ARCADIS U.S., Inc.
1100 Olive Way
Suite 800
Seattle
Washington
Tel 206.325.5254
Fax 206.325.8218
www.arcadis-us.com

ENVIRONMENT

David L. South
Senior Engineer
Washington State Department of Ecology
Toxics Cleanup Program, NWRO
3190 160th Avenue Southeast
Bellevue, Washington 98008-5452

Soil Vapor Investigation Work Plan, 2013
Former Unocal Edmonds Bulk Fuel Terminal
11720 Unoco Road
Edmonds, Washington 98020

Date:
September 26, 2013

Contact:
Scott Zorn

Phone:
206.726.4709

Email:
Scott.Zorn@arcadis-us.com

Our ref:
B0045362.0004

Dear Mr. South:

On behalf of Chevron Environmental Management Company (Chevron), ARCADIS U.S., Inc. (ARCADIS) has prepared this Soil Vapor Investigation Work Plan (work plan) for the Lower Yard of the Former Unocal Edmonds Bulk Fuel Terminal (the Site). This Report is being submitted under Agreed Order (AO) No.DE 4460 which requires the Union Oil Company of California (Unocal), a wholly owned indirect subsidiary of the Chevron Corporation, to conduct additional Site characterization activities that will be used to evaluate vapor intrusion risk due to potential Site redevelopment and to support remedial strategy decisions at the Lower Yard during the Feasibility Study.

The soil vapor probe installation, sampling and data evaluation procedures proposed within this work plan will be completed in accordance with the Washington State Department of Ecology's (Ecology) *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action* (Ecology 2009), the Chevron *Soil Vapor and Indoor Air Sampling Technical Toolkit* (Version 1.8, Chevron 2013) included as **Appendix A** and the ARCADIS Standard Operating Procedure (SOP) for Soil Gas Sampling and Analysis Using United States Environmental Protection Agency (USEPA) Method TO-17 and TO-15 included as **Appendix B**.

Site Description

As defined in the Agreed Order, the Site consists of three areas, the Upper Yard, the Lower Yard and the Willow Creek Fish Hatchery (fish hatchery). The Lower Yard is

currently in escrow for sale to the Washington State Department of Transportation (WSDOT) and is the focus of this investigation.

The Lower Yard is approximately 22 acres in area. ; The Site layout is shown on **Figure 1**. The Lower Yard is currently zoned master plan hillside mixed-use zone 2 (MP2), which would allow for use as mixed general residential and commercial uses, but which prohibits residential use on the ground floor of any building (ARCADIS 2013).

Site Geology and Hydrogeology

The current uppermost stratigraphic unit of the Lower Yard consists primarily of fill material with poorly graded coarse gravels with little to no fines. Remaining un-excavated areas are most likely fill material consisting of sand and gravel and sandy silts with gravel to a depth of 8 to 15 feet below ground surface (bgs).

As described in the Conceptual Site Model (CSM) report (ARCADIS 2013), historical groundwater elevations from 2008 through 2012 range from approximately 2 feet amsl to 15 feet amsl and generally decrease from south to north-northwest primarily towards Puget Sound and towards Edmonds Marsh (east). Depth to water values range from approximately 0.6 feet below top of casing (btoc) to 27 feet btoc (ARCADIS 2013).

Remaining Impacts

A trend analysis for data collected at 21 Site monitoring wells from October 2008 through June 2012 was presented in the CSM (ARCADIS 2013). Results indicated decreasing trends in total TPH and benzene concentrations at all locations evaluated, with the exception MW-510, where LNAPL has been historically present.

Remaining impacts to soil have been identified at the following areas:

- WSDOT Stormwater line: Eleven soil samples exceeded Site cleanup levels (CULs) and/or remediation levels (RELs) in two distinct areas adjacent to the WSDOT stormwater line (See Figure 1) at depths between 4 and 8 feet bgs with total petroleum hydrocarbons (TPH) concentrations ranging from 3,060 to 17,850 mg/kg. The impacted soils adjacent to the WSDOT stormwater line cover an area of approximately 0.31 acres, of the 22 total acres of the Lower Yard. Soils along

the stormwater line, including those with CUL/REL exceedences, were unable to be excavated without compromising the integrity of the stormwater line.

- Detention Basin No. 2 Area (DB-2): Eleven soil samples exceeded Site CULs and/or RELs at depths from 4 feet to 14 feet bgs, with concentrations ranging from 4,413 to 220,400 mg/kg. Free-phase or residual LNAPL was encountered in eight of 17 borings at depths from 7 to 12 feet bgs The area surrounding DB-2, where impacted soils were encountered covers approximately 0.43 acres of the 22 total acres of the Lower Yard.

- Isolated soil samples from four locations exceeded Site CULs and/or RELs for TPH and/or carcinogenic polycyclic aromatic hydrocarbons (cPAHs):

    - During the installation of monitoring well MW-129R, a soil sample was collected at a depth of 7 feet bgs that contained a concentration of total TPH at 3,010 mg/kg.
    - During Phase I of the 2007/2008 Interim Action Investigation one soil sample in the Southwest Lower Yard, sample EX-B18-VV-1-6SW, had a total TPH concentration of 4,980 mg/kg at a depth of 6 feet bgs.
    - During Phase II of the 2007/2008 Interim Action Investigation one soil sample in the southeast Lower Yard, sample EX-BI-F-44-4, had a cPAH concentration of 0.212 mg/kg at a depth of 4 feet bgs.
    - During 2008 Site investigation activities a soil boring (SB-80) was installed southwest of the Point Edwards stormdrain line. The soil sample collected from this boring at a depth of 7.5 feet bgs contained concentrations of TPH at 4,660 mg/kg and cPAHs at 0.693 mg/kg, respectively.

The potential for soil vapor intrusion must be evaluated in areas of remaining impacts as part of the AO, and this work plan proposes collection of soil gas data to complete that evaluation. The potential chemicals of concern for remaining impacts at the Site include: benzene, cPAHs and TPH in the gasoline, diesel and heavy oil carbon ranges. Ecology does not currently have Method B CULs presented in the *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action* (Ecology 2009) for cPAHs and TPH in shallow soil gas. Benzene and specific aliphatic and aromatic TPH carbon ranges (C5-C8 aliphatic, C9-C12 aliphatic and C9-C10 aromatic) will be used for evaluation during this investigation.

Soil Vapor Probe Installation

ARCADIS proposes to install three permanent single level onsite soil vapor probes (VP-1, VP-2 and VP-3) to assess the potential for soil vapor at the Lower Yard adjacent to remaining impacts in soil and groundwater.

The vapor probe locations were selected as worst case scenarios for volatile organic compounds (Gasoline range hydrocarbons) and will be located in the vicinity of locations with maximum gasoline range hydrocarbon detection and/or areas of remaining impacts on the Site.

- Soil vapor probe VP-1 will be located in the vicinity of MW-525 (TPH-17,850 mg/Kg, TPH-G: 1,400 mg/Kg) and will evaluate potential soil vapor adjacent to the WSDOT stormwater line.

- Soil vapor probe VP-2 will be located in the vicinity of B-7 (TPH-111,400 mg/Kg, TPH-G: 1,400 mg/Kg) and will evaluate potential soil vapor adjacent to the drainage basin area 2 (DB-2) and adjacent to groundwater monitoring well MW-510 (LNAPL observed).

- Soil vapor probe VP-3 will be located adjacent to monitoring well MW-129R (TPH-3,010 mg/Kg, TPH-G: ND) and will evaluate potential soil vapor in the adjacent area.

A vapor probe in the location of Sample EX-B18-VV-1-6SW (TPH – 4,980 mg/Kg) in the southwest portion of the lower yard was considered but not selected due to two reasons: 1) Vicinity to the Burlington Northern Santa Fe (BNSF) active railroad tracks and 2) less likelihood of building a structure on the property boundary.

The soil vapor probe locations may be adjusted in the field based on accessibility, and with Ecology approval. Soil vapor probe locations are presented on **Figure 1** and soil vapor probe schematic is presented on **Figure 2**.

The depth to groundwater is approximately 6 feet bgs. In order to collect soil vapor samples from vadose zone (above the groundwater table), each vapor probe will contain one soil vapor probe set at 5 feet bgs or one foot above groundwater, whichever is encountered first. Vapor probes will be cleared to the respective target depth using hand auger and vacuum truck methods. When each respective boring has been advanced to its maximum depth of 5 feet bgs, a 6-inch long, 0.375-inch

outer diameter stainless steel soil vapor screen will be set in a one-foot interval of standard sand pack, allowing approximately three-inches of sand above and below the screen. Teflon tubing (or equivalent) will be connected to the soil vapor screen and capped with a vapor-tight two-way valve or cap at the surface to eliminate the potential for barometric pressure fluctuations to induce vapor transport between the subsurface and the atmosphere. The two-way valve or cap will be installed in the closed position to allow equilibration of soil vapor concentrations to commence immediately after installation.

A one-foot interval of dry, granular bentonite will be placed above the sand pack followed by hydrated bentonite grout to within one-foot of the surface. Sand pack is used around the screened interval of each sample probe to allow soil vapor from the adjacent soil to reach the probes. Dry granular bentonite is used to ensure that the hydrated bentonite grout does not seal the vapor probe screen and inhibit the collection of soil vapor. The surface of each vapor probe location will be fitted with a concrete cap and a flush mounted, traffic rated well box with sufficient room to store the tubing lines and valves or caps.

Continuous soil samples will be collected from a hand auger at each proposed soil vapor probe location during advancement for field screening only. The collected intervals will be screened in the field using a photoionization detector (PID), and will be described by the supervising geologist using visual and manual methods of the Unified Soil Classification System (USCS).

Soil Vapor Sampling

Due to the introduction of atmospheric oxygen into the vadose zone during soil vapor probe installation, an equilibration time is required to allow the sand pack and tubing to equilibrate with the subsurface. A minimum of 48-hours will be allowed for equilibration before purging and sampling of the soil vapor probes.

To assure sampling train integrity a shut-in leak detection test will be implemented. One vapor tight two-way ball valve will be installed closest to the soil vapor port (port valve) and another vapor tight two-way ball valve will be installed on the opposite end of the sampling train as a purge valve (purge valve). While the port valve is left in the closed position, a laboratory provided syringe will be utilized to remove approximately 25 milliliters (ml) from the purge port inducing a vacuum of -8 inches of mercury (approximately -107 inches of water) within the sampling train. The purge valve will be closed and the vacuum within the sampling train will be monitored for a

minimum of 2 minutes. If there is any observable loss in the vacuum within the sampling train after 2 minutes, fittings will be adjusted and the test repeated until the vacuum in the sampling train does not dissipate.

Purging will consist of removing approximately three volumes of stagnant soil vapor at a flow rate of ≤ 200 milliliters per minute (mL/min). The purge volume will be calculated based on the dimensions of the above-ground gauges, tubing, sampling equipment, below-ground tubing, soil vapor probe and sand pack annulus pore space. Purge volume calculation, field conditions, flow rate, pump specifics and other applicable information will be recorded by field personnel on soil vapor sample collection logs.

Purged air will be measured for oxygen, carbon dioxide and methane with a GEM2000 landfill meter. Purged air will also be measured with a PID (for volatile organic compounds) and a helium meter (for leaks).Fixed gas measurements will be compared to laboratory analytical results and support potential biodegradation evaluation. If methane is detected above the lower explosive limit (LEL), an alternative sorbent tube sampling method will be implemented.

A leak test will be conducted to ensure the integrity of the sampling system. The well head and entire sampling train (valves, tubing, gauges, manifold and sample canister) will be placed in an enclosure with pliable weather stripping along the base. A tracer check compound (helium) will be admitted into the enclosure. A helium concentration of between 10 and 20 percent (%) will be maintained in the enclosure as measured using a portable helium detector. Analysis for the tracer compound in the soil vapor sample will be used to assess if leakage occurred. The soil vapor samples will then be collected using 1-Liter batch certified SUMMA™ canisters (or an acceptable alternative) at a flow rate of ≤ 200 mL/min. Soil vapor sampling will be stopped when the canister vacuum has dropped to 5 inHg as measured by the vacuum gauge attached to the SUMMA Canister.

If methane is detected in purged soil vapor above the LEL, sorbent tube sampling methods will be implemented. Sorbent tube sampling will consist of connecting a laboratory provided sorbent tube to the sampling train. Soil vapor will then be actively drawn through the sorbent tube via laboratory provided syringe. The volume of soil vapor required for the sorbent sample will be pre-determined by the laboratory in order to meet appropriate reporting limits for data evaluation. Sorbent tube samples will be sealed with vapor tight caps on both ends and stored on ice. If sorbent tube sampling methods are utilized, sampling procedures will be conducted in accordance

with the ARCADIS SOP (#112409) *Soil-Gas Sampling and Analysis Using USEPA Method TO-17 and TO-15*. Additionally, if sorbent tube sampling methods are utilized, fixed gas data will be obtained through field measurements only.

A duplicate sample collected in-line with its respective parent sample for each day of sampling and an equipment blank sample collected using a laboratory supplied air source will also be submitted to the laboratory for quality assurance purposes.

Purge volume calculation, field conditions, flow rate, VOC concentrations, pump specifics and other applicable information will be recorded by field personnel on soil vapor sample collection logs. The soil vapor samples will be shipped under appropriate chain of custody protocols to Eurofins Air Toxics Ltd. in Folsom, California for analysis of the following:

- Benzene and TPH-G (with specific carbon ranges: C5-C6 aliphatic hydrocarbons, greater than (>)C6-C8 aliphatic hydrocarbons, >C8-C10 aliphatic hydrocarbons, >C10-C12 aliphatic hydrocarbons, >C8-C10 aromatic hydrocarbons, >C10-C12 aromatic hydrocarbons) and naphthalene by Modified United States Environmental Protection Agency (USEPA) Method TO-15 or TO-17.

- Oxygen, carbon dioxide, methane and helium by Modified American Society for Testing and Materials (ASTM) Method D-1946.

If sorbent tube methods are utilized, TPH will not be analyzed as this compound is not directly comparable to Method B CULs presented in the Ecology *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action* (Ecology 2009).

Data Evaluation

Measured concentrations will be reported in micrograms per cubic meter ($\mu g/m^3$). TO-15 reporting limits will be calculated based on method detection limits and potential dilution. TO-17 reporting limits will be calculated based on detected concentrations and sample volume. Detected concentrations of constituents in soil vapor will be compared to health-based screening criteria. These screening criteria define levels that the regulatory agencies have deemed safe for human exposure under a vapor intrusion scenario. Soil vapor data will be compared with Method B soil gas screening levels presented in Table B-1 of the Ecology *Review DRAFT*

Guidance for Evaluation Soil Vapor Intrusion in Washington State: Investigation and Remedial Action (Ecology 2009). Ecology provides draft soil gas screening values for samples collected at depths less than 15 feet bgs and soil gas screening values for samples collected at 15 feet bgs or deeper.

Table 1 : Soil Vapor Data Screening Levels

Measured Concentration ($\mu g/m^3$)	Screening criteria ($\mu g/m^3$)
Benzene	3.2
Naphthalene	14
Σ(C5-C6AL)+(>C6-C8AL)	27,000
Σ(>C8-C10AL)+(>C10-C12AL)	1,400
Σ(C8-C10AR)+(>C10-C12AR)	1,800

It is recognized that petroleum hydrocarbon vapors rapidly biodegrade in the soil column when sufficient oxygen is present. Aerobic biodegradation consumes oxygen and generates carbon dioxide. Comparison of fixed gas concentrations relative to atmospheric levels will be discussed as a qualitative evaluation of the degree to which hydrocarbon vapors may be biodegrading at the Site.

The results of soil vapor investigation will be presented in the Draft Feasibility Study Report scheduled to be submitted to Ecology in December 2013. The soil vapor investigation event at the Site is scheduled for Fall 2013. Should you have any questions or if ARCADIS can be of further assistance, please contact Scott Zorn at (206) 726-4709.

Sincerely,

for

Eric Epple
Geologist II

Scott Zorn
Principal Geologist

Copies:
Cc: Kim Jolitz, Chevron Environmental Management Company

Attachments:

Table 1	Soil Vapor Data Screening Levels
Figure 1	Soil Vapor Probe Locations
Figure 2	Soil Vapor Probe Schematic
Appendix A	Chevron *Soil Vapor and Indoor Air Sampling Technical Toolkit v1.8*
Appendix B	ARCADIS SOP (#112409) *Soil-Gas Sampling and Analysis Using USEPA Method TO-17 and TO-15*

References:

ARCADIS, 2013. Former Unocal Edmonds Bulk Fuel Terminal. *Conceptual Site Model*. May 2013.

Ecology, 2009. *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action*. October 2009.