Staton

SLR

January 9, 2008
Project 001.0173.00007

Mr. Kurt Peterson
Cascadia Law Group, PLLC
1201 Third Avenue, Suite 320
Seattle, Washington 98101

Re: **Revised Feasibility Study Report, Former Arco Service Station #0855, Longview, Washington**

Dear Kurt:

Based on the results of the previous investigation activities, SLR International Corp (SLR) conducted a feasibility study to develop and evaluate potential remedial actions at the above-referenced site, consistent with the Model Toxics Control Act Cleanup Regulation (MTCA; Chapter 173-340 WAC). The site is located at 4603 Ocean Beach Highway in Longview, Washington. The purpose of the remedial action is to reduce the petroleum hydrocarbon concentrations in the soil and groundwater to below the MTCA Method A cleanup levels.

This report was revised to incorporate the information requested by the Washington Department of Ecology (Ecology) in their letter to Wakefield Family LLC dated October 11, 2007.

PREVIOUS INVESTIGATION RESULTS

The results of the previous investigations showed that soil, unconfined shallow groundwater, and semi-confined deeper groundwater beneath the site contain petroleum hydrocarbon concentrations greater than the MTCA Method A cleanup levels. The unconfined groundwater occurs within a sandy fill unit and in laterally discontinuous sandy lenses within an underlying clayey silt unit. The groundwater table beneath the site area occurs at depths ranging from approximately 4 to 7.5 feet below ground surface (bgs). The semi-confined groundwater primarily occurs within a sand unit that is located beneath the clayey silt unit (at depths below approximately 20 feet bgs). The groundwater flow directions in the shallow water-bearing unit and in the semi-confined aquifer are inconsistent and there are flow components in several directions. There is a downward vertical gradient from the shallow water-bearing unit to the semi-confined aquifer, and the two units appear to be hydraulically connected.

The soil that contains petroleum hydrocarbons greater than the MTCA Method A cleanup levels initially occurs in the sandy fill and extends downward through the clayey silt unit to the saturated sand (at a depth of approximately 20 feet bgs). The hydrocarbon concentrations typically decrease with depth within the clayey silt unit; however, near the dispenser island (the primary contaminant source area), the benzene concentrations increase near the top of the underlying sand unit. The impacted soil occurs in the vicinity of the dispenser island, the abandoned underground dispenser lines, the former gasoline underground storage tanks (USTs), and the former waste oil and heating oil USTs. The lateral extents of the impacted soil have been effectively defined. The estimated areas of soil that contain petroleum hydrocarbon concentrations greater than the Method A cleanup levels are shown on Figure 1. The vertical extents of the impacted soil have been defined at all areas except the dispenser island area. Soil samples could not be collected below 25 feet bgs due to heaving sands in the borehole; however, based on the hydrocarbon concentrations near the top of the sand unit and the hydrologic conditions within the unit, SLR believes that the impacted soil does not extend more than 10 feet below the top of the sand unit.

The shallow groundwater that contains petroleum hydrocarbon concentrations greater than the MTCA Method A cleanup levels occurs beneath the dispenser island and extends up to approximately 40 feet in all directions from the dispenser island (Figure 2). Gasoline product (up to 0.24 feet thick in well MW-3) is present on the shallow groundwater beneath the northwestern end of the dispenser island. The lateral extents of the impacted shallow groundwater have been effectively delineated. The impacted shallow groundwater extends off-site to the northeast, beneath Washington Department of Transportation (WSDOT) property (including a localized portion of Ocean Beach Highway). The deep groundwater that contains petroleum hydrocarbon concentrations greater than the Method A cleanup levels occurs beneath the dispenser island and extends up to approximately 85 feet in all directions from the dispenser island (Figure 2). The lateral extents of the impacted deep groundwater have been effectively delineated. The impacted deep groundwater extends off-site to the northwest beneath the eastern corner of neighboring undeveloped land; to the north, northeast, and east beneath WSDOT property (including Ocean Beach Highway); and to the southeast beneath City of Longview property (including a localized portion of 46th Avenue). Since the potential sources of contamination at the site were removed in 1999, SLR believes that the lateral extents of the impacted shallow and deep groundwater have stabilized and that natural attenuation is likely preventing additional contaminant migration. The vertical extents of the impacted groundwater could not be defined because heaving sands prevented the installation of a well below approximately 25 feet bgs.

FEASIBILITY STUDY

Pursuant to the requirements of WAC 173-349-350(8) and WAC 173-340-360, SLR conducted a feasibility study to evaluate and select a remedial alternative that is the substantial equivalent of a cleanup conducted by or supervised by Ecology, in accordance with WAC 173-340-545(2). Based on the site and contaminant conditions described above, SLR screened several remediation technologies to identify applicable methods for remediating the impacted soil beneath the site and the impacted groundwater (shallow and deep) that occurs beneath the site and off-site. The remediation technologies were initially identified by using the Federal Remediation Technologies Roundtable's (FRTR's) Remediation Technologies Screening Matrix and Reference Guide[1], as well as our knowledge of commonly used remediation methods. We assessed the effectiveness and implementability of the technologies to remediate the impacted soil and groundwater, which resulted in a list of technologies that were retained for further consideration (Table 1). The retained technologies were combined to create the four remedial alternatives that are described below.

Due to the silty nature of most of the impacted soil, the relatively limited area of soil contamination, and the presence of impacted soil below the groundwater table, soil excavation is a component of all four remedial alternatives. Soil excavation would extend to a maximum depth of 15 feet bgs to ensure that the confining unit (clayey silt) would not be breached. A cross-sectional view (designated A-A') of the shallow geology and the proposed soil excavation near the dispenser island (applies to all four alternatives) is shown on Figure 3, and the location of the cross section is shown on Figure 4. A monitoring plan that outlines the proposed confirmation sampling program for the excavation activities is attached. Prior to excavation, all of the groundwater monitoring wells located within the areas of proposed excavation would be abandoned by a licensed well driller.

Since natural attenuation appears to be reducing the groundwater concentrations to below the Method A cleanup levels within 50 feet of the property line, we assumed that any active groundwater remediation would only occur near the source areas and would not be conducted off-site. Natural attenuation is a component of all four remedial alternatives. A monitoring plan that describes the proposed natural attenuation monitoring program for the recommended remedial alternative is attached.

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[1] Federal Remediation Technologies Roundtable, 2004. Remediation Technologies Screening Matrix and Reference Guide, Version 4.0. August.

Alternative 1 – Soil Excavation, Product Extraction, and Natural Attenuation

Alternative 1 consists of soil excavation, free product recovery from an open excavation, and natural attenuation of the groundwater contaminants in the shallow water-bearing zone and in the deeper semi-confined aquifer. The soil that contains petroleum hydrocarbon concentrations greater than the MTCA Method A cleanup levels would be excavated to a maximum depth of 15 feet bgs. The impacted soil at the dispenser island and the former gasoline UST area that occurs at depths below 15 feet bgs would be naturally remediated over time by leaching and biodegradation. An estimated total of approximately 4,000 tons of impacted soil would be excavated and hauled off-site for treatment or disposal at a licensed facility. The free product that collects on the shallow groundwater in the open excavation near the dispenser island would be extracted by using a vacuum truck. The recovered product would be hauled off-site for recycling at a licensed facility. The groundwater that was extracted during the product removal activities would be hauled off-site for treatment and disposal at a licensed facility. After product removal, the excavation near the dispenser island, as well as the other excavations, would be backfilled with clean, imported material and completed at ground surface with imported gravel.

Groundwater monitoring of the shallow water-bearing zone and the deeper semi-confined aquifer would be conducted over an estimated 15-year period to assess the groundwater impacts from the remaining soil contamination, and to monitor the natural attenuation of the groundwater contamination. After completing the remedial action (including the groundwater monitoring), institutional controls (a deed restriction) would be implemented, if necessary, to restrict access to any remaining soil beneath the site that contains petroleum hydrocarbon concentrations greater than the Method A cleanup levels.

Alternative 2 – Soil Excavation, Shallow Groundwater/Product Extraction, and Natural Attenuation

Alternative 2 consists of soil excavation, shallow groundwater and free product extraction from an open excavation, and natural attenuation of the remaining groundwater contaminants in the shallow water-bearing zone and in the deeper semi-confined aquifer. The soil that contains petroleum hydrocarbon concentrations greater than the MTCA Method A cleanup levels would be excavated to a maximum depth of 15 feet bgs. The impacted soil at the dispenser island and the former gasoline UST area that occurs at depths below 15 feet bgs would be naturally remediated over time by leaching and biodegradation. An estimated total of approximately 4,000 tons of impacted soil would be excavated and hauled off-site for treatment or disposal at a licensed facility. The free product that collects on the shallow groundwater in the open excavation near the dispenser island would be extracted by using a vacuum truck. The recovered product would be hauled off-site for recycling at a licensed facility. To remediate the shallow groundwater that contains the highest petroleum hydrocarbon concentrations, up to approximately 200,000 gallons of groundwater that collects in the excavation near the dispenser island would be extracted by using suction pumps. The recovered groundwater would be pumped into a temporary treatment system prior to discharge to the storm sewer system under an NPDES permit. The treatment system would consist of two 20,000-gallon sediment settling tanks in series, followed by two pairs of carbon-filled canisters in series. After the product and groundwater recovery, the excavation near the dispenser island, as well as the other excavations, would be backfilled with clean, imported material and completed at ground surface with imported gravel.

Groundwater monitoring of the shallow water-bearing zone would be conducted over an estimated 5-year period to evaluate the performance of the shallow groundwater remediation activities, to assess the groundwater impacts from the remaining soil contamination, and to monitor the natural attenuation of the remaining shallow groundwater contamination. Groundwater monitoring of the deeper semi-confined aquifer would be conducted over an estimated 10-year period to assess the groundwater impacts from the remaining soil contamination, and to monitor the natural attenuation of the deeper groundwater contamination. The deep groundwater monitoring period for Alternative 2 is less than the monitoring period for Alternative 1 because we believe that the primary source of the deep groundwater concentrations (impacted shallow groundwater near the dispenser island) would be actively remediated. After completing the remedial action (including the groundwater monitoring), institutional controls (a deed restriction) would be implemented, if necessary, to restrict access to any remaining soil beneath the site that contains petroleum hydrocarbon concentrations greater than the Method A cleanup levels.

Alternative 3 – Soil Excavation, Shallow Groundwater/Product Extraction, Deep Groundwater Recovery, and Natural Attenuation

Alternative 3 is the same as Alternative 2, except that it also includes active remediation of the deeper semi-confined aquifer and a shorter groundwater monitoring period. To remediate the groundwater in the deeper aquifer that contains the highest petroleum hydrocarbon concentrations, at least one deep groundwater recovery well would be installed near the dispenser island. The groundwater extracted from the well(s) would be pumped into a high capacity air stripper for treatment prior to discharge to the storm sewer system under an NPDES permit. Based on the hydrologic conditions of the deep aquifer and the relatively small area that contains the highest petroleum concentrations (near the dispenser island), we estimate that the deep groundwater recovery/treatment system would operate for up to 2 years. The deep groundwater recovery activities would enhance contaminant leaching within the saturated soil, which would at least partially remove the petroleum hydrocarbons from the impacted soil that occurs near the dispenser island at depths below 15 feet bgs. The soil concentrations that are not addressed by enhanced leaching would decrease over time by natural leaching and biodegradation.

Groundwater monitoring of the shallow water-bearing zone and the deeper semi-confined aquifer would be conducted for up to 5 years to evaluate the performance of the groundwater remediation activities, to assess the groundwater impacts from the remaining soil contamination, and to monitor the natural attenuation of the remaining groundwater contamination. After completing the remedial action (including the groundwater monitoring), institutional controls (a deed restriction) would be implemented, if necessary, to restrict access to any remaining soil beneath the site that contains petroleum hydrocarbon concentrations greater than the Method A cleanup levels.

Alternative 4 – Soil Excavation, Product Extraction, Chemical Oxidation of Shallow and Deep Groundwater, and Natural Attenuation

Alternative 4 is the same as Alternative 1, except that it includes active remediation of the shallow water-bearing zone and the deeper semi-confined aquifer, and a shorter groundwater monitoring period. To remediate the groundwater in the shallow water-bearing zone and the deeper semi-confined aquifer that contains the highest petroleum hydrocarbon concentrations, a mixture of two excellent oxidizing agents, ozone and hydrogen peroxide, would be injected into the shallow and deeper groundwater beneath the former dispenser island area. The ozone and peroxide mixture would oxidize the petroleum hydrocarbons in the groundwater to form carbon dioxide, water, and oxygen (O_2). For costing purposes, we assumed that a rented Applied Process Technology, Inc. (APT) PulseOx P-100 system would be installed near the eastern corner of the site to generate the ozone, mix the ozone and peroxide, and to force the mixture, via underground piping, through a total of 14, one-inch-diameter, steel injection points. Of the 14 injection points, 8 would be screened within the deeper semi-confined aquifer and 6 would be screened within the shallow water-bearing zone. Each shallow injection point would be constructed with a 10-foot-long screen that is installed from approximately 5 to 15 feet bgs. Each deep injection point would be constructed with a 5-foot-long screen that is installed at the top of the deep aquifer. The 6 shallow injection points would be spaced approximately 30 feet apart within the soil excavation area, and the 8 deep injection points would be spaced approximately 30 feet apart in the vicinity of the former dispenser island and in the northern part of the site. The close spacing of the injection points is based on the inconsistent groundwater flow directions beneath the site, the low groundwater flow velocities, and the degradation rate of the ozone/peroxide mixture (approximately 2 days).

The ozone/peroxide injection system would operate for a period of up to 1 year. The injection activities would oxidize the petroleum hydrocarbons on the remaining impacted soil near the top of the deep aquifer; however, it would not remediate the impacted soil that occurs between the bottom of the planned excavation (at 15 feet bgs) and the top of the deep aquifer. The soil concentrations that are not addressed by oxidation would decrease over time by natural leaching and biodegradation.

Groundwater monitoring of the shallow water-bearing zone and the deeper semi-confined aquifer would be conducted for up to 6 years to evaluate the performance of the groundwater remediation activities, to assess the groundwater impacts from the remaining soil contamination, and to monitor the natural attenuation of the remaining groundwater contamination. After completing the remedial action (including the groundwater monitoring), institutional controls (a deed restriction) would be implemented, if necessary, to restrict access to any remaining soil beneath the site that contains petroleum hydrocarbon concentrations greater than the Method A cleanup levels.

EVALUATION OF REMEDIAL ALTERNATIVES

Consistent with MTCA regulations and Ecology guidances, the four remedial alternatives were evaluated for effectiveness, implementability, and relative cost. The criteria are summarized below:

- The **effectiveness** of the alternative at reducing contaminant concentrations to levels protective of human health and the environment. Other factors used to evaluate effectiveness include the permanence of an alternative, the restoration time frame to comply with cleanup standards and applicable state and federal laws, and the consideration of public concerns.
- The technical and practical **implementability** of the alternative.
- The **cost** of the alternative.

Table 2 rates each alternative based on the evaluation criteria. A rating of 1 is the best and a rating of 4 is the worst.

Effectiveness

Alternative 3 is the most effective alternative due to the shortest time frame to remediate the groundwater, and a greater likelihood of protectiveness and permanence. Depending upon the rate of natural attenuation, Alternatives 3 and 4 would be completed in up to 5 years; however, there is more uncertainty with Alternative 4 due to the inability to control how the injected ozone/peroxide mixture would move within the subsurface, especially in the deep zone where a positive head could not be created by the injected fluid to allow for radial flow from each point. Depending upon the affect of shallow groundwater recovery on the deep groundwater concentrations, Alternative 2 would be completed in up to 10 years. Alternative 2 includes removal of impacted shallow soil and groundwater above the area of the highest petroleum concentrations in the deep groundwater and there is a downward vertical flow component from the shallow water-bearing zone to the deep semi-confined aquifer. We estimate that Alternative 1 would take up to 15 years to complete.

All four alternatives would protect human health and the environment through soil excavation, product removal, and natural attenuation; however, the active deep groundwater remediation component of Alternatives 3 and 4 would partially remove the deeper soil contamination (a source of impacted deep groundwater) by enhanced leaching or oxidization, respectively, while Alternatives 1 and 2 would only address the deep soil contamination through natural leaching and biodegradation over time. Alternative 2 is considered more protective than Alternative 1 due to the extraction of the shallow groundwater from the excavation. All four alternatives include groundwater monitoring to ensure protection of human health and the environment over time (permanence).

Implementability

Since the site is vacant, all four alternatives are relatively easy to implement. Due to the presence of the site structures and nearby sidewalks and roads, the soil excavation component of each alternative would be the most difficult to implement. Since the planned excavation work is the same for each alternative and Alternatives 2, 3, and 4 also include the installation of a groundwater treatment system or a groundwater oxidation system, Alternative 1 is rated the easiest to implement and Alternatives 2, 3, and 4 are rated more difficult. For Alternatives 2, 3, and 4, the groundwater treatment or oxidation systems will operate for up to 1 month, 2 years, and 1 year, respectively. Based on the durations of system operation, Alternative 2 is rated less difficult to implement than Alternative 3 and 4, and Alternative 4 is rated less difficult to implement than Alternative 3.

Cost

Alternative 1 is the least expensive alternative ($531,000) and Alternative 4 ($721,000) is the most expensive alternative. The estimated costs for Alternative 2 and Alternative 3 are $543,000 and 692,000, respectively. Alternative 3 costs $29,000 less than Alternative 4 and there is more certainty of the effectiveness of Alternative 3. In comparison with

Alternative 1, Alternative 3 is not disproportionate in cost when considering the increased effectiveness of the cleanup. In comparison with Alternative 2, Alternative 3 may be disproportionate in cost if the shallow impacted groundwater is the primary source of the impacted deep groundwater, and that removal of the impacted shallow soil and groundwater allows the deep groundwater concentrations to attenuate to below the MTCA Method A cleanup levels in less than 10 years. A summary of the capital and operation/maintenance costs of each alternative is shown in Table 3.

For cost estimating purposes, we assumed that Alternative 1 would include 1 initial year of quarterly groundwater monitoring, 1 year of semiannual monitoring, 12 years of annual monitoring, and 1 final year of quarterly monitoring. We assumed that Alternative 2 would include 1 initial year of quarterly groundwater monitoring, 1 year of semiannual monitoring, 7 years of annual monitoring, and 1 final year of quarterly monitoring. We assumed that Alternative 3 would include 1 initial year of quarterly groundwater monitoring, 1 year of semiannual monitoring, 2 years of annual monitoring, and 1 final year of quarterly monitoring. Alternative 4 would include 1 initial year of quarterly groundwater monitoring, 1 year of semiannual monitoring, 3 years of annual monitoring, and 1 final year of quarterly monitoring. Based on the degree of certainty of effectiveness, the Alternative 3 cost estimate includes a 10% contingency cost while the Alternative 4 estimate includes a 15% contingency cost, and the Alternative 1 and Alternative 2 estimates include a 20% contingency cost.

RECOMMENDED ALTERNATIVE

Based on the comparative evaluation of the four alternatives, Alternative 2 is the recommended alternative; however, this recommendation includes a contingency to potentially implement Alternative 3. Alternative 2 is roughly the same cost as Alternative 1 and is more effective due to a shorter restoration time and a greater likelihood of protectiveness. Alternative 2 is considered less effective than Alternatives 3 and 4; however, it costs $149,000 and $178,000 less than Alternatives 3 and 4, respectively, and it is easier to implement. The higher costs for Alternatives 3 and 4 may be disproportionate to the increased effectiveness if the removal of the impacted shallow soil and groundwater allows the deep groundwater concentrations to naturally attenuate to below the MTCA Method A cleanup levels in less than 10 years (greater effectiveness of Alternative 2 than anticipated).

Alternative 2 includes groundwater monitoring to evaluate the effectiveness of the remedial action and the rates of natural attenuation. If the average benzene and GRO concentrations in the deep monitoring well located near the former dispenser island have not decreased by at least 50 percent after two years of monitoring, then we recommend installing and operating a deep groundwater recovery/treatment system (Alternative 3) to extract the groundwater with the highest petroleum concentrations and to enhance the leaching of petroleum from the deeper soil. We selected Alternative 3 instead of Alternative 4 because it is more effective due to greater certainty of protectiveness for the deep groundwater.

If you have any questions, please call me at (425) 402-8800.

Sincerely,

SLR International Corp

Michael D. Staton, L.G.
Principal Geologist

Attachments: Limitations
Tables 1, 2, and 3
Figures 1, 2, 3, and 4
Monitoring Plan

cc: Tom Middleton, Washington Department of Ecology

LIMITATIONS

The services reflected in this report were performed consistent with generally accepted professional consulting principals and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This information is solely for the use of our client unless otherwise noted. Any reliance on this information by a third party is at such party's sole risk.

Opinions and recommendations contained herein apply to conditions existing when services were performed and are intended only for the client, purposes, location, timeframes, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

Table 1 —Technology Screening Summary
Former Arco Service Station #0855
Longview, Washington

TECHNOLOGY CATEGORY	IDENTIFIED TECHNOLOGY	TECHNOLOGY RETAINED FOR USE IN ALTERNATIVES
SOIL		
Ex-Situ Treatment / Disposal	Soil Excavation	Yes
	Biological Treatment including Biopile/Composting and Bioreactors	No
	Off-Site Landfill Disposal	Yes[1]
	Chemical Extraction	No
	Chemical Reduction/Oxidation	No
	Soil Washing	No
	Electrokinetic Separation	No
	Incineration	No
	Thermal Desorption	No
	Asphalt Incorporation	Yes[1]
	Cement Incorporation	Yes[1]
In-Situ Treatment, Including Containment	Containment	No
	Enhanced Bioremediation	No
	Bioventing	No
	Phytoremediation	No
	Soil Vapor Extraction	No
	Thermally Enhanced Extraction	No

Table 1 —Technology Screening Summary
Former Arco Service Station #0855
Longview, Washington

TECHNOLOGY CATEGORY	IDENTIFIED TECHNOLOGY	TECHNOLOGY RETAINED FOR USE IN ALTERNATIVES
GROUNDWATER		
Containment	Slurry Walls and Sheet Pile Walls	No
	Hydraulic Control	No
In-Situ Treatment	Enhanced Bioremediation	No
	Chemical Oxidation	Yes
	Natural Attenuation	Yes
	Air Sparging	No
	Bioslurping (Dual-Phase Extraction)	No
	Phytoremediation	No
	Groundwater/Product Extraction and Treatment	Yes
	Thermal Treatment	No
	Passive/Reactive Treatment Walls	No
	Groundwater Circulation Wells	No
	Passive Product Skimming	No
Ex-Situ Treatment/Disposal	Off-Site Treatment and Disposal or Recycling	Yes
	Oil/Water Separation	No
	Carbon Adsorption	Yes
	UV Oxidation	No
	Air Stripping	Yes

[1] To be used only if cost competitive with other off-site treatment/disposal options.

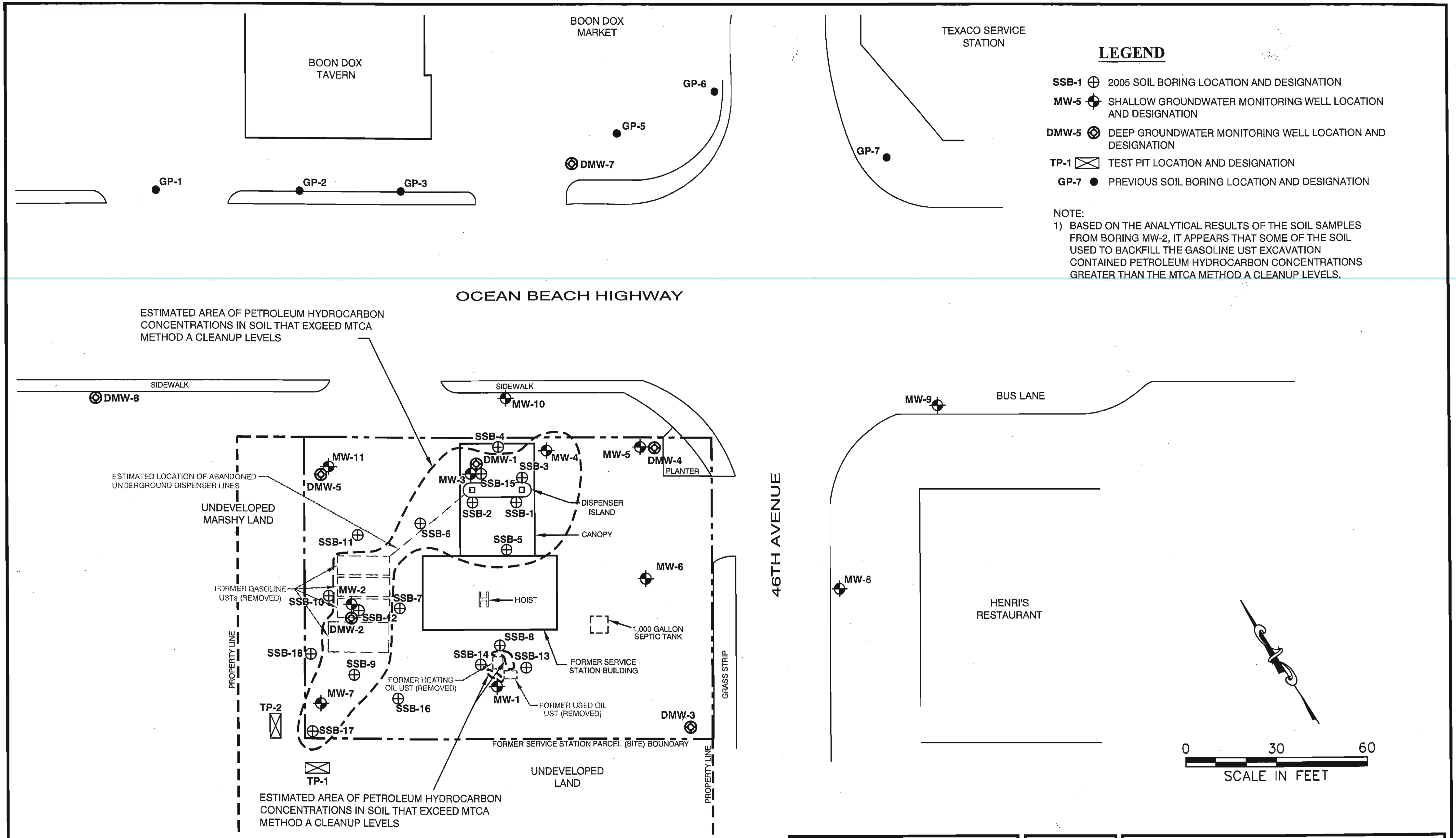
Table 2
Summary of Remedial Alternatives Evaluation
Former Arco Service Station #0855
Longview, Washington

	EVALUATION CRITERIA					
	Effectiveness				**Implementability**	**Cost**
REMEDIAL ALTERNATIVES	Protectiveness	Permanence	Restoration Time Frame	Consideration of Public Concerns	Technical and Administrative Implementability	Cost
Alternative 1 - Soil Excavation, Product Extraction, and Natural Attenuation	4	1	3	TBD	1	1
Alternative 2 - Soil Excavation, Shallow Groundwater/Product Extraction, and Natural Attenuation	3	1	2	TBD	2	2
Alternative 3 - Soil Excavation, Shallow Groundwater/Product Extraction, Deep Groundwater Recovery, and Natural Attenuation	1	1	1	TBD	4	3
Alternative 4 - Soil Excavation, Product Extraction, Chemical Oxidation of Shallow and Deep Groundwater, and Natural Attenuation	2	1	1	TBD	3	4

Notes: TBD = To be determined.
Scale Definition: 1 = best, 4 = worst

Table 3
Summary of Estimated Costs
Former Arco Service Station #0855
Longview, Washington

Alternative	Capital Cost	Monitoring and O&M Cost	Total Cost
Alternative 1 - Soil Excavation, Product Extraction, and Natural Attenuation	$381,000	$150,000	$531,000
Alternative 2 - Soil Excavation, Shallow Groundwater/Product Extraction, and Natural Attenuation	$404,000	$139,000	$543,000
Alternative 3 - Soil Excavation, Shallow Groundwater/Product Extraction, Deep Groundwater Recovery, and Natural Attenuation	$476,000	$216,000	$692,000
Alternative 4 - Soil Excavation, Product Extraction, Chemical Oxidation of Shallow and Deep Groundwater, and Natural Attenuation	$571,000	$150,000	$721,000



LEGEND

SSB-1 ⊕	2005 SOIL BORING LOCATION AND DESIGNATION
MW-5 ⊕	SHALLOW GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
DMW-5 ◎	DEEP GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
TP-1 ☒	TEST PIT LOCATION AND DESIGNATION
GP-7 ●	PREVIOUS SOIL BORING LOCATION AND DESIGNATION

NOTE:
1) BASED ON THE ANALYTICAL RESULTS OF THE SOIL SAMPLES FROM BORING MW-2, IT APPEARS THAT SOME OF THE SOIL USED TO BACKFILL THE GASOLINE UST EXCAVATION CONTAINED PETROLEUM HYDROCARBON CONCENTRATIONS GREATER THAN THE MTCA METHOD A CLEANUP LEVELS.

SLR
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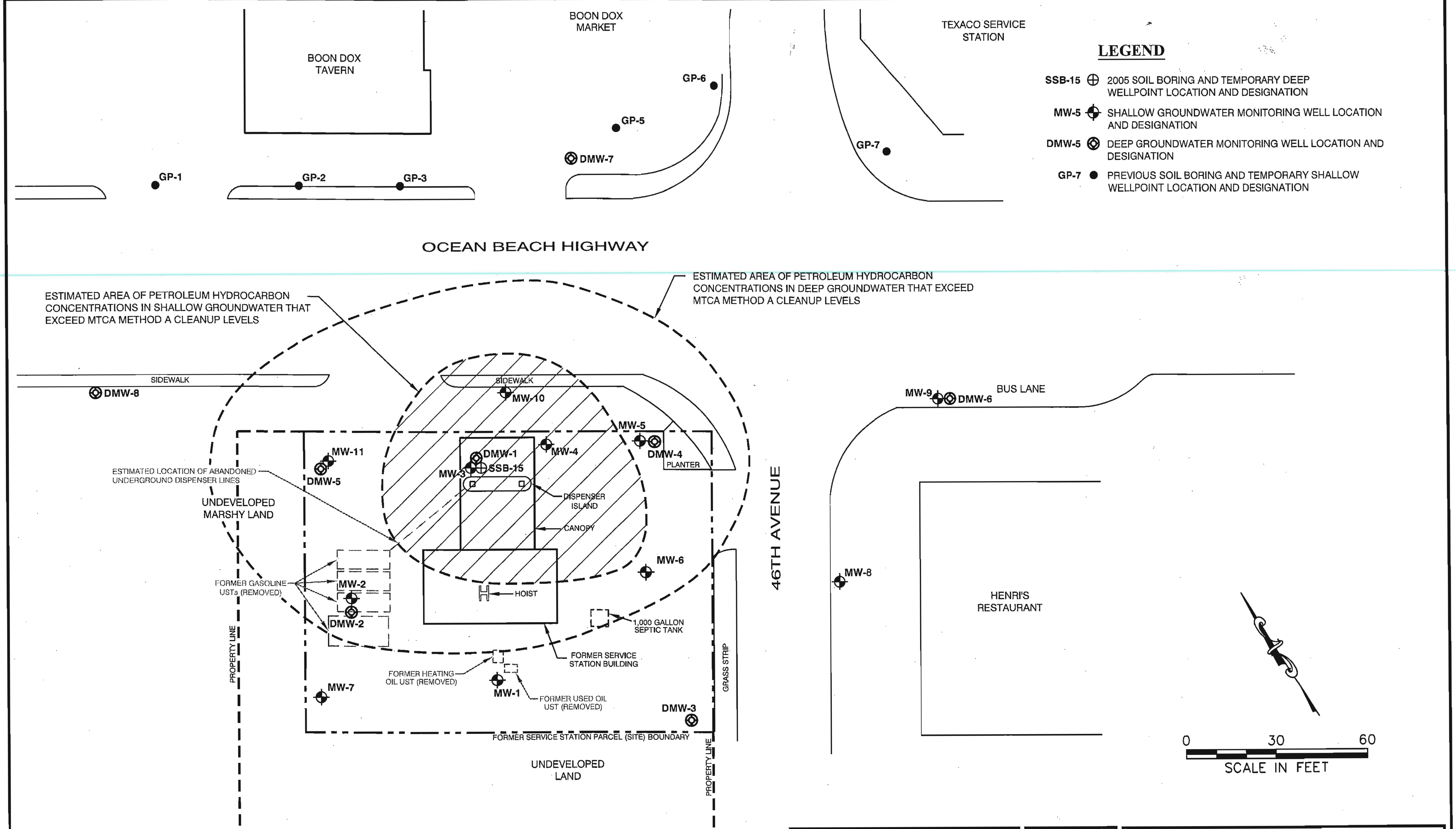
DATE 10/06
DWN. BDT
APPR. MDS
REVIS.
PROJECT NO.
001.0173.00003

FIGURE 1
FORMER ARCO SERVICE STATION #0855
4603 OCEAN BEACH HIGHWAY
LONGVIEW, WASHINGTON
ESTIMATED AREAS OF HYDROCARBON-IMPACTED SOIL



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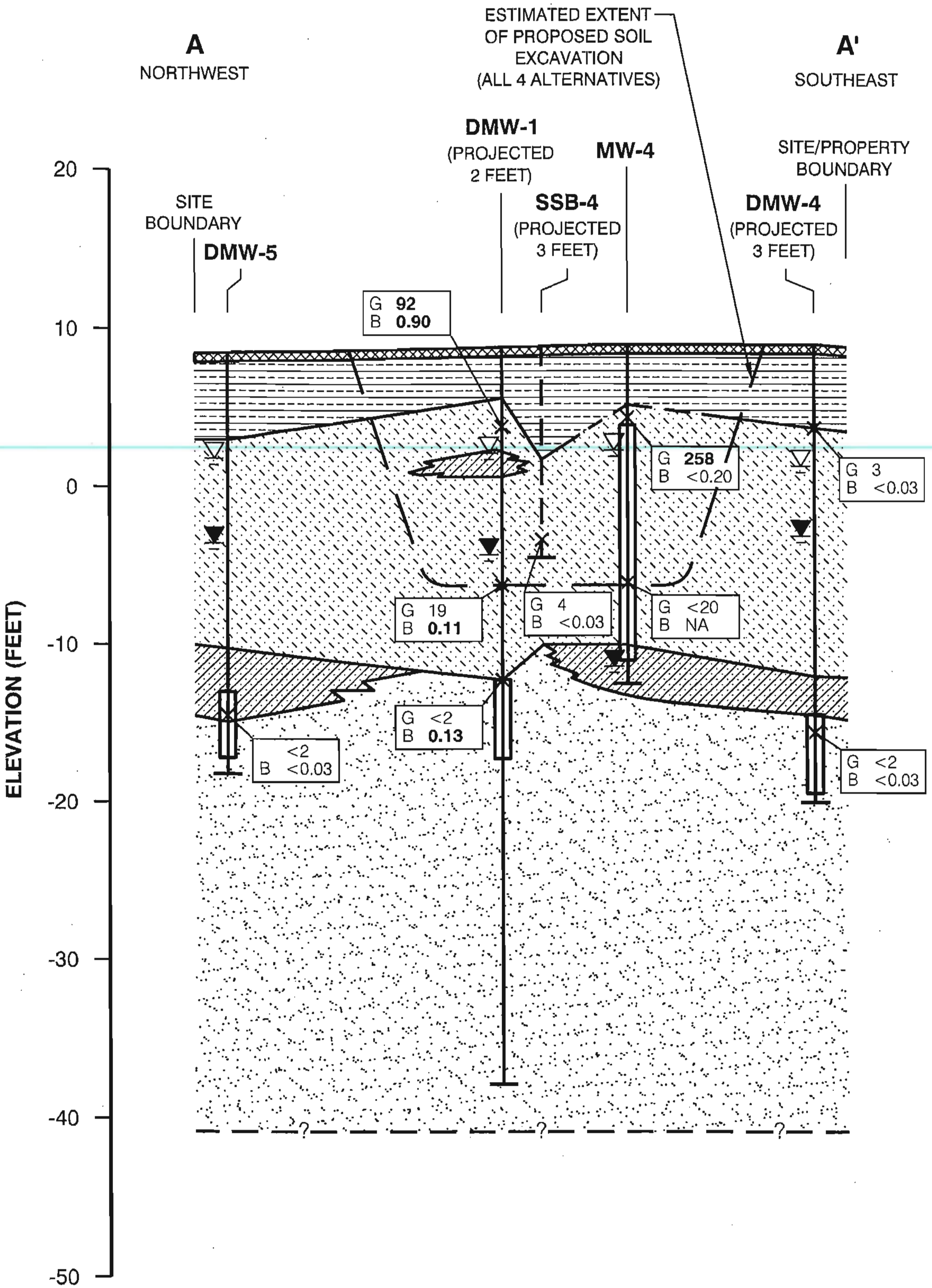
001.0173.00003

FIGURE 2
FORMER ARCO SERVICE STATION #0855
4603 OCEAN BEACH HIGHWAY
LONGVIEW, WASHINGTON
ESTIMATED AREAS OF HYDROCARBON-IMPACTED SHALLOW AND DEEP GROUNDWATER



LEGEND

— — — INFERRED LITHOLOGIC CONTACT

MW-5 MONITORING WELL LOCATION AND DESIGNATION

MONITORING WELL SCREEN LOCATION

SSB-4 SOIL BORING LOCATION AND DESIGNATION

▽ GROUNDWATER LEVEL IN WELL ON AUGUST 16, 2006

▼ GROUNDWATER LEVEL AT TIME OF DRILLING

× SOIL SAMPLE LOCATION

▩ ASPHALT OR CONCRETE

▤ FILL (Silty SAND or Gravelly SAND)

░ Clayey SILT (MH)

▨ Sandy SILT (ML)

░ SAND (SW)

G 19 B **0.11**	G = GASOLINE-RANGE ORGANICS CONCENTRATION IN MILLIGRAMS PER KILOGRAM (mg/kg) B = BENZENE CONCENTRATION IN mg/kg

CONCENTRATIONS IN BOLD EXCEED THE CURRENT MTCA METHOD A CLEANUP LEVELS.

0 30 60
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

NOTES:
1. CROSS SECTION LOCATION IS SHOWN ON FIGURE 4.

2. ELEVATIONS ARE RELATIVE TO NAVD 88 DATUM.

SLR
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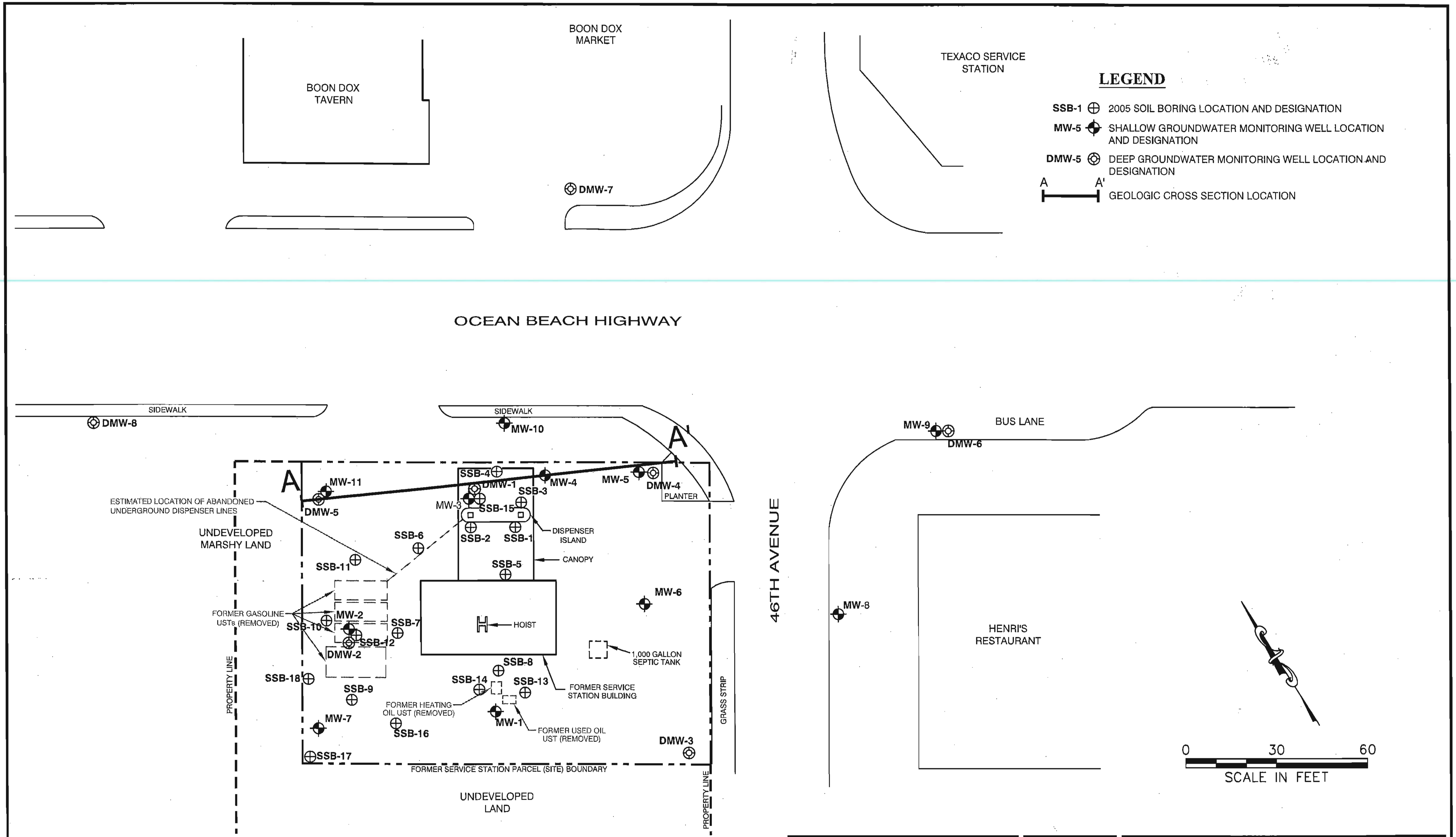
DATE 02/07
DWN. BDT
APPR. MDS
REVIS.
PROJECT NO.
001.0173.00005

FIGURE 3
FORMER ARCO SERVICE STATION #0855
4603 OCEAN BEACH HIGHWAY
LONGVIEW, WASHINGTON

CROSS SECTION A-A'

C:\DRIVE_E\Clients\SLR\001\001.0173.00005\01-03.dwg, 2/13/2007 6:53:19 PM, BDT



SLR

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001.0173.00005

FIGURE 4

FORMER ARCO SERVICE STATION #0855
4603 OCEAN BEACH HIGHWAY
LONGVIEW, WASHINGTON

LOCATION OF GEOLOGIC CROSS SECTION A-A'

C:\DRIVE_E\Clients\SLR\001\001.0173.00005\01-04.dwg, 2/13/2007 6:59:24 PM, BDT

MONITORING PLAN

CONFIRMATION SOIL SAMPLING

The lateral and vertical extents of each soil excavation will be based on soil sample analytical results; however, the vertical extent of any excavation will not extend below 15 feet below ground surface (bgs) under any condition. During the excavation activities, SLR International Corp (SLR) personnel will screen the excavated soil for the presence of petroleum hydrocarbons by using visual appearance, odors, and a photoionization detector (PID). When the excavated soil contains no visible evidence of contamination (e.g., staining, sheen), contains slight or no petroleum-like odors, and exhibits PID readings below 50 parts per million (ppm), SLR will inform the excavation contractor to discontinue excavating at that location.

SLR personnel will collect soil samples from the lateral and vertical extents of each excavation. This systematic sampling will be performed by establishing a grid over the entire site and collecting soil samples at the center of each grid cell and from any sidewalls that occur within each grid cell. The anchor point for the grid will be marked at the northern corner of the temporary chain-link fence that surrounds the site to establish the starting point for the X-axis and Y-axis coordinates of the grid. The X-axis coordinates will be named using letters (starting with "A") and the Y-axis coordinates will be named using numbers (starting with "1"). The grid nodes will be surveyed at intervals equal to or less than 25 feet (each grid cell will cover an area of up to 625 square feet), and where accessible, labeled flags and wooden stakes will be used to mark and identify the grid nodes.

The excavation floor samples will be discrete samples collected from the center of each excavated grid cell. The sidewall samples will be discrete samples collected on up to approximately 25-foot centers. Each sidewall sample will be collected in the area closest to the center of the excavated grid cell. The depths of the sidewall samples will be based on the depths of the excavations. For areas of the excavations that extend to depths of less than 10 feet bgs, the sidewalls samples will be collected at a depth immediately above the high seasonal groundwater table (approximately 3 to 5 feet bgs). For areas of the excavations that extend deeper than 10 feet, two sidewall samples will be collected from each excavated grid cell. The samples will be collected at a depth immediately above the high seasonal groundwater table and at a depth of approximately 10 feet bgs.

The excavation soil samples will be submitted to a Washington Department of Ecology (Ecology)-accredited laboratory for quantitative chemical analysis. All of the samples will be analyzed for benzene, toluene, ethyl benzene, and total xylenes (BTEX) by EPA Method 8021B, and for gasoline-range organics (GRO) by Ecology Method NWTPH-Gx. The samples collected from the area to the west of the former gasoline tank basin will also be analyzed for diesel-range organics (DRO) by Ecology Method NWTPH-Dx (after silica gel/sulfuric acid cleanup). The samples collected from the former used oil tank and heating oil tank area will also be analyzed for DRO and heavy oil-range organics (HO) by Ecology Method NWTPH-Dx (after silica gel/sulfuric acid cleanup). Any samples that contain detected DRO or HO concentrations will also be analyzed for polycyclic aromatic hydrocarbons (PAHs) by EPA Method 8270C.

If a floor sample that is collected at a depth of less than 15 feet bgs contains petroleum concentrations greater than the Model Toxics Control Act (MTCA) Method A cleanup levels, then the sampled grid cell will be deepened by up to 2 feet and re-sampled. If a sidewall sample contains petroleum concentrations greater than the Method A cleanup levels, then the wall of the sampled grid cell will be extended laterally by up to 5 feet and re-sampled. Each excavation will not be completed until the final floor and sidewall samples, except for possibly the 15-foot-deep floor samples, contain petroleum concentrations below the Method A cleanup levels.

NATURAL ATTENUATION MONITORING

After backfilling the excavations, a licensed well driller will install two shallow perched groundwater monitoring wells and two deeper semi-confined aquifer wells within the areas of excavation to replace the previously abandoned wells. The shallow wells will be installed near previous shallow wells MW-2 and MW-3, and the deep wells will be installed near previous deep wells DMW-1 and DMW-2 (see Figure 1 of the report). The wells will be constructed similar to the existing shallow and deep wells. The well installation activities will be conducted under the direction of an SLR geologist.

After installation of the wells, groundwater monitoring will be conducted at the site to evaluate the performance of the excavation activities and to monitor the natural attenuation of the groundwater contamination. This monitoring plan will follow Ecology's Guidance on Remediation of Petroleum-Contaminated Groundwater by Natural Attenuation, dated July 2005. Groundwater monitoring will be conducted on a quarterly basis for the first year, on a semiannual basis for the second year, and then on an annual basis until the groundwater concentrations in all of the shallow and/or deep wells are below the MTCA Method A cleanup levels for two consecutive annual events. Groundwater monitoring of the shallow and/or deep wells would then be conducted on a quarterly basis to determine if the concentrations are below the Method A cleanup levels for four consecutive quarters. If the concentrations are below the Method A cleanup levels for four consecutive quarters, then the monitoring of the shallow and/or deep wells would be discontinued. If concentrations exceed the Method A cleanup levels, then the monitoring program will be continued. SLR would determine the sampling frequency based on the analytical results.

Each semiannual sampling event will be conducted during a period of high seasonal groundwater elevations and a period of low seasonal groundwater elevations. The annual events will be conducted during the period of year that has the greatest average groundwater concentrations in the on-site wells.

To evaluate natural attenuation of groundwater contamination, Ecology recommends monitoring the groundwater conditions (contaminant and geochemical indicator concentrations) within established groundwater flow paths. Within each flow path, groundwater samples should be collected from: an upgradient non-impacted (background) well, a well located within the source area, two wells near the contaminated plume center line that contain concentrations greater than cleanup levels, and a non-impacted downgradient well. Since the flow directions in the shallow perched groundwater zone or in the deeper semi-confined aquifer beneath the site area are not consistent, it will be difficult to establish consistent flow paths. Therefore, all of the on-site and off-site shallow and deep wells (total of 16 wells) will be sampled during the first year of quarterly monitoring. Based on the sampling results from the first year of monitoring, SLR will submit a letter to Ecology that proposes a set of wells to effectively monitor natural attenuation over time.

During each monitoring event, SLR will measure the depths to groundwater and free product, if present, in all of the shallow and deep groundwater monitoring wells to evaluate the flow directions and to try to verify that the free product was effectively removed during the remediation activities. The wells to be sampled will be purged by using a peristaltic pump or disposable bailers. During purging, field instruments will be used to measure dissolved oxygen, redox potential, pH, specific conductivity, temperature, and dissolved ferrous iron. The groundwater samples will be submitted to an Ecology-accredited laboratory for quantitative chemical analysis. The samples will be analyzed for BTEX by EPA Method 8021B, GRO by Ecology Method NWTPH-Gx, DRO by Ecology Method NWTPH-Dx (after silica gel/sulfuric acid cleanup), sulfate by EPA Method 375.2, nitrate by EPA Method 353.2, dissolved manganese by EPA Method 200.8, alkalinity by EPA Method 310.1, and dissolved methane by EPA Method RSK 175.

After completing the quarterly sampling events during the first year of monitoring, SLR will model the analytical data in accordance with the Ecology's Natural Attenuation Analysis Tool Package for Petroleum-Contaminated Groundwater. The modeling results will be used to evaluate if the shallow and deep groundwater plumes are shrinking, stable, or expanding, to calculate the attenuation rates, and to identify the wells that would be sampled during the subsequent monitoring events.

After two years of groundwater monitoring, the groundwater concentrations in the samples from the deep well near the former dispenser island will be evaluated to assess the affects of the remediation activities on the deep groundwater conditions. The average benzene and GRO concentrations in the samples collected from the well during 2009 will be compared with the benzene and GRO concentrations in the sample collected from the well in December 2007. If the average benzene and GRO concentrations in the 2009 samples are not less than 50 percent of the December 2007 concentrations, then a groundwater recovery/treatment system would be installed to extract the deep groundwater that contains the highest petroleum concentrations and to enhance the leaching of petroleum from the remaining impacted soil at depths below 15 feet bgs. Prior to system installation, a work plan that describes the proposed groundwater recovery/treatment system and the system operations would be submitted to Ecology for review.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PROCEDURES

Quality Assurance Objectives

The overall QA objective is to ensure data of known and acceptable quality. All measurements will be made to yield accurate and precise results representative of the media and conditions measured. All data will be calculated and reported in units consistent with those used by regulatory agencies to allow comparability of data. QA objectives for precision, accuracy, and completeness have been established for each measurement variable, where possible. These are presented in Tables 1 and 2.

Analytical Procedures

The analytical methods for the proposed soil and groundwater analyses are summarized in Table 1. Analysis of the samples will be performed by using the procedures based on the following methods:

- **Ecology Method NWTPH-Gx**: GRO by purge and trap or direct injection, and gas chromatography/flame ionization detection (GC/FID) (Ecology, 1997)
- **Ecology Method NWTPH-Dx**: DRO and HO (soil only) by GC/FID (Ecology, 1997). A silica gel cleanup step will be used on all soil and groundwater samples.
- **EPA Method 8021B**: BTEX by GC/PID (EPA, 1986)
- **EPA Method 8270C**: PAHs (soil only) by GC/MS – select ion monitoring (SIM) for soil and GC/MS – high volume injection (HVI) for water (EPA, 1986)

- **EPA Method 375.2**: Sulfate (groundwater only) by ion chromatography (IC) (EPA 1986)

- **EPA Method 353.2**: Nitrate (groundwater only) by IC (EPA, 1986)

- **EPA Method 200.8**: Dissolved manganese (groundwater only) by ICPMS (EPA, 1986)

- **EPA Method 310.1**: Alkalinity (groundwater only) by titration (EPA, 1986)

- **EPA Method RSK 175**: Dissolved methane (groundwater only) by GC/FID (EPA, 1986)

Method detection limits (MDLs) or laboratory-specified practical quantitation limits (PQLs) for each analytical method are provided in Table 1. Where there is no known PQL, or the laboratory cannot specify a PQL in advance of sample analysis, Ecology may assume a factor of 10 times the method detection limit (Ecology, 1993). Data reporting requirements for all analyses are presented below.

To achieve the lower limits of detection required by the data quality objectives, special analytical methods may be used. Any special analytical methods employed will be determined with laboratory concurrence prior to beginning sample analysis.

Field measurements of dissolved oxygen (Method 360.1), redox potential (Eh; Standard Method 2580B), pH (Method 150.1), conductivity (Method 120.1), temperature (Method 170.1), and dissolved ferrous iron (by Standard Method 3500) will be performed according to EPA and standard methods (EPA, 1983; APHA, 1992) where applicable, and to instrument manufacturers' instructions (see Table 2).

Laboratory QA/QC

The Ecology-accredited laboratory will follow the analytical protocols specified by the methods identified above. The laboratory will be required to submit summary data and QA information to permit independent and conclusive determination of data quality. The determination of data quality will be performed using *Laboratory Data Validation Guidelines for Evaluating Inorganic Analyses* (EPA, 1994a) and *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses* (EPA, 1994b), as guidelines for data review.

Laboratory deliverable requirements for the chemical analyses will include the information outlined below and in Table 3.

- A cover letter for each sample batch that includes a summary of any quality control, sample, shipment, or analytical problems, and documentation of all internal decisions. Problems will be outlined and final solutions documented. A copy of the signed chain-of-custody form for each batch of samples will be included in the narrative packet.

- Sample concentrations reported on standard data sheets in proper units and to the appropriate number of significant figures. For undetected values, the lower limit of detection for each compound will be reported separately for each sample. Dates of sample extraction or preparation and analysis must be included.

- A method blank summary will be included.

- Surrogate percent recovery will be calculated and reported.

- Duplicate sample analytical results will be included.

- Matrix spike/matrix spike duplicate (MS/MSD) percent recoveries, spike level, and relative percent difference will be included.

- A list of the detection limits calculated for the laboratory instruments for all compounds will be included.

Sample holding times will be calculated by comparing the date of sample collection (shown on the chain of custody) with the date of sample analysis. All laboratory deliverables will be reviewed for validation of chemical analyses. The main items for review are described in Table 4.

Data Assessment Procedures

Accuracy, precision, completeness, representativeness, and comparability are terms used to assess the quality of analytical data. Accuracy is a measure of the bias in a measurement system and is determined by comparing a measurement with an accepted reference or true value. Precision is a measure of the reproducibility of analyses under a given set of conditions and is determined by measuring the scatter of a group of measurements made at the same specified conditions around their average. Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that could be expected to be obtained under "normal" conditions. Representativeness expresses the degree to which sampling data accurately and precisely represent selected characteristics. Comparability is an expression of the confidence with which one data set can be compared to another.

Routine procedures to be used for measuring precision and accuracy include use of replicate analyses, standard reference materials (SRMs), matrix spikes, and procedural blanks as specified in the analytical method references. Replicate matrix spikes and method blanks will be analyzed by the laboratory. Additional spikes and replicate analyses may be implemented. The minimum frequencies are specified in the analytical method references and as noted below (**Note: A sample batch is a maximum of 20 samples**).

- **Replicate analysis**
    - Benzene and GRO — 5 percent of groundwater samples will be analyzed as matrix spike duplicates.
    - Benzene and GRO — one groundwater sample per sampling event, at a maximum frequency of 10 percent, will be analyzed as a laboratory duplicate.
- **Matrix Spike**
    - Benzene and GRO — one sample per sample batch will be spiked with selected target analytes and analyzed in duplicate.
- **Method blank**
    - Benzene and GRO — one method blank will be analyzed for each groundwater sampling batch.
- **Laboratory control sample (LCS) or standard reference material (SRM)**
    - Benzene and GRO—one LCS will be analyzed per sample batch.

Quality of analytical data represented by precision and accuracy are calculated by using the mean, standard deviation, and percent recoveries. The mean, C, of a series of replicate measurements of concentration, C_i, for a given analyte will be calculated as:

$$\overline{C} = \frac{1}{n} \sum_{i=1}^{n} C_i$$

where:

n = Number of replicate measurements.

The estimate of precision of a series of replicate measurements can be expressed as the relative standard deviation, RSD:

$$RSD = \frac{SD}{\overline{C}} \ x\ 100\%$$

where:

SD = Standard deviation:

$$SD = \sqrt{\frac{\sum_{i=1}^{n} (C_i - \overline{C})^2}{(n - 1)}}$$

Alternatively, for data sets with a small number of points (e.g., duplicate measurements), the estimate of precision will be expressed as a relative percent difference (RPD):

$$RPD = \frac{C_1 - C_2}{\overline{C}} \; x \; 100$$

where:

C_1 = First concentration value or recovery value measured for a variable
C_2 = Second concentration value or recovery value measured for a variable.

Accuracy, as measured by matrix spike or laboratory control sample results, will be calculated as:

$$Recovery = \frac{\Delta C}{C_s} \; x \; 100$$

where:

ΔC = The measured concentration increase due to spiking (relative to the unspiked portion)
C_s = The known concentration increase in the spike

Accuracy can also be measured by analysis of standard reference material or regional reference material, and will be determined by comparing the measured value with the 95 percent confidence interval established for each analyte.

Completeness will be measured for each set of data received by dividing the number of valid measurements actually obtained by the number of valid measurements that were planned.

REFERENCES

APHA. 1992. *Standard Methods for the Examination of Water and Wastewater, 20th Edition.* American Public Health Association. Washington, D.C.

Ecology. 1993. Implementation Memo No. 3. PQLs as Cleanup Standards. Department of Ecology Toxics Cleanup Program. November 24, 1993.

Ecology. 1997. Analytical Methods for Petroleum Hydrocarbons. Publication No. ECY 97-602. June.

EPA. 1983. *Methods for Chemical Analysis of Water and Wastes.* EPA Environmental Monitoring and Support Laboratory Office of Research and Development, Cincinnati, Ohio.

EPA. 1986. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* SW-846, Third Edition.

EPA. 1994a. *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses.* EPA Data Review Work Group.

EPA. 1994b. *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses.* EPA Data Review Work Group.

Table 1

Objectives for Measurement Data – Chemical Analyses
Former Arco Service Station #0855
Longview, Washington

Variable	Units	Lower Limit of Detection	Accuracy[a] (%)	Precision[a] (%)	Completeness (%)	Method No.[b]	Bottle/Preservative	Maximum Holding Time[c]
SOIL								
DRO and HO	mg/kg	DRO: 50[d] HO: 250[d]	70-127 70-127	20 20	95 95	NWTPH-Dx, with silica gel cleanup (3630C)	8-oz. glass jar, PTFE lined lid; keep on ice (4°C)	14 days/40 days
GRO	mg/kg	2[d]	61-153	20	95	NWTPH-Gx	40 ml vial, PTFE lined silicon septum cap; keep on ice (4°C), freeze or analyze within 48 hours	14 days
Benzene	µg/kg	20[d]	66-121	20	95	8021B	40 ml vial, PTFE lined silicon septum cap; keep on ice (4°C), freeze or analyze within 48 hours	14 days
Toluene	µg/kg	20[d]	72-128	20	95	8021B	40 ml vial, PTFE lined silicon septum cap; keep on ice (4°C), freeze or analyze within 48 hours	14 days
Ethylbenzene	µg/kg	20[d]	69-132	20	95	8021B	40 ml vial, PTFE lined silicon septum cap; keep on ice (4°C), freeze or analyze within 48 hours	14 days
Total Xylenes	µg/kg	60[d]	69-131	20	95	8021B	40 ml vial, PTFE lined silicon septum cap; keep on ice (4°C), freeze or analyze within 48 hours	14 days
PAHs	µg/kg	10[d]	57-130[e]	20[e]	95	8270C – SIM	8-oz glass jar, PTFE lined lid; keep on ice (4°C)	14 days/40 days

Table 1

Objectives for Measurement Data – Chemical Analyses
Former Arco Service Station #0855
Longview, Washington

GROUNDWATER								
DRO	mg/L	DRO: 0.25	67-141	20	95	NWTPH-Dx, with silica gel cleanup (3630C)	One 1-L amber glass bottle, PTFE lined lid; HCL to pH<2; keep on ice (4°C)	14 days/40 days
GRO	mg/L	0.10	69-134	20	95	NWTPH-Gx	Two 40-ml vials, PTFE lined silicon septum cap; HCl to pH <2; fill completely with no headspace; keep on ice (4°C)	14 days (7 days if unpreserved)
Benzene	μg/L	1.0	65-118	20	95	8021B	Two 40-ml vials, PTFE lined silicon septum cap; HCl to pH <2; fill completely with no headspace; keep on ice (4°C)	14 days (7 days if unpreserved)
Toluene	μg/L	1.0	72-122	20	95	8021B	Two 40-ml vials, PTFE lined silicon septum cap; HCl to pH <2; fill completely with no headspace; keep on ice (4°C)	14 days (7 days if unpreserved)
Ethylbenzene	μg/L	1.0	73-126	20	95	8021B	Two 40-ml vials, PTFE lined silicon septum cap; HCl to pH <2; fill completely with no headspace; keep on ice (4°C)	14 days (7 days if unpreserved)
Total Xylenes	μg/L	3.0	74-118	20	95	8021B	Two 40-ml vials, PTFE lined silicon septum cap; HCl to pH <2; fill completely with no headspace; keep on ice (4°C)	14 days (7 days if unpreserved)
Dissolved manganese	μg/L	1.0	70-130	20	95	200.8	One 1-L HDPE bottle; preserved with HNO_3 to pH<2 (field filled); keep on ice (4°C)	6 months/6 months
Sulfate	mg/L	0.40	±10	20	95	375.2	One 1-L HDPE bottle; unpreserved; keep on ice (4°C)	28 days
Nitrate	mg/L	0.20	±10	20	95	353.2	One 1-L HDPE bottle; unpreserved; keep on ice (4°C)	48 hours

Table 1

Objectives for Measurement Data – Chemical Analyses
Former Arco Service Station #0855
Longview, Washington

Alkalinity	mg/L as $CaCO_3$	5.0	±10	20	95	310.1	One 1-L HDPE bottle; unpreserved; keep on ice (4°C)	14 days
Dissolved methane	µg/L	0.78	±20	25	95	RSK 175	Two 40-ml vials, PTFE lined silicon septum cap; fill completely with no headspace; keep on ice (4°C)	14 days

NOTES

[a] Accuracy and precision results may deviate from these criteria as identified by the analytical method reference on a substance-specific basis.

[b] Method numbers and analytical methods are from EPA, 1986 (200.8, 300.0, 310.1, 6020, 8021B, 8270C, and RSK 175) and Ecology, 1997 (NWTPH-Dx, NWTPH-Gx).

SIM = select ion monitoring. HVI = high-volume injection.

[c] Where two times are given, the first refers to the maximum time from sample collection to extraction, the second to the maximum time prior to extract analysis.

[d] Dry-weight basis.

[e] Widest/greatest QC limits listed; accuracy and precision limits will vary based on PAH compound.

Table 2

Objectives for Measurement Data — Field Analyses
Former Arco Service Station #0855
Longview, Washington

Variable	Units	Lower Limit of Detection	Accuracy[a] (%)	Precision[a] (%)	Completeness (%)	Method	Method No.[b]	Bottle	Maximum Holding Time
GROUNDWATER									
Dissolved oxygen	mg/L	0.05	±15	±15	95	Probe	360.1	500-mL beaker or flow-through cell	Immediate
Redox potential (Eh)	mV	--	±15	±15	95	Probe	SM 2580B	500-mL beaker or flow-through cell	Immediate
pH	Su	0.01	±10	±10	95	Probe	150.1	500-mL beaker or flow-through cell	Immediate
Conductivity	µS/cm	5	±10	±10	95	Probe	120.1	500-mL beaker or flow-through cell	Immediate
Temperature	°C	0.5	±10	±10	95	Probe	170.1	500-mL beaker or flow-through cell	Immediate
Dissolved ferrous iron	mg/L	1.0	±10	±10	95	Color wheel	SM 3500	500-mL beaker or flow-through cell	Immediate

[a] Accuracy and precision results may deviate from these criteria as identified by the analytical method reference.

[b] Method 120.1, 150.1, 170.1, 360.1 from EPA (1983); Standard Method 2580B and Standard Method 3500 from EPA (1986).

Table 3

Laboratory Deliverables Requirements
Former Arco Service Station #0855
Longview, Washington

The following items will be delivered to support data validation:

- A transmittal letter and case narrative which includes information about receipt of the samples, the analytical results, and any significant problems in any aspect of sample analysis (e.g., deviation from methodologies or quality control parameters)
- Sample analytical results:
    - Groundwater results in mg/L or µg/L
    - Soil results in mg/kg or µg/kg dry-weight
    - Method detection limit for undetected values reported for each analyte on a sample-by-sample basis
    - Date of sample preparation/extraction
    - Date of sample analysis
- Method blank results, including the samples associated with each blank
- Surrogate recovery results for analyses, reported as percent recoveries, including actual spike levels
- Duplicate results for 8021B and NWTPH-G_x analyses
- Matrix spike/matrix spike duplicate (MS/MSD) results and matix spike (MS) results for 8021B and NWTPH-G_x analyses, reported as percent recoveries, including actual spike levels
- Copies of signed chain-of-custody forms

Table 4

Data Validation of Chemical Analyses
Former Arco Service Station #0855
Longview, Washington

The following items will be reviewed for data validation:

- Holding times
- Method blank results
- Equipment rinsate blank results
- Surrogate recovery results
- Field duplicate results
- Laboratory duplicate results
- Matrix spike/matrix spike duplicate (MS/MSD) results
- Matrix spike (MS) results
- Completeness
- Reported method detection limits
- Laboratory control sample results
- Copies of signed chain-of-custody forms