within the groundwater plumes above cleanup levels. Concentrations of benzene exceeded the cleanup level in approximately 15 percent of the groundwater samples collected for five quarters of monitoring during the RI (the second, third, and fourth quarters of 1993 and the first and fourth quarters of 1996); concentrations of cPAHs exceeded the cleanup level in approximately 1 to 10 percent of the samples collected, depending on the cPAH analyzed.

The results of five quarters of monitoring data collected during the RI indicate that the dissolved-phase hydrocarbon plumes located in the tanks farms of Plant 1 and Plant 2 are stabilizing overall in extent and concentration due to on-going intrinsic bioremediation/natural attenuation.

Dissolved copper was the only metal detected in groundwater in Plant 1 and Plant 2 above cleanup levels during the five quarters of monitoring for the RI. Concentrations of dissolved copper exceeded the cleanup level in approximately 7 percent of the samples collected. Dissolved copper was also detected across much of the northern portion of Harbor Island during the USEPA RI, indicating elevated background concentrations. Copper was not detected in soils above the cleanup level. This inorganic metal is associated with marine paints used at shipbuilding and repair facilities adjacent to Plant 1 (Tetra Tech 1988).

Minor occurrences of lead and arsenic were identified in surface soil in Plant 1 above the cleanup levels. Lead concentrations above the cleanup level were detected in approximately 1 percent of the soil samples collected during the RI (only two surface samples) and arsenic concentrations above the cleanup level were detected in less than 1 percent of the soil samples collected (only one surface sample). Dissolved concentrations of lead and arsenic were not detected in groundwater above cleanup levels. Potential sources of arsenic include open-air shipbuilding and repair

activities. The occurrence of lead is most likely associated with stack emissions from the former lead smelter.

The results of surface water sampling conducted during the RI detected petroleum hydrocarbon sheen on the surface water next to the site and some exceedances of surface water standards for cPAHs; however, the cPAH detection cannot be distinguished from other potential non-ARCO sources (e.g., nearby Harbor Island storm sewer out-falls, other up-river sources).

Based on the results of marine sediment sampling conducted at the site, exceedances did not meet the Sediment Standards Criteria to require active remediation. .

2.1.2 Exposure Pathways

The following pathways were evaluated at the site as part of the FFS (Geraghty & Miller 1997):

- Product to Groundwater, Surface Water and Air
- Soil to Groundwater
- Inland Soil to Groundwater to Surface Water
- Soil Particulate to Air
- Soil Direct Contact
- Groundwater to Marine Sediments

These exposure pathways for a cross section of the site are shown on Figure 3. (The location of the cross section is shown on Figure 4.) As described in the following sections, the primary exposure pathways of concern identified for the site are associated with the product plume in the warehouse area (Section 2.1.2.1). Offsite migration of dissolved petroleum hydrocarbons is a secondary concern of the site.

2.1.2.1 Product to Groundwater, Surface Water and Air

The three potential transport pathways associated with product plume beneath the warehouse include (1) migration of vapors beneath the warehouse and offices, (2) occasional product migration into the Duwamish River through discontinuities in the subsurface barriers, and (3) partitioning of hydrocarbons from the product or adjacent soil to the groundwater, and then subsequent transport in dissolved phase to the surface water through groundwater discharges.
These pathways associated with the product plume in the warehouse area are the primary pathways of concern at the site because they pose a direct threat to the surface water and its ecosystem at the shoreline. The selected cleanup action will interrupt these pathways by continuing the use of the existing bulkhead and remedial actions which will focus on removal of the product, dissolved petroleum hydrocarbons, and vapors as discussed in Section 4. These actions will be effective in meeting cleanup levels in groundwater at the point of compliance, providing protection to day workers at the warehouse from fumes and vapors, and preventing migration of product sheen and dissolved petroleum hydrocarbon plumes into the surface water adjacent to the ARCO site.

2.1.2.2 Soil to Groundwater Pathway

The results of five quarters of groundwater monitoring data and groundwater modeling conducted during the RI and FFS indicate that the soil to groundwater pathway for the inland sources appears to be complete and are stabilizing. The last recorded spill to inland soils took place over nine years ago. Groundwater monitoring data indicate that the dissolved plumes associated with these sources are stabilizing and appear to have reached equilibrium with the soils and that dissolved concentrations are generally decreasing. The soil to groundwater pathway inland of the ARCO site (portions of Plant 1 and in Plant 2 tank farms) does not pose a threat to the surface water at the shorelines based on the results of the fate and transport modeling and groundwater monitoring for the site. Therefore, offsite migration to adjacent properties is considered a secondary concern. Accessible TPH contaminated soil hot spots not located beneath the warehouse will be excavated to ensure that the dissolved petroleum hydrocarbon in groundwater emanating from these inland sources does not migrate off property boundaries, and to enhance timely restoration of the impacted areas through natural bioremediation. Monitoring wells will be located along the property boundaries as part of the Groundwater Compliance Monitoring Program to provide early warning of any pending off property migration. A detailed contingency plan is outlined in the compliance groundwater monitoring program for the site as a 'backup' remediation technology in case the preferred corrective option proves ineffective.

The soil to groundwater pathway was not considered in the fate and transport modeling for the areas located at the shoreline, under the warehouse, and the area next to the loading rack. Ecology recognizes the limited access to soils beneath the warehouse foundation. Therefore, the remedial alternatives selected for the inaccessible TPH contamination beneath the warehouse have been designed to treat the soils in-place and to take advantage of the hanging wall conditions along the waterfront that restrict the flow of product to the Duwamish River.

The selected remedy for groundwater at the warehouse area along the shoreline combines several remedial elements to meet the remedial action objectives of removing petroleum vapors, product and the dissolved petroleum hydrocarbons including residual hydrocarbons in soil hot spots beneath the warehouse. These elements include the following technologies: extraction monitoring wells with dual pump functions to remove product from the water table and the dissolved petroleum hydrocarbons from the subsurface, treatment of the extracted groundwater prior to discharge, soil vapor extraction, air sparging below the water table, and monitoring/institutional controls. These technologies will enhance and expedite the natural biodegradation of the TPH under the warehouse. Final configuration of this technology is based on a pilot test study completed in this area and will be implemented under the legal framework of the consent decree.

2.1.2.3 Inland Soil to Groundwater to Surface Water Pathway

The results of groundwater numerical and analytical modeling conducted during the FFS indicate that the dissolved-phase hydrocarbon plumes originating at some locations inland of the waterfront within the tank farm in Plant 1 will not reach the Duwamish River at concentrations above surface water cleanup levels but may exceed cleanup levels at property boundaries. The modeling results have been verified by the five quarters of groundwater monitoring data.

Accessible TPH soil hot spots at the inland locations of Plant 1 shall be excavated using the action levels of 10,000 mg/kg set by U.S. EPA ROD for the rest of the Island.

Accessible TPH soil hot spots at the inland locations of Plant 2, located at the middle of the island shall be excavated using action levels of 20,000 mg/kg. This is the EPA (A Guide to Corrective Action, EPA, May 1995) recommended lower threshold criteria to enable natural attenuation to successfully reduce total petroleum hydrocarbons concentrations to acceptable levels within a reasonable restoration time period (5 years).

The technologies proposed for the accessible inland TPH contaminated soil hot spots and the associated dissolved petroleum hydrocarbon in the groundwater will include soil excavation and on/off site treatment and disposal. This technology will improve groundwater quality at the site, enhance timely restoration of the impacted areas and expedite natural biodegradation of the residual TPH left in place.

2.1.2.4 Soil Particulate to Air Pathway

This pathway is not of concern with respect to TPH, since impacted soils are located within the subsurface (generally 1 to 2 feet below ground surface) for the areas of the tank farm covered with gravel. Other portions of the site are paved with asphalt. The above ground storage tanks and the tank farm walls also offer some protection from the wind. In addition, the hydrocarbons in soils at the site are very weathered, degraded, and mostly comprised of diesel and oil, not the volatile and more toxic compounds present in gasoline.

The remedy for surface soils inorganic constituents selected in the EPA ROD for Harbor Island requires 3 inches of asphalt cap at areas of the Island that exceeded 32.6 mg/kg arsenic, and 1000 mg/kg lead. EPA conducted surface soil investigations for the island including the ARCO site. Ecology and EPA agreed not to duplicate investigation efforts on the Island through a memorandum of agreement (MOA) except where data gaps exist. The results of the EPA RI surface soil investigations indicate that areas of the ARCO site covered with gravel are of limited concern because surface soil exceedances occurred in only two location points and will not require active remediation.

2.1.2.5 Soil Direct Contact Pathway

MTCA regulates points of compliance for human exposure through the direct contact pathway from approximately 0 to 15 feet below ground surface. However, petroleum hot spot excavation for the ARCO site, as outlined in this CAP, will occur from approximately 0 to 5 feet below ground surface, the maximum vertical extent of subsurface soil impact. This will remove the majority of the hot spot soil mass and will eliminate the direct contact pathway as a concern for the accessible impacted areas of the site. Certain inaccessible areas will be treated by the use of vapor extraction and air sparging technologies. Additional protection will be provided for both the accessible and inaccessible impacted areas through restrictive and deed covenants on the property and institutional controls.

2.1.2.6 Groundwater to Marine Sediments

This pathway is not a concern at this time since the results of the Supplemental RI marine sediment sampling conducted in the Duwamish River adjacent to the site did not indicate that impacts due to ARCO operations exceeded the Marine Sediment Cleanup Standards to require active remediation. However, due to the on-going discharges to the bay of petroleum hydrocarbon sheen next to the ARCO site, compliance standards will require evaluation of the sediment, biota, and the surface water next to the site as part of the attached Groundwater Compliance Monitoring and Contingency Program, Exhibit F, of the Consent Decree. This is to ensure that the preferred remedy for the site will provide continued protection to the bay as proposed in this CAP.

2.2 INTERIM REMEDIATION SYSTEM

An interim remediation system has been in operation at the site to remove floating product and associated hydrocarbon vapors from beneath the warehouse area. The interim remediation system consists of a combination of product recovery and soil vapor extraction (SVE) systems. The interim remedial system has been effective in recovering product from beneath the warehouse and reducing the frequency and extent of hydrocarbon sheen in the Duwamish River adjacent to the site. Over 11,700 gallons of product have been collected by the interim system to date. Each of the two elements of the interim system is further described below.

The product recovery system consists of two recovery wells, one located inside the warehouse (RW-1) and one located near the loading rack area (RW-4). Groundwater is pumped from these wells to enhance hydraulic capture of product. The extracted groundwater is treated using an airstripper, then discharged to the sanitary sewer system. Product is collected from these wells via two total fluids pneumatic pumps, and transferred to Tank 20 located in Plant 1 (Figure 2). The recovered product is disposed of/recycled by the terminal. Most of the product recovered to date has been from Recovery Well RW-1. The product thickness in RW-1 has been reduced from approximately 1 foot to approximately 0.01 foot since the system began operating.

The SVE element of the interim system extracts vapors from the vadose zone at five SVE wells located along the west Island bulkhead (wells SVE-1, SVE-2, SVE-3R, SVE-4, and SVE-5). The extracted vapors have been discharged through an exhaust stack to the atmosphere in compliance with the system Puget Sound Air Pollution Control Agency (PSAPCA) permit. During field tests of the SVE system, the radius of influence at each of the SVE wells was estimated to range from 43 to 100 feet (Geraghty & Miller 1994).

The air sparging element of the interim system has been installed, but has not been operated to date. The air sparging system will operate in conjunction with the SVE system. The air sparging system utilizes a compressor to deliver air into the subsurface below the water table to remove volatile hydrocarbons present from the groundwater, and to introduce oxygen to enhance in-situ biodegradation. Oil-free compressed air will be delivered below the groundwater level via Air Sparging Wells AS-1 and AS-2. These wells are located near the southern end of the warehouse where TPH concentrations of 16,000 milligrams per kilogram (mg/kg) were detected during the

supplemental RI activities in the zone of tidal fluctuation below the water table. Hydrocarbon vapors will then be extracted from the overlying vadose zone via SVE Well SVE-5. The pilot test of the system was completed in January 1999. The results of this pilot test will support the design of the selected cleanup action discussed in Section 4.0. Construction details of this system will be outlined in a Remedial Design Report and will be implemented under the legal framework of the Consent Decree.

3.0 SUMMARY OF CLEANUP STANDARDS

The Model Toxics Control Act (MTCA) cleanup regulations provide that a cleanup action must comply with cleanup levels for selected hazardous substances, points of compliance (POCs), and applicable or relevant and appropriate state and federal laws (ARARs) (WAC 173-340-710). The final indicator hazardous substances identified for the site, the associated cleanup levels, and ARARs are briefly summarized in the following sections. POCs will be established within the product plume area and at the downgradient edge of the site or property boundary. POCs will be further defined during development of the compliance monitoring program as discussed in Section 4.3.

3.1 INDICATOR HAZARDOUS SUBSTANCES

Indicator hazardous substances (IHSs) were identified for the ARCO Terminal 21T site as part of the FFS using the criteria outlined in Washington Administrative Code (WAC) 173-340-708(2). The final list of IHSs for groundwater and soil are a subset of the contaminants detected at the site. The final soil IHSs are TPH-G, TPH-D, TPH-O, and free phase product. The final groundwater IHSs are dissolved copper, TPH-G, TPH-D, TPH-O, cPAHs, benzene, and free-phase product.

3.2 CLEANUP LEVELS

Groundwater and soil cleanup levels for the final IHSs were developed based on the industrial zoning of the site and the determination by Ecology that there is no current or planned future use of the groundwater for drinking water purposes. The remedial objectives for groundwater at the site are based on the protection of the adjacent surface waters and its ecosystems and to prevent dissolved petroleum hydrocarbons in the groundwater from migrating off site and impacting adjacent properties.

The subsurface soil action level for TPH at the primary areas of concern (Plant 1) of the site is set to meet the remedial objective of protecting surface water at the property boundaries and shorelines and is:

Total TPH	10,000 mg/kg

This TPH cleanup is also protective for other chemical constituents in petroleum product (i.e., BTEX).

The subsurface soil action level for TPH at the secondary areas of concern (Plant 2) of the site is set to meet the remedial objective of protecting surface water at the property boundaries by improving general groundwater conditions at the source, enhancing timely restoration of the impacted area through natural biodegradation, and is:

Total TPH	20,000 mg/kg

Groundwater cleanup levels were determined by Ecology to be surface water standards that are protective of aquatic organisms in the Duwamish River. These surface water standards are the adopted ambient water quality criteria (WAC 173-201A and Section 304 of the federal Clean Water Act). The category of ambient water quality standards selected as relevant and appropriate for the site are the chronic criteria for protection of aquatic organisms (WAC 173-201A-040). Surface water standards are not established for TPH; therefore, the groundwater cleanup levels for TPH-G, TPH-D, and TPH-O were selected as protective cleanup goals at this time. The following are the cleanup levels for the site groundwater:

Product	No Sheen
Benzene	0.071 mg/L
cPAHs	0.000031 mg/L
Copper	0.0029 mg/L
TPH-G	1.0 mg/L
TPH-D	10 mg/L
TPH-O	10 mg/L

Copper is attributable to off-site sources and is found throughout the groundwater beneath Harbor Island.

3.3 ARARS

The selected cleanup action will comply with federal, state and local ARARs. Applicable requirements are federal and state laws or regulations that legally apply to a hazardous substance, cleanup action, location, or other circumstance at the site. Relevant and appropriate requirements are those federal and state regulations that do not legally apply, but address situations sufficiently similar that they may warrant application to the cleanup action. Potential ARARs pertinent to remediation alternatives include substantive requirements of Chapters 70.94, 70.95, 70.105, 75.20, 90.48, and 90.58 RCW. Others are identified and defined in the FFS (Geraghty & Miller 1997) and they include the Model Toxics Control Act (WAC 173-340), the Washington State Dangerous Waste Regulations (WAC 173-303), Washington State Water Quality Standards for

Surface Water (WAC 173-201A), and laws requiring or authorizing local government permits or approvals for the remedial action implementation.

4.0 SUMMARY OF SELECTED CLEANUP ACTION

Site-specific cleanup action alternatives were developed and analyzed for groundwater and soil in the FFS (Volume II: Evaluation of Remedial Alternatives, Geraghty & Miller 1997), to ensure the protection of human health and the environment at the site.

Based on this initial screening and evaluation of supplemental data collected during the FFS, the following four alternatives were selected for further evaluation:

GW-1: Institutional Controls and Intrinsic Bioremediation/Natural Attenuation of Free-Phase Product (Product)

- Use Restrictions on Groundwater
- Intrinsic Bioremediation/Natural Attenuation of Product

S-1: Institutional Controls and Degradation of Organic Contaminants by Intrinsic Bioremediation/Natural Attenuation

- Deed Restrictions
- Degradation by Intrinsic Bioremediation/Natural Attenuation

GW-2: Pump and Treat for Product Plume Containment

- Use Restrictions on Groundwater
- Installation of Extraction Wells for Product Recovery
- Groundwater Treatment by Air Stripping and Optional Carbon Adsorption
- Effluent Discharge to POTW

S-2: Limited Excavation, Off-Site Treatment and Disposal, Limited In Situ Treatment, Gravel Cover

- Excavation of Accessible TPH Hot Spot Soils
- Off-Site Treatment - Low Temperature Thermal Desorption (LTTD) and/or Stabilization as Required
- Off-Site Disposal
- In-Situ Treatment of Inaccessible Soils - Biological and Vapor Extraction
- Gravel Cap

GW-3: Product Recovery (Skimming)

- Use Restrictions on Groundwater

- Installation of Recovery Wells within the Product Plume (without Groundwater Extraction)
- Disposal of Recovered Product

S-3: Limited Excavation, On Site Treatment and Disposal, Limited In Situ Treatment, Gravel Cover

- Excavation of Accessible TPH Hot Spot Soils
- On-Site Treatment - LTTD and/or Stabilization as Required
- On-Site Disposal of Treated Soil into Excavation
- In-Situ Treatment of Inaccessible Soils - Biological and Vapor Extraction
- Gravel Cover

GW-4: Pump and Treat for Product Plume and Dissolved Petroleum Hydrocarbon Containment, and Air Sparging and Vapor Extraction for Accelerated Mass Removal

- Use Restrictions on Groundwater
- Installation of Extraction Wells with Dual Functions for Product Recovery and Dissolved Petroleum Hydrocarbons
- Treatment by Air Stripping and Optional Carbon Adsorption
- Groundwater Treatment before Effluent Discharge to POTW
- Installation of Sparging and Vapor Extraction Wells to Accelerate Mass Removal

S-4: In-Situ Treatment and Gravel Capping

- In-Situ Treatment of Soils - Biological and Vapor Extraction
- Maintain Existing Warehouse Foundation Cap
- Restriction and Deed Restriction

4.1 Proposed Cleanup Alternatives

The proposed cleanup action for the site was selected based on a comparison of each cleanup action alternative with the following detailed MTCA evaluation criteria (WAC 173-340-360(2) and (3)), consideration of the MTCA remedy selection requirements and cleanup costs:

- Protection of Human Health and the Environment
- Compliance with Cleanup Standards
- Use of Permanent Solutions to the Maximum Extent Practicable
- Compliance with ARARs
- Provision for Compliance Monitoring
- Provision for Reasonable Restoration Time Frame

The following sections present a conceptual description of each element of the proposed cleanup action selected for the site. Detail descriptions with engineering drawings, specifications and justification will be presented in the Remedial Design phase for the site.

THE SELECTED REMEDIAL ALTERNATIVE (GW- 4, S-1, and S-2)

Remedial Alternative GW-4, one of the proposed alternatives in this CAP includes pump and treat for product plume and dissolved petroleum hydrocarbon recovery, air sparging and vapor extraction for accelerated mass removal of residual hydrocarbons in soil beneath the warehouse, maintaining the foundation cap for the warehouse, groundwater compliance monitoring, deed restrictions, institutional controls, and natural attenuation. The major features of this proposed cleanup alternative are presented on Figures 5 and 6. Given the limited access to the contaminated areas of primary concern beneath the warehouse building foundations of the ARCO site, this proposed cleanup action provides the most aggressive means of removing product, dissolved petroleum hydrocarbons, and residual TPH in the soil below the water table present in the warehouse area adjacent to the Duwamish River in comparison with the other cleanup actions evaluated.

A conceptual description of each element of this alternative and how it will be implemented at the site is presented below. Detailed descriptions with engineering drawings and justifications will be presented in the Remedial Design phase for the site:

Active Product Recovery. The focus of the remedial alternative includes the area beneath the warehouse and the areas immediately south, northeast, and north of the warehouse where free product is currently or has historically been detected in the subsurface. The estimated volume of the free product under the warehouse is approximately 14,000 gallons including 11,700 gallons recovered to date. As discussed in Section 2.1.2.1, hydrocarbon impact in the warehouse area along the waterfront provides the primary complete pathway for the IHSs to reach the Duwamish River (i.e., product migration and residual hydrocarbon migration from soil to groundwater and potentially to surface water). The cleanup action developed for groundwater at the ARCO Terminal is focused on removing product and the dissolved petroleum hydrocarbons from beneath the warehouse area along the waterfront and containing inland dissolved petroleum hydrocarbons within property boundaries. The cleanup action also includes remedial elements for mitigating residual hydrocarbons in soil from above and below the water table, which are associated with the product plume. The product plume and associated residual hydrocarbons in soil are potential on-going sources to the groundwater in this area and ultimately to the Duwamish River.

Pilot testing, as described below, was completed in January 1999. It provided additional information to evaluate the effectiveness and applicability of these elements for achieving the remedial objectives of removing free product and the dissolved petroleum hydrocarbons from the warehouse area along the waterfront. The results of the pilot testing will then be used to support the final design and configuration of the selected remedy (e.g., the final combination of remedial elements, number of wells, well spacing, etc.). The proposed conceptual remedy configuration that incorporates these technologies is depicted on Figures 5 and 6. A final remedy configuration will be presented in the Remedial Design for the site with complete engineering drawings, specifications, and justifications. The proposed expanded system has been conceptually designed to take advantage of the hanging wall conditions along the waterfront (comprised of the existing warehouse foundation and Island bulkhead) that restrict the flow of product to the Duwamish River (Figure 3).

A pilot test was conducted by installing a pumping well near the truck loading rack to determine if expansion of the current interim product recovery system is necessary to achieve the remedial objectives for product removal and dissolved petroleum hydrocarbon recovery. The data collected from the pilot test will then be used to support the design of the final groundwater treatment system in the Remedial Design phase.

Groundwater Treatment. Groundwater extraction will be used as part of the product skimming system to depress the water table and accelerate product movement toward the extraction wells (Figure 5). During this active product recovery, petroleum hydrocarbons dissolved in groundwater are usually recovered. The recovered groundwater will continue to be treated by air stripping to meet discharge limits prior to disposal.

Air Sparging & Natural Biodegradation of Residual TPH in the Subsurface Soil at the Shoreline. Pilot testing was conducted to determine the effectiveness of using air sparging technology for removing product from soil above and below the water table along the waterfront beneath the warehouse area. The air sparging pilot test was implemented immediately south of the warehouse to affect soils containing product in the zone of tidal fluctuation. The injection of air below the water level and into hydrocarbon-impacted soils accelerates the mobilization and recovery of the residual hydrocarbons. Results of a focused treatability studies conducted during the FFS shows the area beneath the warehouse to be deficient of oxygen necessary to support effective natural biodegradation of the petroleum hydrocarbons trapped along the shoreline. Therefore, the injection of air will elevate the oxygen levels (in this instance dissolved oxygen) and will improve conditions for aerobic hydrocarbon degradation within the saturated zone. Additionally, the air sparging reduces dissolved-phase hydrocarbon concentrations as the volatile constituents are stripped from the groundwater and captured by the SVE system described below. The pilot test results will be used to support the final design of a full-scale system for the warehouse area to meet the remedial objectives outlined in this CAP.

Soil Vapor Extraction (SVE) and Natural Biodegradation. The proposed cleanup action has been designed to continue operation of a soil vapor extraction (SVE) system installed as part of the interim remediation system to remove volatile hydrocarbons from the vadose zone beneath the warehouse next to the shoreline. Operation of the SVE system will continue to extract the volatile fraction of hydrocarbons present in the warehouse area (ensuring that the soil vapor to air pathway in the area of the product plume is interrupted). The SVE system will also maintain elevated oxygen concentrations within the vadose zone. Operation of the SVE and other technology based applications and systems in this CAP will be discontinued through performance, cleanup and technology standards evaluations as part of the Compliance Monitoring Program developed for the site. Details of the criteria and frequency for such evaluations for discontinuing the SVE and other technology based applications and systems for the site is developed as part of the attached compliance monitoring program, Exhibit F, for the ARCO site.

Product Monitoring. Throughout the site, including the inland areas, free product shall be removed from the water table to the extent practicable whenever present. Selected wells will be evaluated in the compliance groundwater monitoring program to monitor for product thickness as

part of the performance standard evaluation. The containment booms located in the Duwamish River adjacent to the site provide protection to contain petroleum hydrocarbons as a result of the sheen that reached the Duwamish River. The containment booms will be maintained as part of the compliance and performance monitoring program (Exhibit F).

Remedial Alternative S-1 is the second preferred alternative in this CAP to address the warehouse and inland inaccessible TPH soil hot spots. Institutional controls and degradation of organic contaminants by intrinsic bioremediation/natural attenuation, has been selected for inaccessible soils beneath the warehouse area and inland of the warehouse area for Plant 1 and for Plant 2 to ensure protection of the human health and the environment. This remedy is expected to be accelerated following implementation of the warehouse preferred remedy discussed above and the removal of the accessible TPH hot spot soils in Plants 1 and 2 as discussed below. A deed restriction will also be implemented to prevent inappropriate future use of the site.

Remedial Alternative S-2, is the third preferred alternative in this CAP, and addresses the inland accessible TPH soil hot spots. Remedial Alternative S-2 includes excavation of accessible TPH contaminated soil hot spots at the inland portions of Plant 1 and Plant 2. This will ensure that the primary and secondary concerns identified in this CAP are met.

Locations of Accessible Soil for Excavation and Approximate Volumes. The accessible TPH hot spot in Plant 1 will be excavated using the TPH action level of 10,000 mg/kg. The TPH hot spot in Plant 1 is located southeast of the site between the aboveground storage tanks 1, 8, 9, and 13 and are in the vicinity of soil borings B-17, B-20, B-21, B-23, TS-25, TS-26, TS-27, TS-36, TS-37, TS-39, TS-40, TS-40, TS-41 and TS-42. The total volume of this TPH hot spot is approximately 1100 cubic yards. The area is generally depicted in Figure 7. It is Ecology's expectation that this accessible TPH soil hot spot will be excavated without undermining the integrity of the aboveground storage tanks next to the hot spots.

There are two accessible TPH hot spot areas in Plant 2 that will require excavation using the TPH action level of 20,000 mg/kg. The first TPH hot spot is located in the northeast corner of the site at soil boring TS-1. The total volume of this TPH hot spot is approximately 5 cubic yards. The second TPH hot spot is located south and southeast of the site between the above storage tanks no. 59001 and 20001 and are in the vicinity of soil borings B-36, B-37, TS-12, TS-14, TS-15, TS-17, TS-19, TS-31, TS-32, TS-34 and TS-35. The area is generally depicted in Figure 8. The total volume of this TPH hot spot is approximately 600 cubic yards. It is Ecology's expectation that these accessible TPH soil hot spots will be excavated without undermining the integrity of the aboveground storage tanks next to the hot spot.

The excavated TPH soil hot spots in Plants 1 and 2 will be treated on/off site and disposed on/off site. Excavation of the accessible TPH soil hot spots will improve general groundwater conditions at the source, enhance restoration time for the impacted areas, and enhance bioremediation of the residual TPH contaminated soil left in place. In addition, the groundwater monitoring program will be implemented to monitor the ongoing intrinsic degradation/natural attenuation of the residual TPH in soils as part of the selected cleanup action. A deed restriction will also be implemented to

prevent inappropriate future use of the site. The total estimated costs for the selected remedies for soils and groundwater including costs to date is approximately $7.8 million.

4.2 Contingency Plans.

A contingency plan is a cleanup technology that serves as a "backup" remediation technology in the event that the Preferred Option fails or proves ineffective in a timely manner (5 years). The contingency plan and implementation criteria is included in the Compliance Monitoring Plan (Exhibit F of the Consent Decree) and summarized below.

Inland Groundwater Contingency Plan for Property Boundary Shall Include:

- Use migration control technology
- Enhance the chances of bioremediation by added nutrients as appropriate

Shoreline Contingency Plan Shall Include:

- Expand hydraulic control to ensure removal of free product from the water table
- Sediment and bioassay sampling as determined necessary through the groundwater compliance monitoring program

This contingency plan is outlined in detail in the Groundwater Monitoring Program, Exhibit F, of the Consent Decree.

4.3 Other Controls

Access Restrictions. The site is an active operating facility and has restricted access (fences, signs, work permit requirements) as part of standard operations. These restrictions are in place 24 hours/day and 7 days/week. The Access and Operating Procedures for the ARCO site is contained in Exhibit C of the Consent Decree.

Deed Restrictions. Institutional controls are measures undertaken to limit or prohibit activities that may interfere with the integrity of a cleanup action or result in exposure to hazardous substances at the site. Such measures are required to assure continued protection of human health and the environment when a cleanup action results in residual concentrations of IHS that exceed MTCA Methods A or B cleanup levels and where conditional points of compliance are established.

The site is currently an "industrial" site and is anticipated to be zoned and used as an industrial site in the foreseeable future. The proposed cleanup action for the site includes the implementation and maintenance of institutional controls to prevent future human exposure to the constituents present in the soil (including vapors) and groundwater beneath the Terminal. ARCO will add a restrictive covenant to the property to restrict the property use to industrial purposes or interfering with remedial actions implemented in this CAP. A copy of the Restrictive Covenant for the ARCO site is contained in Exhibit D of the Consent Decree.

Work Construction. Schedule to begin work under this proposed CAP and other construction activities for the Remedial Design are contained in Exhibit E of the Consent Decree. Work construction at the ARCO site will be conducted under a Safety and Health Plan prepared under WAC 173-340-810.

4.4 **Groundwater Compliance Monitoring**.

The attached groundwater compliance monitoring plan, Exhibit F, is consistent with WAC 173-340-410, and includes protection monitoring, performance monitoring, and confirmational monitoring. The three types of compliance monitoring to be conducted include the following:

- **Protection Monitoring** to confirm that human health and the environment are adequately protected during construction and the operation and maintenance period of the cleanup action.
- **Performance Monitoring** to confirm that the cleanup action has attained cleanup standards and other performance standards.
- **Confirmational Monitoring** to confirm the long-term effectiveness of the cleanup action once cleanup actions and other performance standards have been attained.

Points of Compliance: Soil. The determination of adequate soil treatment will be based on the remedial actions ability to comply with the groundwater cleanup standards for the site, to meet performance standards designed to minimize human health or environmental exposure to soils above cleanup levels, and to provide practicable treatment of contaminated soils. Performance standards designed to minimize human and environmental exposure to soils above the cleanup levels set for the site shall include: 1) Performance monitoring as outlined in the Groundwater Monitoring Program for the site and 2) a covenant on the property which limits the site to industrial use only and prohibits any activity which may interfere with the protectiveness of the remedial action.

Groundwater. The achievement of cleanup levels in groundwater shall be measured at points of compliance located within the product plume area and at the downgradient edge of the site. These points of compliance and performance shall consist of a network of monitoring wells located in the product plume area and on the downgradient property boundary. The exact location of these wells are identified in the attached Groundwater Compliance Monitoring Program, Exhibit F of the Consent Decree .

Product Monitoring. Throughout the site, including the inland areas, free product shall be removed from the water table to the extent practicable whenever present. Product occurrence or, if appropriate, product thickness, will be monitored at the inland and shoreline locations of the site as outlined in the groundwater monitoring program. Use of source identification and removal shall be used as needed to ensure that dissolved petroleum hydrocarbons associated with the free product do not adversely impact off site properties. The duration of the product

monitoring will be based on the performance and cleanup standards outlined in the attached Groundwater Compliance Monitoring Plan, Exhibit F, for the site.

5.0 JUSTIFICATION FOR THE SELECTED CLEANUP ACTION

The cleanup action, as proposed, is designed to accomplish the following requirements: protect human health and the environment, comply with cleanup standards per WAC 173-340-700, comply with applicable state and federal laws per WAC 173-340-710, provide compliance monitoring per WAC 173-340-410, use permanent solutions to the maximum extent practicable per WAC 173-340-360 (2), (3), (4), (5), (7), and (8), provide a reasonable time restoration per WAC 173-340-360 (6), and consider public concerns per WAC 173-340-600. The following sections discusses how the proposed cleanup action will meet these requirements.

Protection of Human Health and the Environment

Active product recovery at the shoreline will prevent free-phase migration of contamination into the Bay. Active groundwater treatment will capture and prevent the spread of dissolved petroleum hydrocarbons from migration into the Bay and expedite groundwater quality restoration. The air sparging technology will reduce dissolved-phase hydrocarbon concentrations below the water table as the volatile constituents are stripped from the groundwater and captured by the soil vapor extraction (SVE) system. The SVE system installed as part of the interim remediation system will continue to remove volatile hydrocarbons from the vadose zone beneath the warehouse next to the shoreline. Operation of the SVE system will continue to extract the available volatile fraction of hydrocarbons present in the warehouse area (ensuring that the soil vapor to air pathway in the area of the product plume is interrupted). The SVE system will also maintain elevated oxygen concentrations within the vadose zone and this will improve the general conditions for natural attenuation at the warehouse. Excavation of accessible inland petroleum hydrocarbon contaminated soil hot spots will improve general groundwater conditions at the source, enhance restoration time frame, and expedite natural biodegradation of the residual TPH contaminated soils left behind. Contingency plans coupled with monitoring wells by the shoreline and the property boundaries will provide additional protection by providing a means for a ‘backup’ remediation technology in case the Preferred Corrective Option proves ineffective.

Comply with Cleanup Standards per WAC 173-340 through 760

The overall goal of cleaning up groundwater for the protection of surface water quality and containing contaminated groundwater within property limits will be met. The goal of soil cleanup standards and action levels for petroleum hydrocarbons is to protect the beneficial use of groundwater (surface water quality and associated ecosystem) and to contain residual contamination within property boundaries. The selected remedy that includes air sparging to strip volatile petroleum hydrocarbons trapped in the residual soil from below the water table and active vapor extraction to capture the vapor phase interrupting the groundwater to soil to air pathways, and active product and dissolved petroleum hydrocarbons recovery from the smear zone and below, will result in substantive compliance with the soil cleanup standards by reducing

concentrations of contaminants in soils to levels that will support and maintain the attainment of groundwater quality standards under the warehouse. Excavation of accessible inland TPH soil hot spots will help improve the general groundwater quality at the TPH soil hot spots that act as sources of ongoing groundwater contamination, enhance groundwater quality restoration time frame, and expedite natural bioremediation of the residuals TPH left behind.

Use of Permanent Solutions to the Maximum Extent Practicable per WAC 173-340-360 (4), (5), (7), and (8).

Excavation of accessible TPH soil hot spots and treatment, product recovery, groundwater treatment, and petroleum vapor recovery are permanent treatment technologies that will effectively improve groundwater quality permanently and in a timely restoration time frame.

Compliance with Applicable State and Federal Laws per WAC 173-340-710.

The preferred alternative meets all state and federal laws. All activities carried out to implement the preferred alternative will meet any laws requiring or authorizing local government permits or approval for the remedial action on the site.

Provide Compliance Monitoring per WAC 173-340-410

The preferred alternative provides for long-term monitoring to ensure that groundwater continues to meet cleanup standards after remedial actions have been completed. During the remedial actions, performance monitoring will be conducted to confirm that cleanup actions have attained cleanup standards and treatment goals. After remedial actions, performance monitoring will be conducted to ensure and confirm that cleanup actions have attained cleanup standards and performance standards. Protection monitoring will be used to ensure that human health and the environment are being adequately protected during construction and operation of the cleanup actions. The specifics and details of these monitoring activities, locations, number and type of analytes, frequency, duration, and contingency plans are described in the attached Compliance Groundwater Monitoring Plan, Exhibit F, developed for the site. Schedule for this activity is contained in Exhibit E of the Consent Decree.

Provide for a Reasonable Restoration Time Frame per WAC 173-340-360 (6).

Natural attenuation with active excavation of accessible TPH soil hot spots (e.g., source control) will provide for a reasonable restoration time frame of 5 years for the site groundwater that is protective of the surface water and its ecosystem (primary concern) and protect adjacent properties (secondary concern).

In view of subsurface TPH soil hot spots that generate dissolved petroleum hydrocarbons in the groundwater above cleanup standards, Ecology believes that natural attenuation alone will not be sufficient to provide a reasonable restoration time frame for the site.

The projected 5-year restoration time frame is reasonable, and will allow for a meaningful statistical evaluation of compliance monitoring data and constitutes that time after the active

Preferred Options have been implemented. For the shoreline (beneath the warehouse), restoration time begins after free product is removed from the water table. The time projected for the free product removal under the warehouse is 18 months after installation and startup of the preferred option at the shoreline. If Contingency implementation for the shoreline is needed as a result of the groundwater compliance monitoring or other performance standards, restoration time begins immediately after contingency implementation activity.

Where contingency plan implementation is not necessary, restoration time for the site is 5 years and the restoration clock begins 30 days after implementation of the Preferred Corrective Option for the site. This is the time required to reduce residual TPH in the subsurface to reasonable levels and groundwater quality below state standards and to collect meaningful statistical data to evaluate groundwater compliance data.

Other specific time lines are outlined in Exhibit E, Schedule of Deliverables, and are detailed in the attached Compliance Groundwater Monitoring Program, Exhibit F, for the ARCO Site.

Consider Public Concerns per WAC 173-340-600

The public is given the opportunity to comment on this Final CAP during a 30-day public comment period. This review will include the following additional documents: Consent Decree, Restrictive Covenants, Project Schedule, and Groundwater Compliance and Contingency Program. The Remedial Design (RD) will be subject to a separate pubic comment period in the future. Ecology will consider all comments received. At the end of the comment period, Ecology will prepare a responsiveness summary listing each comment received and Ecology's response to the comment.

6.0 IMPLEMENTATION SCHEDULE

Exhibit E of the Consent Decree contains an outline of the schedule for the cleanup activities. The Consent Decree will become effective once signed by the Court. As outlined in the schedule, specifics on detailed analysis may be needed to complete the remedial design. Ecology has review and approval authority for these documents and the public has an opportunity to participate in each milestone through the 30-day public comment period.

7.0 REFERENCES

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FIGURES