SLR

February 22, 2007
Project 001.0173.00005

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

Re: **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.

## 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

Department of Ecology (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.

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.

**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

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

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,

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.

quarterly monitoring. We assumed that Alternative 2 would include 2 years of semiannual groundwater monitoring, 7 years of annual monitoring, and 1 year of quarterly monitoring. We assumed that Alternative 3 would include 2 years of semiannual groundwater monitoring, 2 years of annual monitoring, and 1 year of quarterly monitoring, and that Alternative 4 would include 2 years of quarterly monitoring and 3 years of annual 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 $150,000 and $184,000 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 deep groundwater concentrations in the wells located near the dispenser island have not decreased by at least 50 percent after two years of semiannual 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.

# 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<br>Former Arco Service Station #0855<br>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<br>Former Arco Service Station #0855<br>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**

| REMEDIAL ALTERNATIVES | EVALUATION CRITERIA | | | | | |
|---|---|---|---|---|---|---|
| | Effectiveness | | | | Implementability | Cost |
| | 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 | $108,000 | $504,000 |
| **Alternative 2 - Soil Excavation, Shallow Groundwater/Product Extraction, and Natural Attenuation** | $404,000 | $112,000 | $516,000 |
| **Alternative 3 - Soil Excavation, Shallow Groundwater/Product Extraction, Deep Groundwater Recovery, and Natural Attenuation** | $476,000 | $190,000 | $666,000 |
| **Alternative 4 - Soil Excavation, Product Extraction, Chemical Oxidation of Shallow and Deep Groundwater, and Natural Attenuation** | $570,000 | $130,000 | $700,000 |

BOON DOX TAVERN

BOON DOX MARKET

TEXACO SERVICE STATION

GP-1 GP-2 GP-3 GP-5 GP-6 GP-7 DMW-7

## 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.

OCEAN BEACH HIGHWAY

ESTIMATED AREA OF PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL THAT EXCEED MTCA METHOD A CLEANUP LEVELS

SIDEWALK DMW-8

SIDEWALK MW-10

MW-9 BUS LANE

SSB-4 DMW-1 SSB-3 MW-4 MW-5 DMW-4 PLANTER

MW-11 DMW-5 MW-3 SSB-15 DISPENSER ISLAND

ESTIMATED LOCATION OF ABANDONED UNDERGROUND DISPENSER LINES

UNDEVELOPED MARSHY LAND

SSB-2 SSB-1 SSB-6 SSB-5 CANOPY

SSB-11 MW-6

FORMER GASOLINE USTs (REMOVED) MW-2 SSB-10 SSB-7 HOIST

SSB-12 DMW-2 1,000 GALLON SEPTIC TANK

PROPERTY LINE SSB-8 SSB-18 SSB-14 SSB-13 FORMER SERVICE STATION BUILDING

SSB-9 FORMER HEATING OIL UST (REMOVED)

MW-7 SSB-16 MW-1 FORMER USED OIL UST (REMOVED)

TP-2 DMW-3 GRASS STRIP

SSB-17

FORMER SERVICE STATION PARCEL (SITE) BOUNDARY

TP-1

UNDEVELOPED LAND

PROPERTY LINE

ESTIMATED AREA OF PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL THAT EXCEED MTCA METHOD A CLEANUP LEVELS

46TH AVENUE

MW-8

HENRI'S RESTAURANT

0 30 60

SCALE IN FEET

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DATE 10/06
DWN. BDT
APPR. [illegible]
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**

BOON DOX TAVERN

BOON DOX MARKET

TEXACO SERVICE STATION

GP-1 GP-2 GP-3 GP-5 GP-6 GP-7 DMW-7

## LEGEND

- SSB-15 ⊕ 2005 SOIL BORING AND TEMPORARY DEEP WELLPOINT LOCATION AND DESIGNATION
- MW-5 ⊕ SHALLOW GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
- DMW-5 ⊚ DEEP GROUNDWATER MONITORING WELL LOCATION AND DESIGNATION
- GP-7 ● PREVIOUS SOIL BORING AND TEMPORARY SHALLOW WELLPOINT LOCATION AND DESIGNATION

OCEAN BEACH HIGHWAY

ESTIMATED AREA OF PETROLEUM HYDROCARBON CONCENTRATIONS IN SHALLOW GROUNDWATER THAT EXCEED MTCA METHOD A CLEANUP LEVELS

ESTIMATED AREA OF PETROLEUM HYDROCARBON CONCENTRATIONS IN DEEP GROUNDWATER THAT EXCEED MTCA METHOD A CLEANUP LEVELS

SIDEWALK

DMW-8

SIDEWALK

MW-10

MW-9

DMW-6

BUS LANE

MW-5

DMW-4

PLANTER

MW-11

DMW-5

DMW-1

SSB-15

MW-3

MW-4

ESTIMATED LOCATION OF ABANDONED UNDERGROUND DISPENSER LINES

UNDEVELOPED MARSHY LAND

DISPENSER ISLAND

CANOPY

MW-6

FORMER GASOLINE USTs (REMOVED)

MW-2

DMW-2

HOIST

1,000 GALLON SEPTIC TANK

FORMER SERVICE STATION BUILDING

PROPERTY LINE

FORMER HEATING OIL UST (REMOVED)

MW-7

MW-1

FORMER USED OIL UST (REMOVED)

DMW-3

GRASS STRIP

FORMER SERVICE STATION PARCEL (SITE) BOUNDARY

UNDEVELOPED LAND

PROPERTY LINE

46TH AVENUE

MW-8

HENRI'S RESTAURANT

0 30 60

SCALE IN FEET

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DATE 09/06
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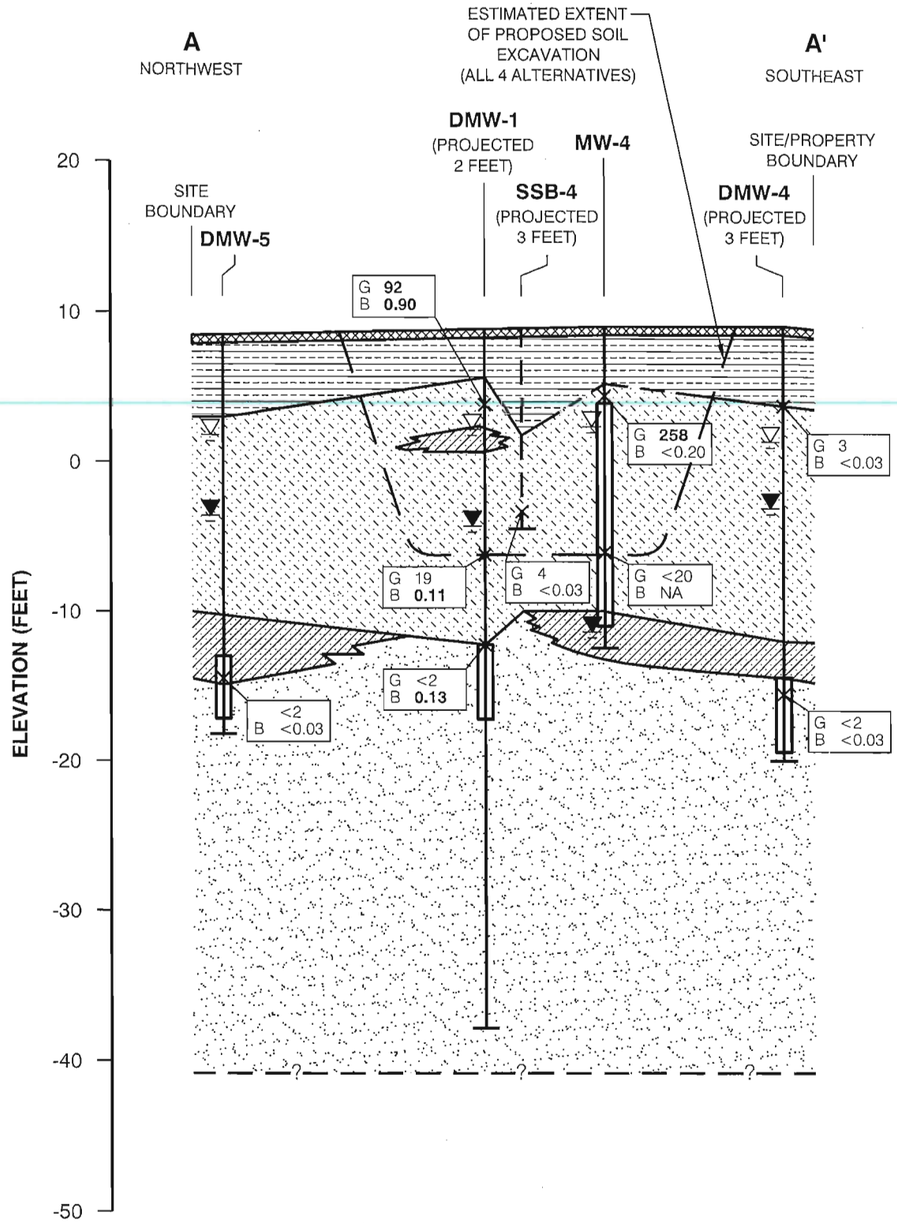
APPR. MDS
REVIS.
PROJECT NO. 001.0173.00003

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.

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001.0173.00005

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

**CROSS SECTION A-A'**

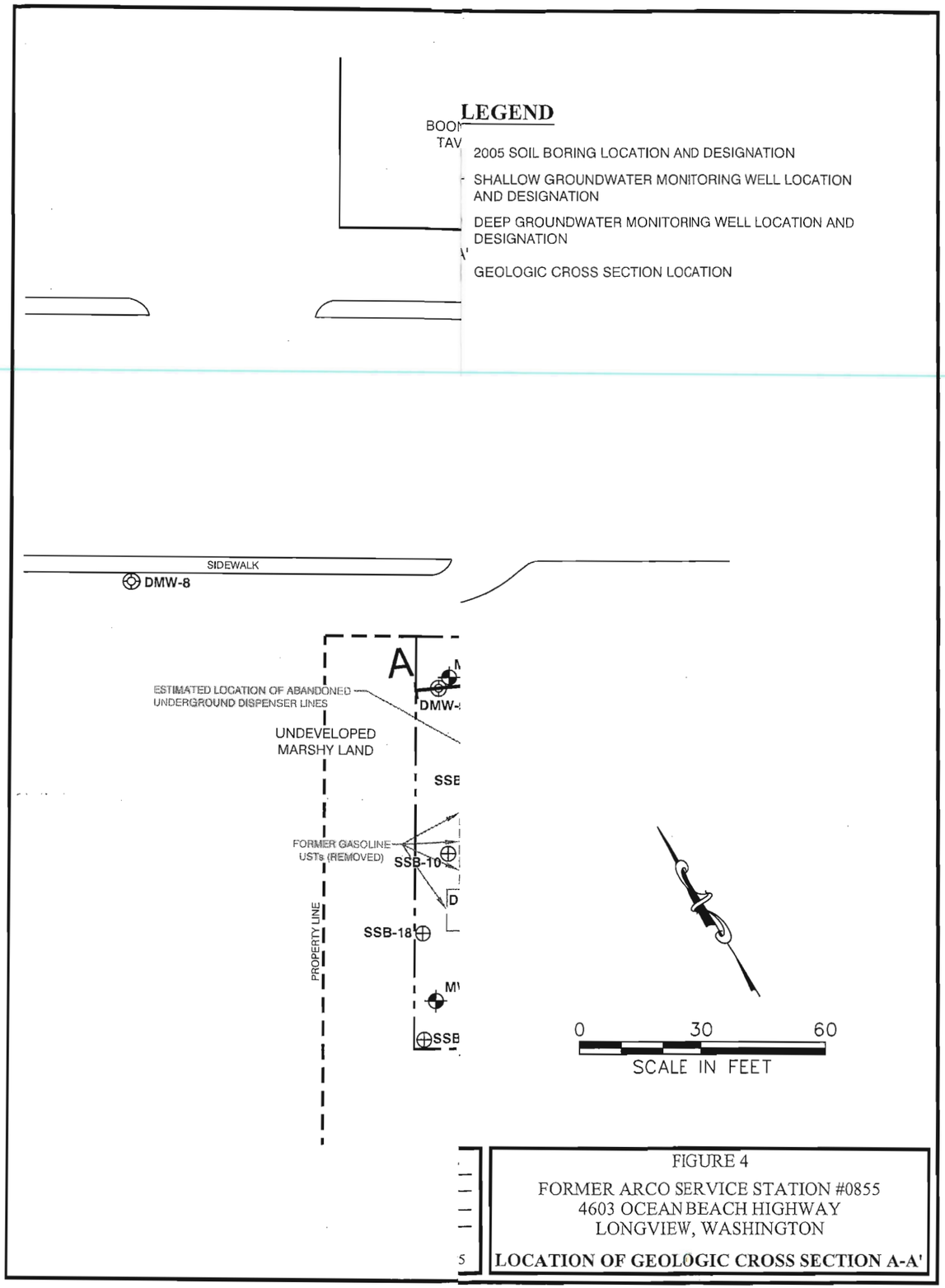


FIGURE 4

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

**LOCATION OF GEOLOGIC CROSS SECTION A-A'**

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