GW – 001

River Terrace Voluntary Corrective Measures Bioventing System Annual Report (1)

2015

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December 21, 2017

Via Certified Mail No. 7015 3010 0002 0440 9455
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Mr. John E. Kieling, Chief
New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Bldg 1
Santa Fe, New Mexico 87505-6313

Re: RESPONSE TO APPROVAL WITH MODIFICATIONS
RIVER TERRACE VOLUNTARY CORRECTIVE MEASURES BIOVENTING SYSTEM ANNUAL REPORT (JANUARY - DECEMBER 2014), MARCH 2015, AND
RIVER TERRACE VOLUNTARY CORRECTIVE MEASURES BIOVENTING SYSTEM ANNUAL REPORT (JANUARY - DECEMBER 2015), MARCH 2016, AND
RIVER TERRACE VOLUNTARY CORRECTIVE MEASURES BIOVENTING /AIR SPARGING SYSTEM ANNUAL REPORT (JANUARY - DECEMBER 2016), MARCH 2017
WESTERN REFINING SOUTHWEST, INC. - BLOOMFIELD TERMINAL
EPA ID# NMD089416416
HWB-WRB-15-002
HWB-WRB-16-001
HWB-WRB-17-001

Dear Mr. Kieling:

This letter provides the Western Refining Southwest, Inc. (Western) response to comments in NMED's Approval with Modifications letter dated August 18, 2017.

NMED Comment 1:

The following comments address editorial issues. No revisions to the Reports are necessary; however, ensure all issues are addressed in future reports.

a. The abbreviation "NPP" was found in the Depth to Product column in the tables. The designation was not defined in the footnotes or list of acronyms. Define all acronyms in future reports.

b. In Figure 3, River Terrace Annual Report Bloomfield Terminal River Terrace Well Location Map (all Reports), well DW-1 is indicated as an inactive well while well DW-2 is indicated as an active well. The description in the Reports indicates the opposite. Correct Figure 3 in future reports.

c. In the Executive Summary (2015 Report), Western states,"[t]he Dewatering System consists of two dewatering wells (DW-2 and DW-3), and a collection gallery, each is equipped with a dedicated submersible pump." However, in Section 1.l, Site Location and Description, Western states, "[t]he active dewatering system consists of two dewatering wells (DW-1 and DW-3) and a collection gallery, each equipped with variable-speed submersible pumps." Provide the correct well references in future reports.

d. In Section 3.1.2 (2016 Report), Groundwater Field Parameters, Western states, "[a] summary of the groundwater field parameters collected during the sampling event are included in Table 2." These parameters were included in Table 1. Ensure future reports provide correct references to tables.

Western Response:

The noted issues will be addressed in future reports.

NMED Comment 2:

The contaminant concentrations in the groundwater samples collected from the GAC-Inlet are more elevated compared to those in samples collected from wells DW-1 and DW-3 according to the Groundwater Monitoring Summary Tables and GAC Filter Monitoring Tables. For example, during the week of the April 28, 2015 sampling event, the benzene concentrations in the groundwater samples from wells DW-1and DW-3 were reported as non-detect and 0.082 mg/L, respectively. During the same period (the April 1 and May 6, 2015 sampling events), the benzene concentrations in samples collected from the GAC-Inlet were reported at higher concentrations of 0.130 and 0.140 mg/L, respectively. Since the GAC-Inlet receives groundwater from DW-1, DW-3 and the collection gallery, the elevated concentrations appear to originate from the collection gallery. In an updated Facility-Wide Groundwater Monitoring Plan, propose to collect groundwater samples from the collection gallery, and present and discuss the analytical results for BTEX, MTBE, TPH-GRO, and ORO, and total lead concentrations in the next annual report.

Western Response:

The 2018 Facility-Wide Groundwater Monitoring Plan will incorporate the requested analyses of groundwater samples collected at the collection gallery.

NMED Comment 3:

According to a NMED letter dated April 18, 2007, the sampling requirement for wells DW-2 and MW-48 was removed from the monitoring plan; however, more than 10 years have passed since the update and the subsurface conditions may have changed due to the on-going remedial activities. In addition, the hydrocarbon concentration in well TP-5 has been increasing since 2012 according to the Groundwater Monitoring Summary Tables. TP-5 is located within 20 feet from DW-2. Propose to collect groundwater samples from wells DW-2 and MW-48 for analysis for BTEX, MTBE, TPH-GRO and DRO, and total lead in an updated Facility-Wide Groundwater Monitoring Plan. Present and discuss the results in the next annual report.

Western Response:

The 2018 Facility-Wide Groundwater Monitoring Plan will incorporate the requested analyses of groundwater samples collected at the collection gallery.

NMED Comment 4:

In the Executive Summary (all Reports), Western states that a "[t]otal of 219,715, 401,618 and 401,137 gallons of impacted groundwater were removed and treated in 2014, 2015 and 2016, respectively." The volume of recovered groundwater was almost doubled since 2014 to 2015. Provide an explanation for the increased volume in the response letter. In addition, the volume fraction of recovered groundwater appears to be different among the two wells and the collection gallery. For example, if DW-3 and the collection gallery yield much more water compared to the DW-1's production rate, the submersible pump may be removed from DW-1 and placed in other extraction wells (e.g., DW-2) to achieve a higher recovery rate. Install a well flow totalizer in each dewatering well to optimize effectiveness of the system. It should be noted that the contaminant concentrations in samples collected from well DW-1 have been consistently low while the concentrations in samples collected from TP-5, located adjacent to DW-2, have been increasing in recent years. Evaluate the benefit of extracting groundwater from well DW-2 or other wells rather than DW-1 and provide recommendations in the next annual report.

Western Response:

The groundwater recovery increase observed in 2015 and into 2016, is believed to be associated with the pump maintenance activities conducted in March, 2015; and the recovery from several years of drought conditions in the region that resulted in a Navajo Dam (San Juan River) high-flow discharge event in 2016.

Western proposes to re-evaluate the entire River Terrace System in early 2018, as noted in the response to Comments 5 and 7.

NMED Comment 5:

In Section 4.2 (2014 Report), Recommendations, Western states, "[W]estern has removed the impacted soil from the River Terrace System and believes the groundwater is our main focus for remediation." NMED concurs with Western's statement. The biovent (BV) wells address impacted soil in the vadose zone; however, they provide little effect for impacted groundwater; thus, the existing system must be modified to target groundwater cleanup. Discuss the modification or replacement of the BV wells to focus the treatment to the saturated zone. Propose to submit a work plan to modify or replace the existing BV wells, and provide a plan to evaluate the effectiveness of the modification in the work plan.

Western Response:

The BV wells have always addressed both groundwater and soil impacts. The wells were originally designed with two stingers in the wells, one shorter and one longer to accommodate fluctuations in water levels. The longer stinger actually acts as a sparging system depending on water levels in the individual wells. Also, Western has continually evaluated and updated the system with NMED concurrence to improve the performance, including the installation of the groundwater collection gallery and air sparge lines A and B.

The original bioventing remediation system clearly has been effective in addressing both soil impacts and groundwater concentrations. Since the 2006 system start-up, the majority of groundwater concentrations have been reduced to near or below regulatory clean-up levels. A work plan to modify or replace the existing wells is not warranted at this time.
In early 2018, Western proposes to re-evaluate the entire River Terrace System and meet with NMED to discuss a path-forward to closure.

NMED Comment 6:

In Section 4.1.2 (2014 and 2015 Reports), Soil Vapor Monitoring, Western states, "[s]oil gas field measurements indicate that the aeration system has been successful in maintaining sufficient oxygen within the subsurface to help sustain bioremedial activity." Although the measured oxygen levels (17.6 - 20.9%) in the monitoring wells support Western's statement, the pressure reading indicates "zero" in each monitoring well, possibly implying no influence from the BV wells. When the air is distributed in the vadose zone from the BV wells, an increased pressure reading is expected among wells located within the radius of influence. Provide an explanation regarding the zero-pressure reading in the response letter. Ensure that the pressure gauge is appropriate for the range of the measurement and can display readings with sufficient resolution across the range.

Western Response:

Beyond possible variations in injection flow rates and pressures, the field measurements of pressure readings at the land surface may be affected by a number of factors, including shallow and variable depth to the potentiometric surface, variable lithology and permeability, changes in barometric pressure/surface temperature, etc. These factors are too numerous to indicate one variable (e.g. pressure) as the culprit. In the 2015 report, some of the wells have shown elevated pressure readings, but the readings have varied over time, including zero readings. Historical pressure readings reflecting similar trends have been reported since system start-up. It is important to note that the pressure readings were recorded by experienced professionals using the appropriate equipment.

Although some of the wells registered zero-pressure readings, the oxygen levels have remained sufficient to support bioremediation and an injection pressure adjustment has not been necessary. Another consideration is that raising the injection pressure (and flow) may be detrimental to bioremedial activity. A slow flow of air is preferred to achieve an effective and efficient bioremediation effort[1].

NMED Comment 7:

In Section 1.1 (2016 Report), Site Location and Description, Western states, "[i]nstallation of the air sparging component of the biovent system was completed in late 2012, and consists of two air sparging lines (Air Sparging Line A and Air Sparging Line B). Each air sparging line consists of air sparging tubes that extend down into the groundwater (Western Refining, 2013). Air from the biovent main air blower is pushed into each sparging tube, causing a bubbling effect in the groundwater while also

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[1] Testa, S.M. and Winegardner, D.L., 2000, *Restoration of Contaminated Aquifers Petroleum Hydrocarbons and Organic Compounds*, 2nd ed. CRC Press LLC, p. 309

oxygenating the surrounding subsurface." While sparging the contaminated groundwater, VOCs will be partitioned into the air. Although previous soil vapor monitoring data indicates that the effect of BV wells is not a concern for vapor-phase VOCs, the stripped VOCs (especially when air sparging performs effectively) may cause an increase in soil vapor concentrations. In an updated Facility-Wide Groundwater Monitoring Plan, propose to collect soil gas samples in the vicinity of the two air sparge lines. Propose to collect pressure readings and soil gas samples from wells DW-3 and MW-48 and the collection gallery for BTEX and TPH GRO analyses. Provide and discuss the analytical data in the next annual report. In addition, evaluate the need for a soil vapor extraction system to address vapor-phase VOCs in the vicinity of the air sparging system.

Western Response:

The BV wells have always addressed both groundwater and soil impacts. As noted above in response to Comment 5, the existing BV wells combine air sparging with air injection into the vadose zone and soil gas monitoring data has indicated the system is effectively removing the VOCs from the vadose zone including any VOCs partitioned from air sparging. Bioremediation of the VOCs, which may be stripped from groundwater along the two air sparging lines (i.e., A and B), is anticipated to be similarly effective along the air sparge lines as demonstrated in the nearby BV wells.

In early 2018, Western proposes to re-evaluate the entire River Terrace System and meet with NMED to discuss a path-forward to closure.

NMED Comment 8:

In Section 3.3.2 (2016 Report), Aeration System Monitoring, Western states, "[t]he effectiveness of the air system was monitored using a portable pressure gauge at various points along the air injection piping system. Pressure measurements were collected at BV-1, B[V]-3, BV-4, BV-5, BV-6, Air Sparging Line A, Air Sparging Line B, and at the discharge of the main air blower. The readings are used to ensure a uniform distribution of air throughout the system." In future reports, tabulate the readings in a manner similar that presented in 2014 and 2015 Reports. Provide a revised table tabulating the 2016 pressure readings with the 2017 Annual Report,

Western Response:

The readings will be summarized in tables in future reports, as was completed in prior years.

NMED Comment 9:

In Section 4.2 (2016 Report), Recommendations, Western states, [i]n 2016 lead concentrations over the regulatory limit were present in TP-8 and TP-9 and were not present in 2015. The results also show the same detection in MW-49 which is located on the river side of the slurry wall. Western believes these lead detections could be due to the quality of the river water during the sampling run." The lead detections may indicate that water migrates through the bentonite slurry and sheet pile barrier wall. Consequently, hydrocarbons in groundwater may be leaching through the wall to the San Juan River. In addition, since the groundwater flows along the slurry wall, the elevated lead concentrations may be present in the groundwater around the vicinity of the slurry wall. Collect groundwater samples from wells OW 11+15, OW 16+60 and OW6+70 and analyze the samples for total lead. Discuss the results in the next annual report.

Western Response:

The reference to the quality of the river water during the sampling run was to the visible turbidity in the surface water. Upon further review, the analytical results of the river water samples collected since 2013 have been non-detect (<0.005 mg/l) for dissolved lead. NMED mentions the possibility of hydrocarbons leaching through the wall to the San Juan River; however, the hydraulic gradient is maintained such that any potential for flow would be from the river side of the barriers toward the remediation area. Also, the difference in water levels measured on opposite sides of the sheet pile and slurry wall clearly show the lack of groundwater flow through these hydraulic barriers.

NMED then appears to discuss the slurry wall that is present on top of the bluff, which is totally unrelated to the River Terrace Remediation System. Prior chemical analyses of groundwater samples collected at the observations wells along the slurry wall at the top of the bluff have not indicated problems with lead being present in the groundwater at concentrations above regulatory standards. Further, on-going chemical analyses of groundwater samples collected across most of the refinery do not show there to be sources of lead contaminated groundwater that could possibly threaten the lower river terrace area. Also, there is no evidence to show flow of groundwater off the bluff towards the river terrace. Monitoring of seeps at the top of the bluff shows very little potential for groundwater flow down the bluff to the river terrace area and there is little groundwater present in the collection wells present on the down-gradient side of the slurry wall that runs along the top of the bluff. In fact, well OW6+70 did not have sufficient water in 2016 even allow for sample collection.

The more likely scenario is that a small volume of sediment was entrained in the groundwater samples that were collected with bailers and then preserved without filtration for totals analyses. A water sample collected at MW-49 would be expected show the presence of organic contaminants before showing elevated metals if the contaminants were being transported via groundwater flow to that location from the back side of the slurry/sheet pile wall. However, there are no detections of either BTEX or TPH in the groundwater samples collected from MW-49.

Western proposes to discuss this request further with NMED prior to making changes to the 2018 Facility-Wide Groundwater Monitoring Plan, as we do not believe there is any source of lead contamination in the area of the river terrace and the low concentrations of lead reported in the groundwater samples are likely the results of collecting the groundwater samples with bailers.

NMED Comment 10:

In Appendix C, Western includes Hall Environmental Analysis Laboratory's *Quality Assurance Plant Revision* 10.1. Approval of the Reports does not constitute approval of the Quality Assurance Plan. No response is necessary.

Western Response:

The Laboratory QA Plan will not be included in future report submittals. It is of course always available if NMED were to desire a copy.

<u>Extension Requests:</u>

Facility-Wide Groundwater Monitoring Plan

Western requests an extension to submit the Facility-Wide Groundwater Monitoring Plan to the regular due date of June 30th. The reason for the extension is that the plan covers more than the River Terrace area and incorporates New Mexico Oil Conservation Division (OCD) requirements. The 2017 OCD Discharge Permit renewal includes additional sampling requirements. Meanwhile, Western will conduct the additional groundwater sampling discussed in Comments 2 and 3.

Work Plan to Modify or Replace Existing BV Wells:

Western requests an extension to submit a work plan to modify or replace existing BV wells until 30 days after NMED and Western meet to discuss a path-forward to closure.

If you have any questions regarding this response to comments, please contact me at 915-534-1483.

Sincerely,

Western Refining Southwest, Inc.

Alle S. Hains

By: ALLEN S. HAINS, P.E.
Manager Remediation Projects

cc: D. Cobrain, NMED HWB
K. Van Horn, NMED HWB
L. Tsinnajinnie, NMED HWB
M. Suzuki, NMED HWB
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K. Robinson, Western Refining Southwest, Inc., Bloomfield Terminal

Western Refining

Bloomfield Refinery

River Terrace
Voluntary Corrective Measures
Bioventing System Annual Report

January – December 2015
Submitted March 2016

Western Refining

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2016 MAR -1 P 3:21

February 29, 2015

John E. Kieling, Bureau Chief
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Fed X Tracking #: 7757 6182 8334 (to NMED)
Fed X Tracking #: 7757 6186 3678 (to OCD)

Re: River Terrace Voluntary Corrective Measures
Bioventing System Annual Report
January 2015 through December 2015

Dear Mr. Kieling and Mr. Chavez,

Western Refining Southwest, Inc. - Bloomfield Terminal submits the River Terrace Voluntary Corrective Measures Bioventing System Annual Report pursuant to Section V.B.1. of the July 2007 Consent Order. This report summarizes monitoring activities and data gathered at the River Terrace throughout 2015.

If you have questions or would like to discuss any aspect of the report, please contact me at (505) 632-4166.

Sincerely,

Kelly Robinson

Kelly R. Robinson
Environmental Manager - Logistics
Western Refining Southwest, Inc.

Cc: Allen Hains – Western Refining – El Paso

50 County Road 4990, Bloomfield, New Mexico 87413 • 505 632-4101 • www.wnr.com

Western Refining™

RIVER TERRACE ANNUAL REPORT
Voluntary Bioventing System

January – December 2015

Bloomfield Refinery
Western Refining Southwest, Inc.
#50 Rd 4990
Bloomfield, New Mexico 87413

Submitted: March 2016

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List of Acronyms

benzene, toluene, ethylbenzene, and total xylene (BTEX)

below grade surface (bgs)

biovent well (BV)

central federal register (CFR)

dewatering well (DW)

diesel range organics (DRO)

dissolved oxygen (D.O.)

feet (ft)

degrees Fahrenheit (°F)

gasoline range organics (GRO)

granulated activated carbon (GAC)

investigation derived waste (IDW)

liters (L)

liquid petroleum gas (LPG)

maximum contaminant level (MCL)

methyl tert-butyl ether (MTBE)

micrograms per liter (ug/L)

micro mhos per centimeter (umhos/cm)

milligrams per liter (mg/L)

millivolts (mV)

monitoring well (MW)

New Mexico Administrative Code (NMAC)

New Mexico Environment Department Hazardous Waste Bureau (NMED-HWB)

Oxidation reduction potential (ORP)

parts per million (ppm)

photoionization detector (PID)

polyvinyl chloride (PVC)

pounds per square inch (psi)

Resource Conservation and Recovery Act (RCRA)

separate phase hydrocarbon (SPH)

Solid Waste Management Units (SWMUs)

Standard cubic feet per minute (scfm)

Temperature (TEMP)

Temporary piezometer (TP)

top of casing (TOC)

total petroleum hydrocarbon (TPH)

United States Environmental Protection Agency (USEPA)

volatile organic constituent (VOC)

Water Quality Control Commission (WQCC)

Executive Summary

This Report is a summary of monitoring activities conducted in 2015 at the River Terrace Bioventing System located at the Bloomfield Refinery. The following is a synopsis of activities performed at the River Terrace in 2015.

Dewatering System

The Dewatering System consists of two dewatering wells (DW-2 and DW-3), and a collection gallery, each is equipped with a dedicated submersible pump. Dewatering well DW-3 allows for enhanced dewatering capability within the southwest corner of the River Terrace area, the area with the highest dissolved phase concentrations within the River Terrace Area. The well extends approximately six feet below the water table, and is constructed to allow for higher groundwater recovery efficiency.

The dewatering wells operate off of independent level control systems. As each individual pump senses a low water column level, the pump will shut down for a period of time to allow the well to recover before resuming pumping. The cycle of operation frequency for the dewatering pumps is directly reflective of the operational level of the San Juan River. Groundwater pumped by the dewatering system is pumped through two GAC filters operating in series before discharging into the facility raw water ponds. A total of 401,618 gallons of impacted groundwater was removed and treated through the GAC filters in 2015.

Aeration System

The aeration system ran throughout 2015, except during times when regular maintenance was performed on the mechanical equipment. The aeration system includes an air sparging component, which allows for air to be injected both within the subsurface and below the groundwater surface. The air pressure readings collected at each of the biovent well, air sparging line, and at the main air blower were consistent, affirming an even distribution of air throughout the biovent area.

Soil gas field readings were collected to measure organics, oxygen, and carbon dioxide in the subsurface. The PID meter detected low level concentrations of organics, ranging between 0.0 ppm and 67.3 ppm. The highest concentration was detected at DW-3, located within the active area of the bioventing system. The measured oxygen levels ranged between 17.6% and 19.8% throughout the River Terrace.

Soil gas samples were collected at specific wells and analyzed for volatile organic compounds (benzene, toluene, ethylbenzene, and xylenes), and TPH-GRO. The analytical results for samples collected in 2015 were not detected above the respective laboratory screening level, with the exception of the following:

- Benzene was detected in a sample collected at DW-3, with a concentration detected of 0.79 ug/L.
- Ethylbenzene was detected in samples collected at DW-3, with a concentration detected of 7.0 ug/L.
- Xylene was detected in samples collected at DW-3, with a concentration detected of 4.40 ug/L.
- TPH-GRO was detected in samples collected at DW-3 with a concentration detected of 61.0 ug/L.

Soil gas field measurements indicate that the aeration system has been successful in maintaining sufficient oxygen within the subsurface to help sustain bioremedial activity. Well location DW-3 shows the highest soil gas concentrations, which also correlates to the groundwater results in this location.

Western has conducted three separate in-situ respiration tests at the River Terrace area in May 2006, September 2007, and October 2009. In a response letter from the New Mexico Environment Department – Hazardous Waste Bureau (NMED) dated November 23, 2010 (NMED, 2010), NMED granted approval to discontinue conducting the in-situ respiration tests. Therefore to-date, no additional in-situ respiration testing has been conducted.

Groundwater Monitoring

Groundwater samples were collected at specific wells and analyzed for volatile organic compounds (benzene, toluene, ethylbenzene, xylenes, and MTBE), TPH-DRO, TPH-GRO, total lead, and total mercury. The analytical results for samples collected in 2015 during San Juan River low flow conditions were below their respective screening levels with the following exceptions:

- Benzene was detected at concentrations above the respective MCL (0.005 mg/L) at one location (DW-3). The concentration of benzene detected was 0.082 mg/L. All other benzene sample results were below the laboratory detection limit.

- Xylenes were detected at concentrations above the respective WQCC screening level of 0.62 mg/L at one location (TP-5). The concentration of xylene detected was 1.300 mg/L.
- Lead was detected ac concentrations above the respective MCL (0.0150 mg/l) at TP-5. The concentration of lead detected was 0.019 mg/l.

In addition, TPH-DRO was detected above the respective laboratory reporting limit at TP-5, TP-6, TP-8, TP-9, TP-13 and DW-3. The detected concentrations ranged between 0.22 mg/l and 1.6 mg/l, with the highest concentration detected at TP-6. TPH-GRO was detected above the respective laboratory reporting limit at TP-5, TP-6, TP-8, and DW-3. The detected concentrations ranged between 1.4 mg/l and 7.1 mg/l, with the highest concentration detected at TP-5.

Conclusions

Soil gas field measurements indicate that the aeration system has been successful in maintaining sufficient oxygen within the subsurface to help sustain bioremedial activity. Groundwater samples indicate that the impacted groundwater in the River Terrace area remains within the influence area of the aeration system.

The groundwater sample results show that the slurry wall is continuing to perform as designed, preventing impacted ground water from reaching the river. Elevated groundwater concentrations are localized to the area around DW-3. The analytical for samples collected at monitoring well MW-49, located on the river side of the river terrace slurry wall, show that the San Juan River continues to not be impacted by the groundwater impacts within the biovent area.

Section 1
Introduction

1.1 Site Location and Description

Owner: San Juan Refining Company, a New Mexico Corporation
1250 Washington Street
Tempe, Arizona 85281

Operator: Western Refining Southwest, Inc.
(Formerly Giant Industries Arizona, Inc.), an Arizona Corporation
1250 Washington Street
Tempe, Arizona 85281

Facility: Bloomfield Terminal (physical address)
50 Road 4990
Bloomfield, New Mexico 87413

Western Refining Southwest, Inc. (postal address)
P.O. Box 159
Bloomfield, New Mexico 87413

US EPA ID: NMD089416416

SIC Code: 5171 (Previously Operated under 2911)

The former Bloomfield Refinery Facility is currently owned by San Juan Refining Company, a New Mexico corporation, and operated by Western Refining Southwest, Inc. formerly known as Giant Industries Arizona, Inc., an Arizona corporation. The former Bloomfield Refinery had an approximate refining capacity of 18,000 barrels per day. Various process units operated at the facility, including crude distillation, reforming, fluidized catalytic cracking, sulfur recovery, merox treater, catalytic polymerization, and diesel hydrotreating. Products produced at the refinery included gasoline, diesel fuels, jet fuels, kerosene, propane, butane, naphtha, residual fuel, fuel oils, and LPG.

The Facility is located on approximately 263 acres south of Bloomfield, New Mexico in San Juan County (Figure 1). The Facility complex is bisected by County Road 4990 (Sullivan Road), which runs east-west. The process units, tank farm, wastewater treatment system, raw water ponds, and fire training area are located north of the county road. The crude oil and product unloading areas, loading racks, maintenance buildings/90-day storage area, pipeline offices, transportation truck shop, and Class I injection well are located south of the country road (Figure 2).

The former Refinery is located on a bluff 120 feet above the south side of the San Juan River. The top of the bluff is relatively flat and is at an elevation of 5,540 feet above sea level. Based on the available site-specific and regional subsurface information, the site is underlain by the Quaternary Jackson Lake terrace deposits, which unconformably overlie the tertiary Nacimiento Formation. The Jackson Lake deposits consist of fine grained sand, silt, and clay that grades to course sand, gravel and cobble size material closer to the contact with the Nacimiento Formation. The Jackson Lake Formation is over 40 feet thick near the southeast portion of the site and generally thins to the northwest toward the San Juan River. The Nacimiento Formation is primarily composed of fine grained materials (e.g., carbonaceous mudstone/claystone with interbedded sandstones) with a reported local thickness of approximately 570 feet (Groundwater Technology, 1994).

The River Terrace Area is located north of the Hammond Ditch, approximately 120 feet lower in elevation than the Former Refinery process and Tank Farm areas. Since 2006, Western has operated a bioventing system for the purpose of providing oxygen to the subsurface and support aerobic biodegradation of petroleum hydrocarbons that were identified in soil along the western portion of the River Terrace to a depth of approximately 8 feet below existing grade surface (bgs).

In 2013, optimization activities to the biovent system were completed which included removal of impacted soil, installation of an air sparging system, and installation of an additional dewatering well. These enhancements allowed for the system to continue to target the subsurface soils, as well as enhance the groundwater remediation efforts through additional pumping and air sparging.

The River Terrace System currently consists of the following:

- Five biovent wells (BV-1, BV-3, BV-4, BV-5, and BV-6);
- Ten temporary piezometers (TP-3, and TP-5 thru TP-13);
- Three dewatering wells (DW-1, DW-2, and DW-3);
- Two monitoring wells (MW-48, and MW-49);
- Two air sparging lines (Air Sparging Line A, and Air Sparging Line B); and
- One collection gallery.

The active dewatering system consists of two dewatering wells (DW-1 and DW-3) and a collection gallery, each equipped with variable-speed submersible pumps. The collection gallery, consisting of a 4-inch perforated pipe with an 8-inch diameter vertical riser pipe and submersible pump, was installed and placed into operation by early October 2009. Dewatering well DW-3 was installed as part of the most recent optimization activities, and is constructed with a 4-inch machine slotted PVC well casing that is placed inside a 5.5-inch diameter steel pipe. The steel pipe is packed with larger diameter cobbles, allowing for better groundwater pumping efficiency. The dewater system pumps water through two GAC filters before discharging to the facility raw water ponds. The purpose of the dewatering system is used to enhance the effectiveness of the bioventing system by dewatering the influenced area, and also remove impacted groundwater for treatment.

Installation of the air sparging component of the biovent system was completed in late 2012, and consists of two air sparging lines (Air Sparging Line A and Air Sparging Line B). Each air sparging line consists of air sparging tubes that extend down into the groundwater (Western Refining, 2013). Air from the biovent main air blower is pushed into each sparging tube, causing a bubbling effect in the groundwater while also oxygenating the surrounding subsurface.

The biovent portion of the system continues to remain active, although the majority of the impacted soils within the subsurface were removed as part of the completed optimization activities. The main air blower injects air into the subsurface through the BV wells. The air supply promotes biodegradation within the subsurface.

Section 2
Background

This section presents a summary of the events and activities conducted at the River Terrace Area since 1999.

1999

- Installation of a bentonite slurry and sheet pile barrier wall adjacent to the San Juan River was completed. The barrier extends approximately 35 feet below the ground surface, and extends around the perimeter of the riverbank from the bluff opposite the west end of the process area to the river inlet station. The bentonite slurry and sheet pile barrier wall was installed to prevent hydrocarbons from migrating into the San Juan River.

2004

- Two groundwater monitoring wells (MW-48 and MW-49) were installed in October 2004 to replace two piezometers (P-4 and P-5). Additionally in October 2014, eight temporary piezometers were installed (TP-1 through TP-8). The purpose of installing the monitoring wells and piezometers was to determine the extent of hydrocarbon impacts in soil on the refinery side of the bentinite slurry wall and sheet pile barrier.

2005

- Bloomfield Refinery initiated construction of the River Terrace Bioventing Project to provide oxygen to the subsurface and support aerobic biodegradation of petroleum hydrocarbons existing in the soil at the River Terrace. Construction activities included the following:
  - Installation of five additional piezometers (TP-9 through TP-13) within the eastern portion of the River Terrace area in April 2005.
  - Construction of an aeration system designed to increase bioremedial activity in the subsurface. The aeration system included installation of 13 bioventing wells (BV-1 through BV-13), all located within the western portion of the River Terrace area. The bioventing wells were installed in August 2005.
  - Construction of a dewatering system designed to expand the bioremedial vadose zone. The dewatering system included installation of two dewatering wells (DW-1 and DW-2). The dewatering wells were installed in August 2005.

2006

- Operation of the Bioventing System commenced in January 2006. System monitoring activities were conducted in compliance with the approved River Terrace Voluntary

Corrective Measures Monitoring Plan (Revised) dated October 28, 2005 (Malcolm Pirnie, 2005).

- An In-Situ Respiration Test was conducted in May 2006. The results of the In-Situ Test were used to evaluate progress of the bioremedial activity.
- Quarterly performance monitoring was conducted in March, June, September, and December of 2006.

2007

- Quarterly performance monitoring of the Bioventing System was conducted in February, June, August, and October 207.
- An In-Situ Respiration Test was conducted in September 2007. The results of the In-Situ Test were used to evaluate progress of the bioremedial activity.
- The dewatering pumps were replaced in February 2007.
- Breakthrough in the lead GAC (V-612) was detected in April 2007. Upon confirmation of breakthrough, GAC filter V-611 became the lead GAC filter. V-612 was replaced and placed back in service in June as the lag filter.

2008

- Quarterly performance monitoring activities for the Bioventing System were conducted in March, May, July, and November 2008.
- The aeration system blower bearings were replaced in February 2008.
- The monitoring well MW-48 dewatering pump was replaced in August 2008.
- Blower piping was upgraded in October 2008.

2009

- Quarterly performance monitoring for the Bioventing System was conducted in March, April, September, and October 2009.
- An In-Situ Respiration Test was conducted during the week of October 26, 2009.
- In order to improve and optimize the dewatering system, a collection gallery, pump, and piping system were installed in the southwest portion of the River Terrace and put in service October 13, 2009.

2010

- Quarterly performance monitoring for the Bioventing System was conducted in March, April, July, and October of 2010.
- Following suspension of refining operations on November 23, 2009, operation of the River Pump station decreased, thus impacting the frequency of the River Terrace dewatering system. Although the aeration system continued to operate consistently, operation of the dewatering system has become infrequent due to the decreased demand for fresh water to support current facility operations.

2011

- In March 2011, Western received approval from NMED-HWB to modify the piping of the River Terrace dewatering system. Piping modifications included installation of a 3,000-gallon surge tank and booster pump which allows the treated water from the River Terrace dewatering system to discharge directly into the Refinery's fresh water ponds. Piping modifications were completed in April 2011.
- Approved modifications to on-going monitoring at the River Terrace (NMED, 2011) were implemented as part of the 2011 sampling program for the River Terrace. The approved sampling modifications included the following:
  - Soil gas sampling to be conducted annually at all TP wells, DW-1, and MW-49. The sampling is to be performed during San Juan River low flow conditions.
  - Soil gas monitoring (O_2, CO_2, and PID readings) for TP-1, TP-2, DW-1, MW-49, and TP-5 through TP-9 is to be performed semi-annually. The monitoring is to be performed during San Juan River high and low flow conditions.
  - Groundwater monitoring of TP-3, -7, -9, -10, -11, -12, -13, and DW-1 is to be conducted biennually (beginning 2011). Samples are to be collected during low flow conditions of the San Juan River.
  - Groundwater monitoring of TP-1, -2, -5, -6, -8, and MW-49 is to be conducted semi-annually. The monitoring is to be performed during San Juan River high and low flow conditions.
  - Discontinue analysis of barium and chromium analysis for all TP wells, MW-49, and DW-1.
  - Samples at the GAC in-let, outlet of lead vessel, and outlet of lag vessel are to be collected quarterly.
- High and low flow monitoring events were conducted in June 2011 and July 2011, respectively.
- Quarterly performance monitoring of the Biovent System GAC filters inlet and outlet occurred in March, May, July, and October of 2011.

- Additional samples outside of what was required were collected at the discharge of the lead GAC filter on a monthly basis, with the exception that a sample was not collected in April 2011 due to the dewatering system being off-line.

2012

- In June 2012, the lead GAC filter was exchanged for a new filter. The biovent dewatering system consists of two GAC filters that operate in series. The new filter was placed in the lag position, and the previous lag filter was placed in the lead position.

- In October 2012, Western submitted a Work Plan that summarized proposed activities to optimize the remediation progress at the River Terrace. Approval of the Work Plan was issued by NMED-HWB on October 12, 2012. Field activities commenced on October 20, 2012 and included the following activities:

    - Removal of impacted clay soil at the River Terrace;

    - Installation of a sparging piping to target areas of the river terrace where groundwater is impacted;

    - Decommissioning of TP-1, TP-2, BV-2, and BV-7 through BV-13 were all decommissioned during excavation activities.

    - Air Sparging Line A and Air Sparging Line B were added to system.

2013

- Western completed and put into service dewatering well DW-3 located within the southwest corner of the River Terrace. This new dewatering well adds additional value to the current dewatering system at the river terrace as historical analysis have shown this area to contain higher concentrations of impacted groundwater.

- The High Flow Monitoring Event did not take place in 2013. The one week spring peak release (5,000 cfs) did not take place because of the threat of a water shortage in the San Juan River Basin. San Juan County is experiencing a severe drought.

2014

- Quarterly performance monitoring of the GAC filters for the Bioventing System was conducted in March, April, July, and October of 2014.

- The High Flow Monitoring Event did not take place in 2014. The one week spring peak release (5,000 cfs) did not take place because of the threat of a water shortage in the San Juan River Basin. San Juan County is experiencing a severe drought.

2015

- Monthly and Quarterly performance monitoring of the GAC filters for the Bioventing System was conducted. Samples in addition to the required frequency were collected at the GAC filters to monitor their operations.
- The High Flow Monitoring Event did not take place in 2015. The one week spring peak release (5,000 cfs) did not take place because of the threat of a water shortage in the San Juan River Basin.
- General pump maintenance was performed on the recovered water transfer pump in March 2015.
- A section of the blower discharge piping was replaced due to a crack at a joint connection.

Section 3
Performance Monitoring

Performance monitoring at the River Terrace area includes collecting groundwater and soil gas samples for laboratory analysis, collecting field measurement and system readings, and evaluating system treatment performance by the GAC filter system. The location of the river terrace wells and aeration system is shown in Figure 3 and Figure 4. A summary of the field methods used to conduct performance monitoring at the River Terrace is provided in Appendix B. The following is a summary of monitoring activities conducted at the River Terrace area in 2014.

3.1 Groundwater Monitoring

Groundwater samples were collected in 2015 only during low flow operation of the San Juan River (i.e. with a river flow rate of approximately 500 scfm). The San Juan River did not experience a high flow operating period in 2015 due to continued drought conditions in the area. Groundwater sampling activities during low flow conditions of the San Juan River were conducted during the week of April 28, 2015. The following is a summary of activities performed during the groundwater monitoring event conducted in 2015.

3.1.1 Groundwater Measurements

Depth-to-groundwater and depth-to-product measurements were collected from TP-3, TP-5 through TP-13, DW-3, and MW-49. The measurements were collected prior to the collection of groundwater samples during the San Juan River low flow sampling events. A summary of the groundwater measurements is provided in Table 2.

3.1.2 Groundwater Field Parameters

Groundwater field parameters (temperature, pH, conductivity, D.O., and ORP) were collected prior to collecting groundwater samples. Groundwater field parameters were collected from TP-3, TP-5 thru TP-13, DW-3, and MW-49. A summary of the groundwater field parameters collected during the sampling event are included in Table 2.

3.1.3 Groundwater Sampling

Groundwater samples were collected from TP-3, TP-5 thru TP-13, DW-3, and MW-49. Groundwater samples were submitted to Hall Environmental Analytical Laboratory and analyzed for the following constituents:

- Volatile Organic Compounds – BTEX and MTBE by EPA Method 8260B,
- Total Petroleum Hydrocarbons (TPH) – Gasoline Range Organics (GRO) by EPA Modified Method 8015D,
- Total Petroleum Hydrocarbons (TPH) – Diesel Range Organics (DRO) by EPA Modified Method 8015D,
- Total Recoverable Metals – Total lead by EPA Method 6010C, and
- Total Recoverable Metals – Total mercury by EPA Method 7470 (DW-1 only).

A summary of the groundwater analysis is provided in Table 2 and the analytical reports are provided as Appendix D.

3.2 Soil Vapor Monitoring

3.2.1 Pressure Readings

During the sampling event, field pressure readings were collected from TP-3, TP-5 thru TP-13, DW-1, DW-3, and MW-49 using a hand-held magnahelic gauge connected to the sample port at the top of each well. Refer to Table 1 for a summary of the pressure readings collected during the 2015 sampling event.

Injection pressure readings were collected from the bioventing wells, the air sparging lines, and at the discharge of the main air blower as part of the Low Flow Sampling Event activities. Table 3 provides a summary of the field readings collected in 2015.

3.2.2 Soil Gas Field Parameters

Field measurements of soil gas hydrocarbons (using a PID), oxygen, and carbon dioxide concentrations (using a multi-gas meter) were collected from TP-3, TP-5 thru TP-13, DW-1, DW-3, and MW-49 during the Low Flow Sampling Event. A summary of the soil gas field parameters is provided in Table 1.

3.2.3 Soil Gas Sampling

Soil gas samples were collected from TP-3, TP-5 thru TP-13, DW-1, DW-3, and MW-49 during low flow operation of the San Juan River. All soil gas samples were collected in tedlar bags, and submitted to Hall Environmental Analytical Laboratory to be analyzed for the following parameters:

- Volatile Organic Compounds – BTEX by EPA Method 8260B
- Total Petroleum Hydrocarbons – GRO by EPA Method 8015D

A summary of the soil gas analytical results is provided in Table 1.

3.3 Bioventing System Performance Monitoring

3.3.1 GAC Sampling

Extracted groundwater from the active dewatering wells is treated prior to discharging to the raw water ponds, located within the east portion of the refinery. Extracted groundwater is pumped through two granular activated carbon (GAC) filters positioned in series for removal of dissolved-phase hydrocarbons.

GAC influent (GAC-Inlet) samples, GAC effluent samples (GAC-Lag), and lead GAC filter effluent samples (GAC-Lead) are required to be collected quarterly. Additional samples were collected to monitor system performance. Samples were submitted to Hall Environmental Analytical Laboratory and analyzed for the following parameters:

- Volatile Organic Compounds – BTEX and MTBE by EPA Method 8021B
- Total Petroleum Hydrocarbons – Gasoline Range Organics by EPA Method 8015B
- Total Petroleum Hydrocarbons – Diesel Range Organics by EPA Method 8015B

A summary of the analytical results for samples collected at the GAC filters is provided in Table 4.

3.3.2 In-Situ Respiration Test

Western has conducted three separate in-situ respiration tests at the River Terrace area in May 2006, September 2007, and October 2009. The suspension of refining operations causes the dewatering system to operate intermittently which in turn affects exposure of the vadose zone thus affecting the accuracy of the in-situ respiration test. In a response letter from NMED dated November 23, 2010 (NMED, 2010), NMED-HWB granted approval to discontinue conducting the in-situ respiration tests. Therefore an in-situ respiration was not performed in 2014.

Section 4
Conclusions and Recommendations

This section summarizes and provides an evaluation of the results shown in field monitoring data and analytical data. The analytical reports for groundwater and soil gas samples are provided in Appendix D. The regulatory criteria and groundwater clean-up standards used to compare the river terrace sample results are provided in Appendix A.

4.1 Conclusions

4.1.1 Groundwater Monitoring

Groundwater samples were collected at specific wells and analyzed for volatile organic compounds (benzene, toluene, ethylbenzene, xylenes, and MTBE), TPH-DRO, TPH-GRO, total lead, and total mercury. The analytical results for samples collected in 2015 during San Juan River low flow conditions were below their respective screening levels with the following exceptions:

- Benzene was detected at concentrations above the respective MCL (0.005 mg/L) at one location (DW-3). The concentration of benzene detected was 0.082 mg/L. All other benzene sample results were below the laboratory detection limit.
- Xylenes were detected at concentrations above the respective WQCC screening level of 0.62 mg/L at one location (TP-5). The concentration of xylene detected was 1.300 mg/L.
- Lead was detected ac concentrations above the respective MCL (0.0150 mg/l) at TP-5. The concentration of lead detected was 0.019 mg/l.

In addition, TPH-DRO was detected above the respective laboratory reporting limit at TP-5, TP-6, TP-8, TP-9, TP-13 and DW-3. The detected concentrations ranged between 0.22 mg/l and 1.6 mg/l, with the highest concentration detected at TP-6. TPH-GRO was detected above the respective laboratory reporting limit at TP-5, TP-6, TP-8, and DW-3. The detected concentrations ranged between 1.4 mg/l and 7.1 mg/l, with the highest concentration detected at TP-5.

Table 2 provides a summary of the analytical groundwater results. Lead was inadvertantly not sampled at DW-1 during the 2015 sampling event. A sample will be collected as part of the 2016 sampling activities. A concentration map showing the benzene, toluene, ethylbenzene, xylenes, and TPH-DRO concentrations for the River Terrace wells during low flow conditions is provided in Figure 5.

4.1.2 *Soil Vapor Monitoring*

Soil gas field readings were collected to measure organics, oxygen, and carbon dioxide in the subsurface. The PID meter detected low level concentrations of organics, ranging between 0.0 ppm and 67.3 ppm. The highest concentration was detected at DW-3, located within the active area of the bioventing system. The measured oxygen levels ranged between 17.6% and 19.8% throughout the River Terrace.

Soil gas samples were collected at specific wells and analyzed for volatile organic compounds (benzene, toluene, ethylbenzene, and xylenes), and TPH-GRO. A summary of the results is provided in Table 1. Figure 6 is a concentration map showing the benzene, toluene, ethylbenzene, and xylenes concentrations for the River Terrace wells during low flow conditions. The analytical results for samples collected in 2015 were not detected above the respective laboratory screening level, with the exception of the following:

- Benzene was detected in a sample collected at DW-3, with a concentration detected of 0.79 ug/L.
- Ethylbenzene was detected in samples collected at DW-3, with a concentration detected of 7.0 ug/L.
- Xylene was detected in samples collected at DW-3, with a concentration detected of 4.40 ug/L.
- TPH-GRO was detected in samples collected at DW-3 with a concentration detected of 61.0 ug/L.

Soil gas field measurements indicate that the aeration system has been successful in maintaining sufficient oxygen within the subsurface to help sustain bioremedial activity. Well location DW-3 shows the highest soil gas concentrations, which also correlates to the groundwater results in this location.

4.1.3 *Optimized Biovent System Monitoring*

Groundwater Treatment System

A total of 401,618 gallons of impacted groundwater was removed and treated through the GAC filters. In addition to the quarterly samples collected at the GAC filter inlet and at the outlet of each GAC filter, additional samples were voluntarily collected to monitor the progress of the treatment system. The benzene, ethlylebenzene, and xylenes concentrations at the inlet of the GAC filters decreased over time during 2015, with concentrations below the respective screening levels since October 2015.

Pressure readings were collected at the biovent wells, air sparging lines, and the main air blower in 2015. The air injection system ran consistently throughout 2015 and required no changes to the air distribution. The pressure readings at each BV well was consistent and at a sufficient level to provide aeration to the vadose zone.

4.2 Recommendations

Groundwater monitoring data collected in 2015 continues to shows that groundwater impacts are localized to within the southwest portion of the River Terrace, with the highest concentrations within the vicinity of DW-3. Western believes that it is no longer necessary to monitor the eastside of the River Terrace because no contamination has been found there as demonstrated by the data.

Section 5
References

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Tables

Table 1
2015 Soil Gas Monitoring Data Summary

Sample Location	Sampling Activities	Date	Purge Volume (gal)	Depth to Water (ft below TOC)	Pressure (Inches of Water)	PID (ppm)	Oxygen (%)	Carbon Dioxide (%)	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)	TPH-GRO (ug/L)
TP-1	*****Decommissioned November 2012**	November 2012	***	***	***	***	***	***	***	***	***	***	***
TP-2	*****Decommissioned November 2012**	November 2012	***	***	***	***	***	***	***	***	***	***	***
TP-3 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	2.3	7.53	0.00	0.0	19.8	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07-09-13	20*	7.11	0.00	2.2	19.4	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2012	Week of 05-31-12	NR^2	5.32	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2012	Week of 04-09-12	NR^2	7.37	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	High Flow 2011	Week of 06-13-11	NR^2	5.80	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2011	Week of 07-26-11	12.9	7.71	0.00	0.1	20.3	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
TP-5	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	1.8	5.13	0.00	0.3	19.8	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/21/14	9.5	5.19	0.00	5.0	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/09/13	20*	4.95	0.00	1.1	19.4	0.0	<0.10	<0.10	<0.10	<0.30	6.9
	High Flow 2012	Week of 05-31-12	6.3	3.42	0.00	0.8	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	Low Flow 2012	Week of 04-19-12	9.4	5.09	0.50	0.6	20.8	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	Low Flow 2011	Week of 07-26-11	10.3	5.69	0.40	2.2	20.3	0.0	<0.10	<0.10	<0.10	<0.30	12.0
	High Flow 2011	Week of 06-13-11	9.0	4.95	0.00	0.9	19.4	0.1	<0.10	<0.10	<0.10	<0.30	<5.0

Table 1
2015 Soil Gas Monitoring Data Summary

Sample Location	Sampling Activities	Date	Purge Volume (gal)	Depth to Water (ft below TOC)	Pressure (Inches of Water)	PID (ppm)	Oxygen (%)	Carbon Dioxide (%)	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)	TPH-GRO (ug/L)
TP-6	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	1.9	6.00	0.00	0.0	19.8	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/21/14	11.2	6.11	0.00	2.8	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/9/13	20*	5.79	0.00	0.1	19.1	0.1	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2012	Week of 05-31-12	7.5	4.06	0.00	0.2	20.9	0.0	<0.10	<0.10	<0.10	<0.30	7.9
	Low Flow 2012	Week of 04-19-12	11.0	6.01	0.00	0.0	20.8	0.0	<0.10	<0.10	<0.10	<0.30	6.8
	Low Flow 2011	Week of 07-26-11	11.9	6.58	0.50	0.5	20.3	0.0	<0.10	<0.10	<0.10	<0.30	10
	High Flow 2011	Week of 06-13-11	9.7	5.36	0.00	0.9	19.8	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
TP-7 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	1.7	6.05	0.00	0.0	19.7	0.1	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/09/13	20*	5.59	0.00	0.0	17.8	2.7	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2012	Week of 05-31-12	NM	2.73	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2012	Week of 07-01-12	NM	5.79	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2011	Week of 07-26-11	10.6	6.15	0.00	0.1	19.8	0.4	<0.10	<0.10	<0.10	<0.30	5.8
	High Flow 2011	Week of 06-13-11	11.0	2.95	0.00	0.1	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0

Table 1
2015 Soil Gas Monitoring Data Summary

Sample Location	Sampling Activities	Date	Purge Volume (gal)	Depth to Water (ft below TOC)	Pressure (Inches of Water)	PID (ppm)	Oxygen (%)	Carbon Dioxide (%)	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)	TPH-GRO (ug/L)
TP-8	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	0.81	8.06	0.00	0.10	19.80	0.00	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/21/14	11.4	6.22	0.00	1.2	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/09/13	20*	6.29	0.00	11.8	18.5	0.7	<0.10	<0.10	0.12	<0.30	17.0
	High Flow 2012	Week of 05-31-12	9.2	5.02	0.00	0.6	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	Low Flow 2012	Week of 04-19-12	11.9	6.50	2.00	0.0	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	Low Flow 2011	Week of 07-26-11	12.5	7.46	3.90	0.5	20.3	0.0	<0.10	<0.10	<0.10	<0.30	8.7
	High Flow 2011	Week of 06-13-11	11.3	6.26	0.00	0.1	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
TP-9	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	2.4	5.93	0.00	0.0	19.8	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/21/14	12.8	6.98	0.00	2.1	19.0	1.7	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/09/13	20*	5.23	0.00	0.6	19.4	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2012	Week of 05-31-12	4.0	2.18	0.00	0.0	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	Low Flow 2012	Week of 04-19-12	10.6	5.75	0.00	0.0	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	Low Flow 2011	Week of 07-26-11	9.7	5.93	0.00	0.5	20.8	0.0	<0.10	<0.10	<0.10	<0.30	8.2
	High Flow 2011	Week of 06-13-11	4.9	2.13	0.00	0.0	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0

Table 1
2015 Soil Gas Monitoring Data Summary

Sample Location	Sampling Activities	Date	Purge Volume (gal)	Depth to Water (ft below TOC)	Pressure (Inches of Water)	PID (ppm)	Oxygen (%)	Carbon Dioxide (%)	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)	TPH-GRO (ug/L)
TP-10 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	2.1	5.50	0.00	0.0	19.8	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/09/13	20*	4.99	0.00	0.5	19.4	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2012	Week of 05-31-12	NR^2	2.82	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2012	Week of 04-19-12	NR^2	5.33	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2011	Week of 07-26-11	9.1	5.57	0.00	0.1	20.5	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2011	Week of 06-13-11	NR^2	3.08	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
TP-11 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	2.0	5.84	0.00	0.0	17.9	1.4	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/09/13	20*	5.45	0.00	0.3	19.4	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2012	Week of 05-31-12	NR^2	3.48	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2012	Week of 04-19-12	NR^2	5.75	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	High Flow 2011	Week of 06-13-11	NR^2	3.81	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2011	Week of 07-26-11	9.8	6.03	0.00	0.0	20.4	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
TP-12 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	2.1	7.57	0.00	0.0	19.8	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/09/13	20*	7.10	0.00	0.1	19.4	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2012	Week of 05-31-12	NR^2	5.00	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2012	Week of 04-19-12	NR^2	7.45	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	High Flow 2011	Week of 06-13-11	NR^2	5.24	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2011	Week of 07-26-11	12.9	7.67	0.00	0.2	20.5	0.0	<0.10	<0.10	<0.10	<0.30	<5.0

Table 1
2015 Soil Gas Monitoring Data Summary

Sample Location	Sampling Activities	Date	Purge Volume (gal)	Depth to Water (ft below TOC)	Pressure (Inches of Water)	PID (ppm)	Oxygen (%)	Carbon Dioxide (%)	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)	TPH-GRO (ug/L)
TP-13 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	4.7	6.45	0.00	0.0	17.6	1.4	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/09/13	20*	5.88	0.00	0.1	19.3	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2012	Week of 05-31-12	NR^{2}	3.78	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}
	Low Flow 2012	Week of 04-19-12	NR^{2}	6.29	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}
	High Flow 2011	Week of 06-13-11	NR^{2}	3.82	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}
	Low Flow 2011	Week of 07-26-11	10.8	6.46	0.00	0.2	20.4	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
DW-1 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	41.9	6.30	0.00	3.3	17.6	1.8	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/09/13	80*	9.64	0.00	0.0	19.0	0.4	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2012	Week of 05-31-12	NM	3.99	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}
	Low Flow 2012	Week of 04-19-12	NM	6.41	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}	NR^{2}
	High Flow 2011	Week of 06-13-11	75.1	4.54	0.00	0.0	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	Low Flow 2011	Week of 07-26-11	101.0	6.68	0.00	0.5	20.3	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
DW-3	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	Pumping	11.23	0.00	67.3	18.4	0.6	0.79	<0.20	7.00	4.40	61.0
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/21/14	50.7	6.92	0.00	25.8	20.3	0.6	0.74	<0.10	12.0	20.0	150.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/09/13	20*	6.64	0.00	9.7	18.7	0.6	0.25	<0.10	1.30	11.0	61.0

Table 1
2015 Soil Gas Monitoring Data Summary

Sample Location	Sampling Activities	Date	Purge Volume (gal)	Depth to Water (ft below TOC)	Pressure (Inches of Water)	PID (ppm)	Oxygen (%)	Carbon Dioxide (%)	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Xylenes (ug/L)	TPH-GRO (ug/L)
MW-49	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04-28-15	15.1	9.65	0.00	0.0	19.8	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/21/14	73.9	10.08	0.00	0.8	19.9	0.8	<0.10	<0.10	<0.10	<0.30	<5.0
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/09/13	50*	9.17	0.00	0.1	17.0	2.9	<0.10	<0.10	<0.10	<0.30	<5.0
	HighFlow 2012	Week of 05-31-12	42.3	5.76	0.00	0.0	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	Low Flow 2012	Week of 04-19-12	70.1	9.56	0.00	0.0	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0
	Low Flow 2011	Week of 07-26-11	67.0	9.76	0.00	0.2	19.7	0.3	<0.10	<0.10	<0.10	<0.30	5.4
	High Flow 2011	Week of 06-13-11	45.3	5.74	0.00	0.0	20.9	0.0	<0.10	<0.10	<0.10	<0.30	<5.0

Notes:

NR^1 = Not Required (NMED, 2009)
NR^2 = Not Required (NMED, 2011)
NM = Not Measured
NA = Inadvertently not Analyzed

* Purge volumes based on calculation of approximately 10 L/min pumping rate. 2-inch diameter wells pumped for approximately 2 minutes; 4-inch wells were pumped for 5 minutes; and 6-inch wells were pumped for 8 minutes.

** Due to drought, river conditions never met high flow requirements.

*** Well Decommissioned November 2012 as part of biovent system enhancements.

TABLE 2
2015 Groundwater Monitoring Data Summary

											MCL	WQCC 20NMAC 6.2.3103	MCL	WQCC 20NMAC 6.2.3103	USEPA Regional Screening Levels			40 CFR 141.62 (MCL)	
											0.005	**0.75**	**0.700**	**0.620**	**0.012**			**0.0150**	**0.002**
Sample Location	**Sampling Event**	**DATE**	**Depth to Water (ft below TOC)**	**Depth to Product (ft below TOC)**	**Total Well Depth (ft below TOC)**	**Conductivity (umhos/cm)**	**D.O. (mg/L)**	**ORP (mV)**	**pH**	**TEMP (°F)**	**Benzene (mg/L)**	**Toluene (mg/L)**	**Ethylbenzene (mg/L)**	**Xylene (mg/L)**	**MTBE (mg/L)**	**TPH-DRO (mg/L)**	**TPH-GRO (mg/L)**	**Lead (mg/L)**	**Mercury (mg/L)**
TP-1	*****Decommissioned November 2012**	November 2012	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
TP-2	*****Decommissioned November 2012**	November 2012	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
TP-3 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04/28/15	7.53	NPP	12.35	891	2.56	29.3	7.69	54.7	<0.001	<0.001	<0.001	<0.0015	<0.001	<0.20	<0.05	<0.005	NR^2
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	7.11	NPP	12.35	421	2.06	62	7.47	66.4	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.05	**0.0051**	NR^2
	High Flow 2012	Week of 05/29/12	5.32	NPP	12.35	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2012	Week of 04/09/12	7.37	NPP	12.35	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2011	Week of 07/25/11	7.71	NPP	12.35	434	3.76	256	6.30	66.2	<0.001	<0.001	<0.001	<0.002	<0.0025	<0.20	<0.05	<0.005	NR^2
	High Flow 2011	Week of 06/13/11	5.80	NPP	12.35	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
TP-5	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04/28/15	5.13	NPP	5.13	828	2.28	-257	7.56	55.1	<0.010	<0.010	**0.063**	**1.300**	<0.010	**0.75**	**7.1**	**0.019**	NR^2
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/22/14	5.19	NPP	8.84	526	0.34	-251	7.30	53.7	<0.005	<0.005	**0.027**	**0.450**	<0.005	**2.2**	**4.0**	**0.012**	NR^2
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	4.95	NPP	8.84	431	2.55	-210	7.56	68.1	<0.010	<0.010	**0.022**	**0.590**	<0.010	**0.69**	**4.6**	**0.013**	NR^2
	High Flow 2012	Week of 05/29/12	3.42	NPP	8.84	470	1.48	-33	6.30	61.1	<0.005	<0.005	**0.017**	**0.450**	<0.005	**1.10**	**4.20**	**0.0260**	NR^2
	Low Flow 2012	Week of 04/09/12	5.09	NPP	8.84	363	0.93	-266	6.80	50.9	<0.005	<0.005	**0.020**	**0.410**	<0.005	**0.60**	**1.80**	**0.3600**	NR^2
	Low Flow 2011	Week of 07/26/11	5.69	NPP	8.84	932	1.78	192	6.70	68.5	<0.010	<0.01	**0.051**	**1.200**	<0.025	**0.24**	**4.9**	**0.0550**	NR^2
	High Flow 2011	Week of 06/13/11	4.95	NPP	8.84	561	0.72	273	6.95	62.2	<0.010	<0.01	**0.350**	**4.200**	<0.025	**3.20**	**20**	**0.0580**	NR^2

TABLE 2
2015 Groundwater Monitoring Data Summary

										MCL	WQCC 20NMAC 6.2.3103	MCL	WQCC 20NMAC 6.2.3103	USEPA Regional Screening Levels			40 CFR 141.62 (MCL)	
										0.005	0.75	0.700	0.620	0.012			0.0150	0.002
Sample Location	**Sampling Event**	**DATE**	**Depth to Water (ft below TOC)**	**Depth to Product (ft below TOC)**	**Total Well Depth (ft below TOC)**	**Conductivity (umhos/cm)**	**D.O. (mg/L)**	**ORP (mV)**	**pH**	**TEMP (ºF)**	**Benzene (mg/L)**	**Toluene (mg/L)**	**Ethylbenzene (mg/L)**	**Xylene (mg/L)**	**MTBE (mg/L)**	**TPH-DRO (mg/L)**	**TPH-GRO (mg/L)**	**Lead (mg/L)**	**Mercury (mg/L)**
TP-6	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**		**	**
	Low Flow 2015	Week of 04/28/15	6.00	NPP	9.94	800	1.77	-185	7.73	55.8	<0.001	<0.001	**0.0087**	**0.0048**	<0.001	**1.6**	**1.5**	**0.0150**	NR^2
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/22/14	6.11	NPP	9.94	552	4.25	-83	7.11	53.5	<0.001	<0.001	**0.028**	**0.093**	<0.001	**1.7**	**3.5**	**0.0084**	NR^2
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	5.79	NPP	9.94	457	6.84	-7	7.71	70.2	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	**0.0100**	NR^2
	High Flow 2012	Week of 05/29/12	4.06	NPP	9.94	450	1.67	-6	7.10	61.9	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	**0.360**	**0.0240**	NR^2
	Low Flow 2012	Week of 04/09/12	6.01	NPP	9.94	612	6.00	-64	7.53	51.0	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	**0.0230**	NR^2
	Low Flow 2011	Week of 07/26/11	6.58	NPP	9.94	706	3.90	182	6.70	68.1	<0.001	<0.001	<0.001	<0.002	<0.0025	<0.20	<0.05	<0.0050	NR^2
	High Flow 2011	Week of 06/13/11	5.36	NPP	9.94	699	1.08	153	6.89	62.0	<0.001	<0.001	**0.002**	**0.002**	<0.0025	<0.20	**0.2**	**0.0520**	NR^2
TP-7 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04/28/15	6.05	NPP	9.72	773	3.09	-62.4	7.76	54.8	<0.002	<0.002	<0.002	<0.003	<0.002	<0.20	<0.50	<0.005	NR^2
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	5.59	NPP	9.72	704	5.67	-56	7.40	64.9	<0.010	<0.010	<0.010	<0.020	<0.010	<0.20	<0.50	**0.0014**	NR^2
	High Flow 2012	Week of 05/29/12	2.73	NPP	9.72	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2012	Week of 04/09/12	5.79	NPP	9.72	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2011	Week of 07/26/11	6.15	NPP	9.72	1081	1.82	219	6.80	69.2	<0.001	<0.001	<0.001	<0.002	<0.0025	<0.20	<0.05	**0.0061**	NR^2
	High Flow 2011	Week of 06/13/11	2.95	NPP	9.72	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
TP-8	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04/28/15	8.06	NPP	9.72	907	2.64	-93.6	7.76	54.0	<0.005	<0.005	**0.0099**	**0.044**	<0.005	**1.3**	**1.4**	**0.0091**	NR^2
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/22/14	6.22	NPP	9.72	957	2.33	-226	7.56	53.6	<0.005	<0.005	**0.019**	**0.083**	<0.005	**2.3**	**4.0**	**0.0080**	NR^2
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	6.29	NPP	9.72	995	1.71	-179	7.40	68.0	<0.005	<0.005	**0.014**	**0.091**	<0.005	**1.60**	**4.00**	**0.0110**	NR^2
	High Flow 2012	Week of 05/29/12	5.02	NPP	9.72	789	1.92	79	7.00	60.9	<0.005	<0.005	**0.019**	**0.110**	<0.005	**1.30**	**3.00**	**0.0550**	NR^2
	Low Flow 2012	Week of 04/09/12	6.50	NPP	9.72	883	1.65	-209	7.55	50.2	<0.005	<0.005	**0.022**	**0.069**	<0.005	**0.83**	**0.41**	**0.0190**	NR^2
	Low Flow 2011	Week of 07/26/11	7.46	NPP	9.72	825	2.09	119	6.70	67.2	<0.005	<0.005	**0.029**	**0.130**	<0.013	**0.62**	**2.1**	**0.0054**	NR^2
	High Flow 2011	Week of 06/13/11	6.26	NPP	9.72	886	0.88	204	6.68	59.9	<0.005	<0.005	**0.026**	**0.140**	<0.013	**1.0**	**1.9**	**0.0600**	NR^2

TABLE 2
2015 Groundwater Monitoring Data Summary

										MCL	WQCC 20NMAC 6.2.3103	MCL	WQCC 20NMAC 6.2.3103	USEPA Regional Screening Levels			40 CFR 141.62 (MCL)	
										0.005	0.75	0.700	0.620	0.012			0.0150	0.002
Sample Location	**Sampling Event**	**DATE**	**Depth to Water (ft below TOC)**	**Depth to Product (ft below TOC)**	**Total Well Depth (ft below TOC)**	**Conductivity (umhos/cm)**	**D.O. (mg/L)**	**ORP (mV)**	**pH**	**TEMP (ºF)**	**Benzene (mg/L)**	**Toluene (mg/L)**	**Ethylbenzene (mg/L)**	**Xylene (mg/L)**	**MTBE (mg/L)**	**TPH-DRO (mg/L)**	**TPH-GRO (mg/L)**	**Lead (mg/L)**	**Mercury (mg/L)**
TP-9	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04/28/15	5.93	NPP	10.97	1833	3.38	-104	7.35	51.9	<0.001	<0.001	<0.001	<0.0015	<0.001	**0.35**	<0.050	**0.0056**	NR[2]
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/22/14	6.98	NPP	10.97	1410	5.09	-54	7.05	50.8	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	<0.0050	NR[2]
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	5.23	NPP	10.97	1330	4.80	65	7.00	65.5	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	**0.0091**	NR[2]
	High Flow 2012	Week of 05/29/12	2.18	NPP	10.97	1113	1.82	148	6.90	58.3	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	<0.0025	NR[2]
	Low Flow 2012	Week of 04/09/12	5.75	NPP	10.97	1290	2.08	-125	7.18	47.8	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.05	<0.0050	NR
	Low Flow 2011	Week of 07/26/11	5.93	NPP	10.97	1690	2.38	237	6.70	66.5	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	<0.0050	NR[2]
	High Flow 2011	Week of 06/13/11	2.13	NPP	10.97	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]
TP-10 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04/28/15	5.50	NPP	9.95	695	1.78	46.3	7.60	50.7	<0.001	<0.001	<0.001	<0.0015	<0.001	<0.20	<0.050	**0.024**	NR[2]
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	4.99	NPP	9.95	340	2.01	60	7.50	63.1	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	**0.0013**	NR[2]
	High Flow 2012	Week of 05/29/12	2.82	NPP	9.95	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]
	Low Flow 2012	Week of 04/09/12	5.33	NPP	9.95	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]
	Low Flow 2011	Week of 07/26/11	5.57	NPP	9.95	406	2.24	257	6.60	66.1	<0.001	<0.001	<0.001	<0.002	<0.0025	<0.20	<0.05	<0.0050	NR[2]
	High Flow 2011	Week of 06/13/11	3.08	NPP	9.95	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]
TP-11 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04/28/15	5.84	NPP	9.98	797	2.06	34.4	7.67	51.9	<0.001	<0.001	<0.001	<0.0015	<0.001	<0.20	<0.050	<0.0050	NR[1]
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	5.45	NPP	9.98	500	1.92	-28	7.40	62.4	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	**0.0130**	NR[1]
	High Flow 2012	Week of 05/29/12	3.48	NPP	9.98	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]
	Low Flow 2012	Week of 04/09/12	5.75	NPP	9.98	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]
	Low Flow 2011	Week of 07/26/11	6.03	NPP	9.98	476	2.24	264	6.70	65.0	<0.001	<0.001	<0.001	<0.002	<0.0025	<0.20	<0.05	<0.0050	NR[2]
	High Flow 2011	Week of 06/13/11	3.81	NPP	9.98	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]	NR[2]

TABLE 2
2015 Groundwater Monitoring Data Summary

											MCL	WQCC 20NMAC 6.2.3103	MCL	WQCC 20NMAC 6.2.3103	USEPA Regional Screening Levels			40 CFR 141.62 (MCL)	
											0.005	0.75	0.700	0.620	0.012			0.0150	0.002
Sample Location	**Sampling Event**	**DATE**	**Depth to Water (ft below TOC)**	**Depth to Product (ft below TOC)**	**Total Well Depth (ft below TOC)**	**Conductivity (umhos/cm)**	**D.O. (mg/L)**	**ORP (mV)**	**pH**	**TEMP (ºF)**	**Benzene (mg/L)**	**Toluene (mg/L)**	**Ethylbenzene (mg/L)**	**Xylene (mg/L)**	**MTBE (mg/L)**	**TPH-DRO (mg/L)**	**TPH-GRO (mg/L)**	**Lead (mg/L)**	**Mercury (mg/L)**
TP-12 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 07/11/15	7.57	NPP	11.79	1064	2.51	-33.9	7.55	51.0	<0.001	<0.001	<0.001	<0.0015	<0.001	<0.20	<0.050	<0.0050	NR^2
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	7.10	NPP	11.79	561	2.61	-32	7.60	56.6	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	**0.0058**	NR^2
	High Flow 2012	Week of 05/29/12	5.00	NPP	11.79	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2012	Week of 04/09/12	7.45	NPP	11.79	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2011	Week of 07/26/11	7.67	NPP	11.79	903	2.13	268	6.70	58.6	<0.001	<0.001	<0.001	<0.002	<0.0025	<0.20	<0.05	<0.0050	NR^2
	High Flow 2011	Week of 06/13/11	5.24	NPP	11.79	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
TP-13 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04/28/15	6.45	NPP	16.09	600	5.66	-15.7	7.83	50.5	<0.002	<0.002	<0.002	<0.003	<0.002	**0.22**	<0.050	**0.0064**	NR^2
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	5.88	NPP	16.09	365	3.23	-54	7.50	60.7	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	**0.0068**	NR^2
	High Flow 2012	Week of 05/29/12	3.78	NPP	16.09	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2012	Week of 04/09/12	6.29	NPP	16.09	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2011	Week of 04/19/10	6.46	NPP	16.09	406	1.86	262	6.60	63.7	<0.001	<0.001	<0.001	<0.002	<0.0025	<0.20	<0.05	<0.0050	NR^2
	High Flow 2011	Week of 04/19/10	3.82	NPP	16.09	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Baseline	Week of 08/15/05	6.27	NPP	16.09	1226	NR	NR	6.97	58.4	<0.0005	<0.0005	<0.0005	**0.004**	<0.0025	*<1.00	<0.05	NR	NR
DW-1 (Bi-Annual)	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04/28/15	6.30	NPP	15.62	2053	2.13	-114	7.26	53.5	<0.001	<0.001	<0.001	<0.0015	<0.001	<0.20	<0.050	****	<0.0002
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	9.64	NPP	15.62	1936	2.43	-93	7.00	68.8	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	**0.0014**	<0.0002
	High Flow 2012	Week of 05/29/12	3.99	NPP	15.62	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2012	Week of 04/09/12	6.41	NPP	15.62	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2
	Low Flow 2011	Week of 07/26/11	6.68	NPP	15.62	3116	2.67	156	6.70	68.1	<0.001	<0.001	<0.001	<0.002	<0.0025	<0.20	<0.05	<0.0050	<0.0002
	High Flow 2011	Week of 06/13/11	4.54	NPP	15.62	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2	NR^2

TABLE 2
2015 Groundwater Monitoring Data Summary

											MCL	WQCC 20NMAC 6.2.3103	MCL	WQCC 20NMAC 6.2.3103	USEPA Regional Screening Levels			40 CFR 141.62 (MCL)	
											0.005	0.75	0.700	0.620	0.012			0.0150	0.002
Sample Location	**Sampling Event**	**DATE**	**Depth to Water (ft below TOC)**	**Depth to Product (ft below TOC)**	**Total Well Depth (ft below TOC)**	**Conductivity (umhos/cm)**	**D.O. (mg/L)**	**ORP (mV)**	**pH**	**TEMP (ºF)**	**Benzene (mg/L)**	**Toluene (mg/L)**	**Ethylbenzene (mg/L)**	**Xylene (mg/L)**	**MTBE (mg/L)**	**TPH-DRO (mg/L)**	**TPH-GRO (mg/L)**	**Lead (mg/L)**	**Mercury (mg/L)**
DW-3	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04/28/15	11.23	NPP	14.64	1507	6.74	-243	7.58	57.4	**0.082**	<0.010	**0.400**	**0.290**	<0.010	**0.76**	**2.1**	<0.0050	NR^2
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/22/14	6.92	NPP	14.64	1048	0.68	-266	7.36	54.6	**0.067**	<0.010	**0.720**	**1.300**	<0.010	**1.7**	**8.8**	<0.0050	NR^2
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	10.86	NPP	14.64	945	1.15	-265	7.55	67.1	**0.098**	<0.010	**1.700**	**4.100**	<0.010	**3.30**	**23**	**0.0055**	NR^2
	Baseline	Week of 05/14/13	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**4.80**	**31.00**	NS	NS
	Baseline	Week of 02/14/13	NS	NS	NS	NS	NS	NS	NS	NS	**0.082**	<0.010	**0.055**	**0.140**	NS	NS	**2.2**	NS	NS
	Baseline	Week of 11/19/12	NS	NS	NS	NS	NS	NS	NS	NS	**1.400**	**0.0029**	**1.800**	**8.500**	NS	**5.20**	**27.0**	NS	NS
MW-49	High Flow 2015	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2015	Week of 04/28/15	9.65	NPP	16.48	936.00	1.94	-140.80	7.65	52.90	<0.001	<0.001	<0.001	<0.0015	<0.001	<0.20	<0.050	<0.0050	NR^2
	High Flow 2014 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2014	Week of 04/22/14	10.08	NPP	16.48	1255	4.84	-111.2	7.45	51.08	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	**0.0064**	NR^2
	High Flow 2013 **	No High Flow	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
	Low Flow 2013	Week of 07/11/13	9.17	NPP	16.48	749	1.67	-105	7.35	63.4	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.050	**0.0013**	NR^2
	High Flow 2012	Week of 05/29/12	5.76	NPP	16.48	653	2.07	77	7.1	61.2	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.05	<0.0025	NR^2
	Low Flow 2012	Week of 04/09/12	9.56	NPP	16.48	570	1.61	-113.5	7.71	49.2	<0.001	<0.001	<0.001	<0.002	<0.001	<0.20	<0.05	<0.0050	NR^2
	High Flow 2011	Week of 06/13/11	5.74	NPP	16.48	738	0.96	232	6.88	63.4	<0.001	<0.001	<0.001	<0.002	<0.0025	<0.20	<0.05	<0.005	NR^2
	Low Flow 2011	Week of 07/26/11	9.76	NPP	16.48	641	2.15	169	7.00	61.5	<0.001	<0.001	<0.001	<0.002	<0.0025	<0.20	<0.05	<0.0050	NR^2

Notes:
NR = Not Required (Voluntary Corrective Measures - Revised Monitoring Plan - October 2005)
NR^1= Not Required (Approval With Direction - June 2009)
NR^2= Not Required (Approval With Direction - May 2011)
NS = Not Sampled
* Per NMED letter Approval with Direction 2008 Groundwater Remediation and Monitoring Annual Report (Comment 9) dated Sept. 1, 2009 all future DRO analysis will be analyzed at a lower detection level of 0.2mg/L by EPA Method 8015B.
** Due to drought, river conditions never met high flow requirements.
*** Well Decommissioned November 2012 as part of biovent system enhancements.
(Bi-Annual) = Samples taken every other year starting in 2011.

Table 3
2015 Biovent Wells Field Reading Summary

Sample Location	Sampling Event	Sample Date	Pressure (psi)
BV - 1	Low Flow	04/21/15	2.0
BV - 3	Low Flow	04/21/15	2.0
BV - 4	Low Flow	04/21/15	2.0
BV - 5	Low Flow	04/21/15	2.0
BV - 6	Low Flow	04/21/15	2.0
Air Sparging Line A	Low Flow	04/21/15	2.0
Air Sparging Line B	Low Flow	04/21/15	2.0
Main Blower	Low Flow	04/21/15	2.1

Table 4
2015 River Terrace Annual Report
GAC Filter Monitoring

			MCL	WQCC 20NMAC 6.2.3103	MCL	WQCC 20NMAC 6.2.3103			
Sample Location	**Sampling Event**	**DATE**	**Benzene (mg/L)**	**Toluene (mg/L)**	**Ethylbenzene (mg/L)**	**Xylene (mg/L)**	**TPH-DRO (mg/L)**	**TPH-GRO (mg/L)**	**MTBE (mg/L)**
			0.005	**0.750**	**0.700**	**0.620**			
GAC-INLET	4th Quarter	12/30/15	<0.005	<0.005	0.0097	< 0.0075	1.1	0.74	<0.005
		11/11/15	<0.005	<0.005	0.008	< 0.0075	< 0.20	0.38	<0.005
		10/01/15	<0.005	<0.005	<0.005	0.086	0.29	0.60	<0.005
	3rd Quarter	09/01/15	<0.005	<0.005	0.180	0.850	0.35	7.1	---
		08/03/15	<0.005	<0.005	0.170	0.850	1.2	5.2	<0.005
		07/01/15	0.016	<0.005	0.290	0.100	1.30	2.20	<0.005
	2nd Quarter	06/01/15	0.018	<0.010	0.440	0.220	1.60	2.00	<0.010
		05/06/15	0.140	<0.005	0.670	0.550	3.1	4.0	---
		04/01/15	0.130	<0.010	0.790	1.000	2.90	4.6	<0.010
	1st Quarter	03/02/15	0.120	<0.010	0.770	1.800	2.20	7.3	<0.010
		02/02/15	0.090	<0.010	0.490	0.270	3.2	3.8	<0.010
		01/05/15	0.081	<0.010	0.720	0.500	1.1	4.2	<0.010
GAC-LEAD	4th Quarter	12/30/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	0.0016
		11/11/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	0.0015
		10/01/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	0.0011
	3rd Quarter	09/01/15	<0.001	<0.001	<0.001	<0.0015	<0.20	0.28	---
		08/03/15	<0.001	<0.001	<0.001	<0.0015	<0.20	0.23	0.0011
		07/01/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	0.0015
	2nd Quarter	06/01/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	<0.0010
		05/06/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	---
		04/01/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	<0.0010
	1st Quarter	03/02/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	0.0017
		02/02/15	<0.001	<0.001	<0.001	<0.0015	0.4	<0.050	<0.0010
		01/05/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	0.0016
GAC-LAG	4th Quarter	11/11/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	<0.0010
		10/01/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	<0.0010
	3rd Quarter	09/01/15	<0.001	<0.001	<0.001	<0.0015	<0.20	0.46	---
		08/03/15	<0.001	<0.001	<0.001	<0.0015	<0.20	0.15	<0.0010
		07/01/15	<0.001	<0.001	<0.001	<0.0015	<0.20	0.15	<0.0010
	2nd Quarter	04/01/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	<0.0010
	1st Quarter	03/02/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	<0.0010
		01/05/15	<0.001	<0.001	<0.001	<0.0015	<0.20	<0.050	<0.0010

Notes:

🟨 = Analytical result exceeds the respective screening level.

MTBE = Methyl tert-butyl ether

MCL - Maximum Contaminant Level

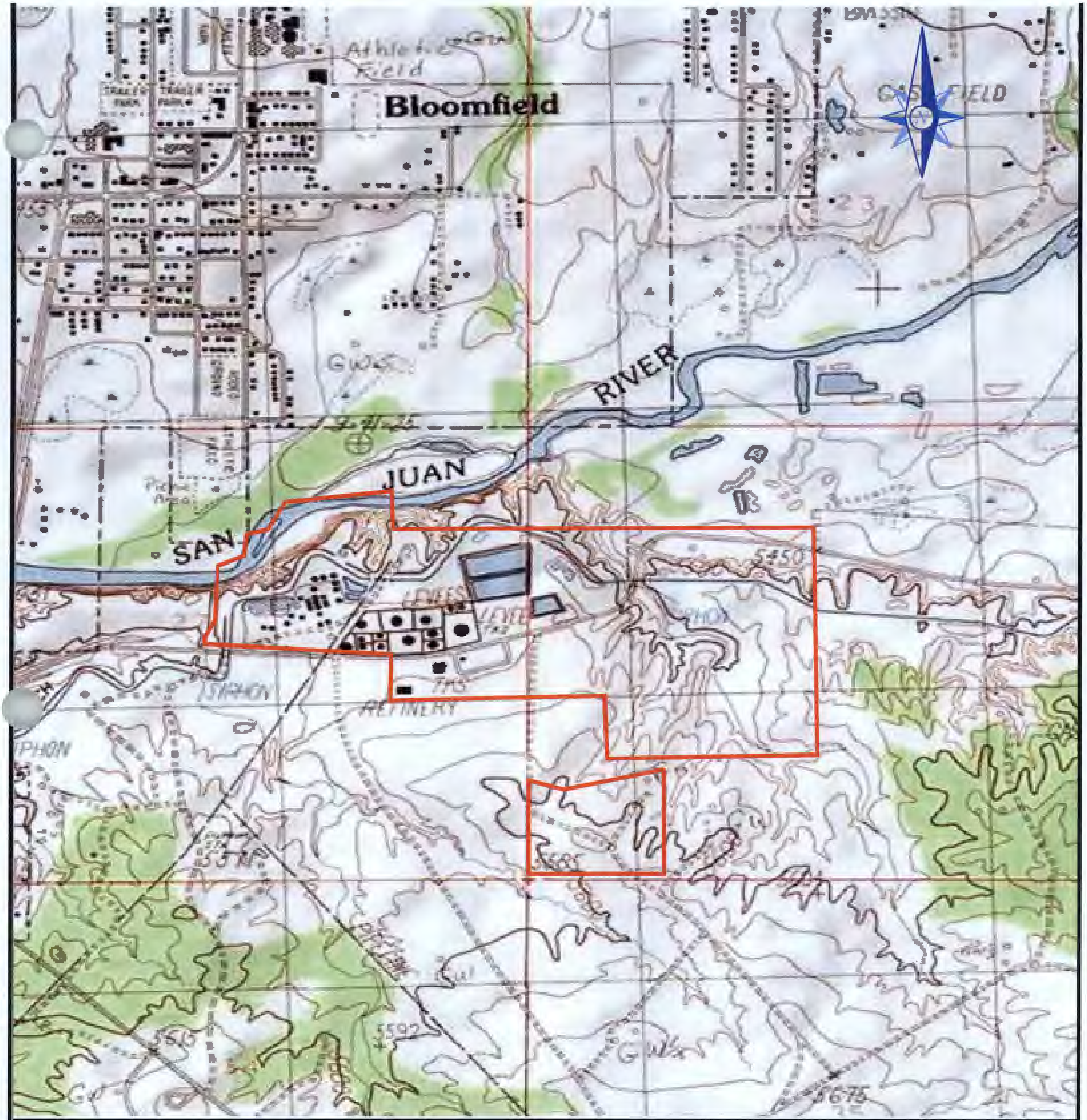
TPH-DRO = Total Petroleum Hydrocarbons - Diesel Range Organcis

TPH-GRO = Total Petroleum Hydrocarbons - Gasoline Range Organics

WQCC = Water Qaulity Control Comission

--- = Not analyzed

Figures



Approximate Property Boundary

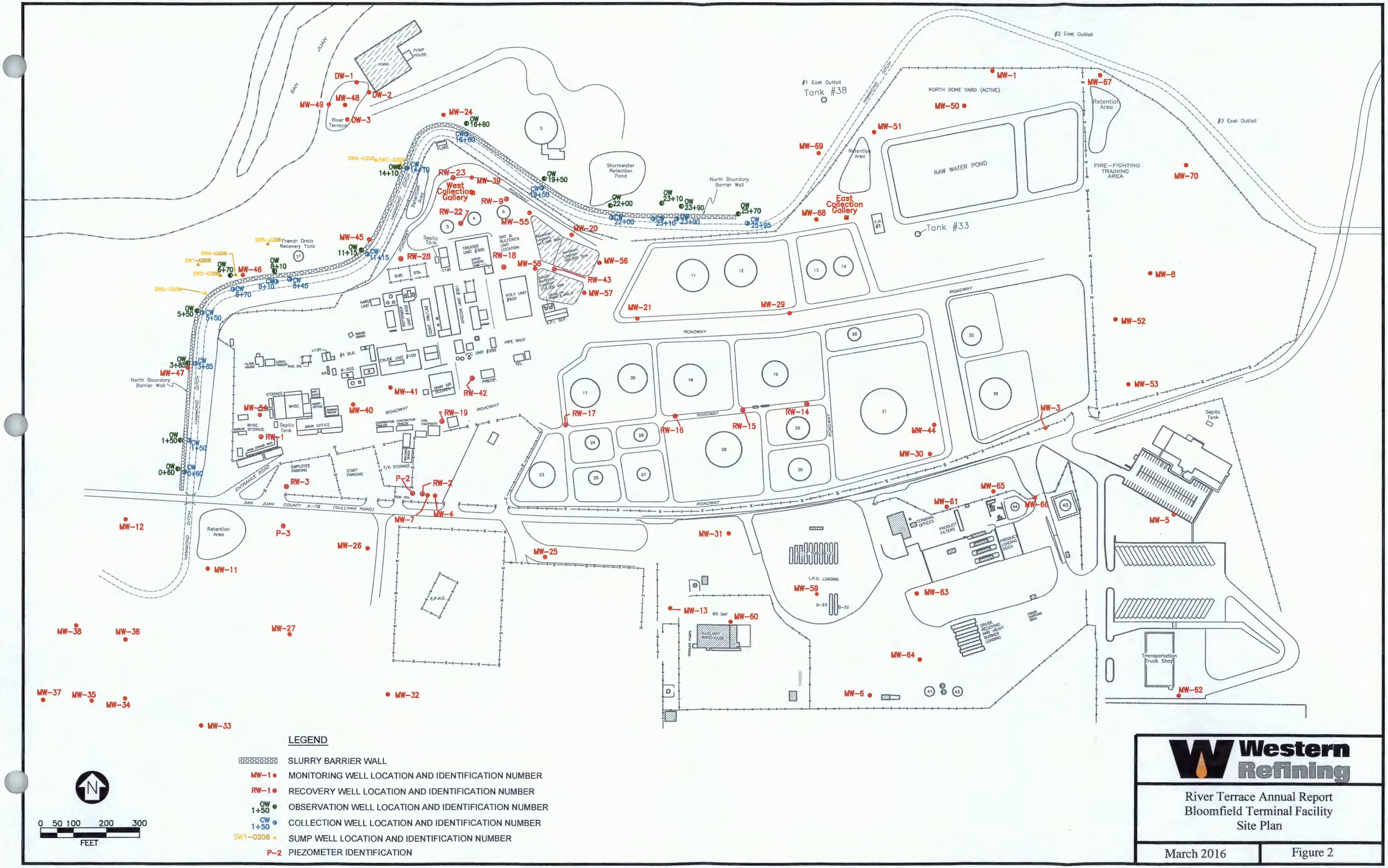
0 500 1000 1500 2000
Feet

Western Refining

River Terrace Annual Report
Bloomfield Terminal
Facility Site Map

March 2016

Figure 1



Western Refining

River Terrace Annual Report
Bloomfield Terminal Facility
Site Plan

March 2016

Figure 2

- ◇ Denotes Bioventing Wells
- ● Temporary Wells
- ▲ Active De-Watering Wells
- △ Inactive De-Watering Wells
- ○ Monitoring Wells
- ✳ Monitoring Well Used for Dewatering

Western Refining

River Terrace Annual Report
Bloomfield Terminal
River Terrace Well Location Map

March 2016

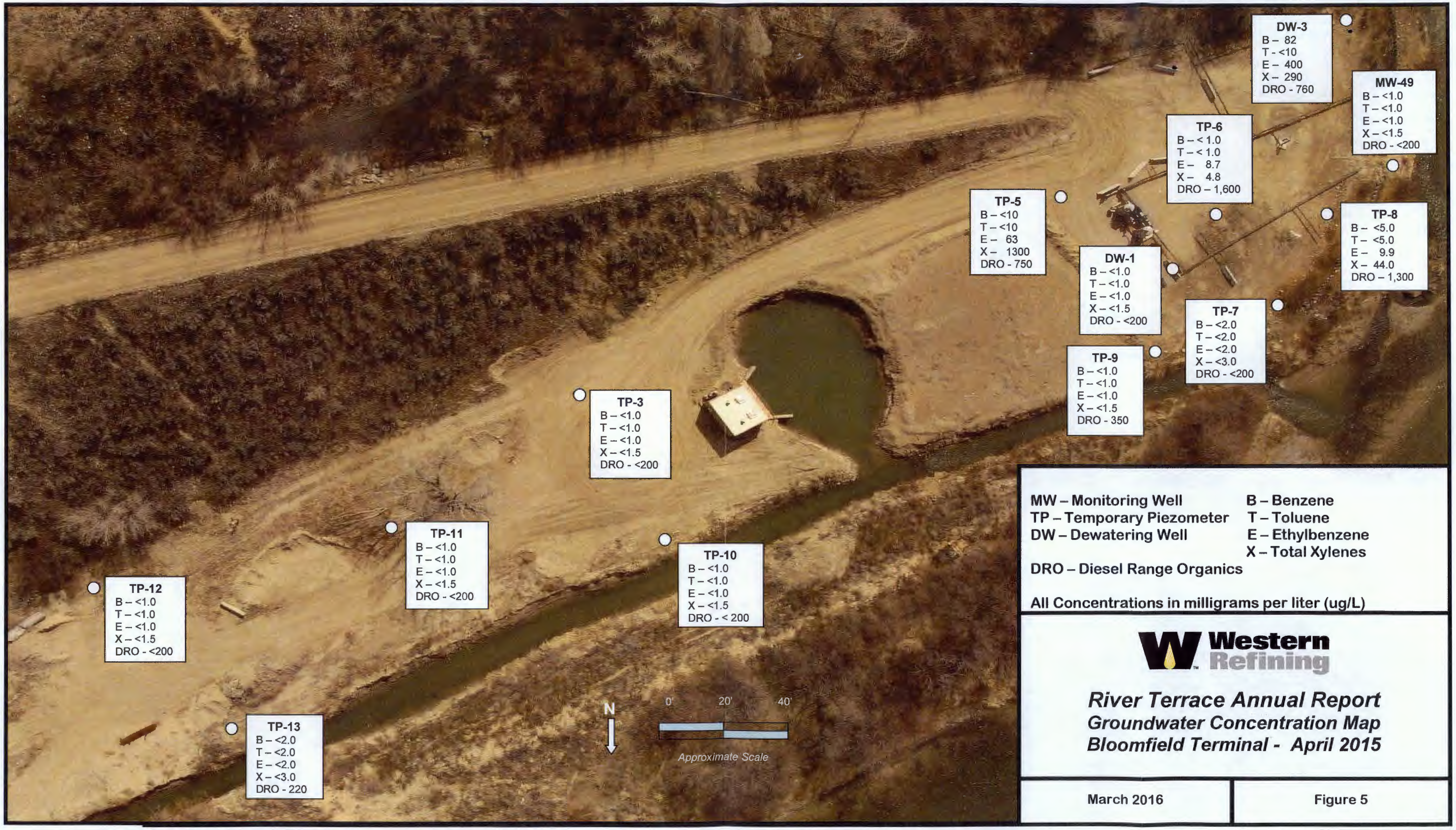
Figure 3

Western Refining

River Terrace Annual Report
Bloomfield Terminal
Biovent System Layout

March 2016

Figure 4



MW – Monitoring Well
TP – Temporary Piezometer
DW – Dewatering Well
DRO – Diesel Range Organics

B – Benzene
T – Toluene
E – Ethylbenzene
X – Total Xylenes

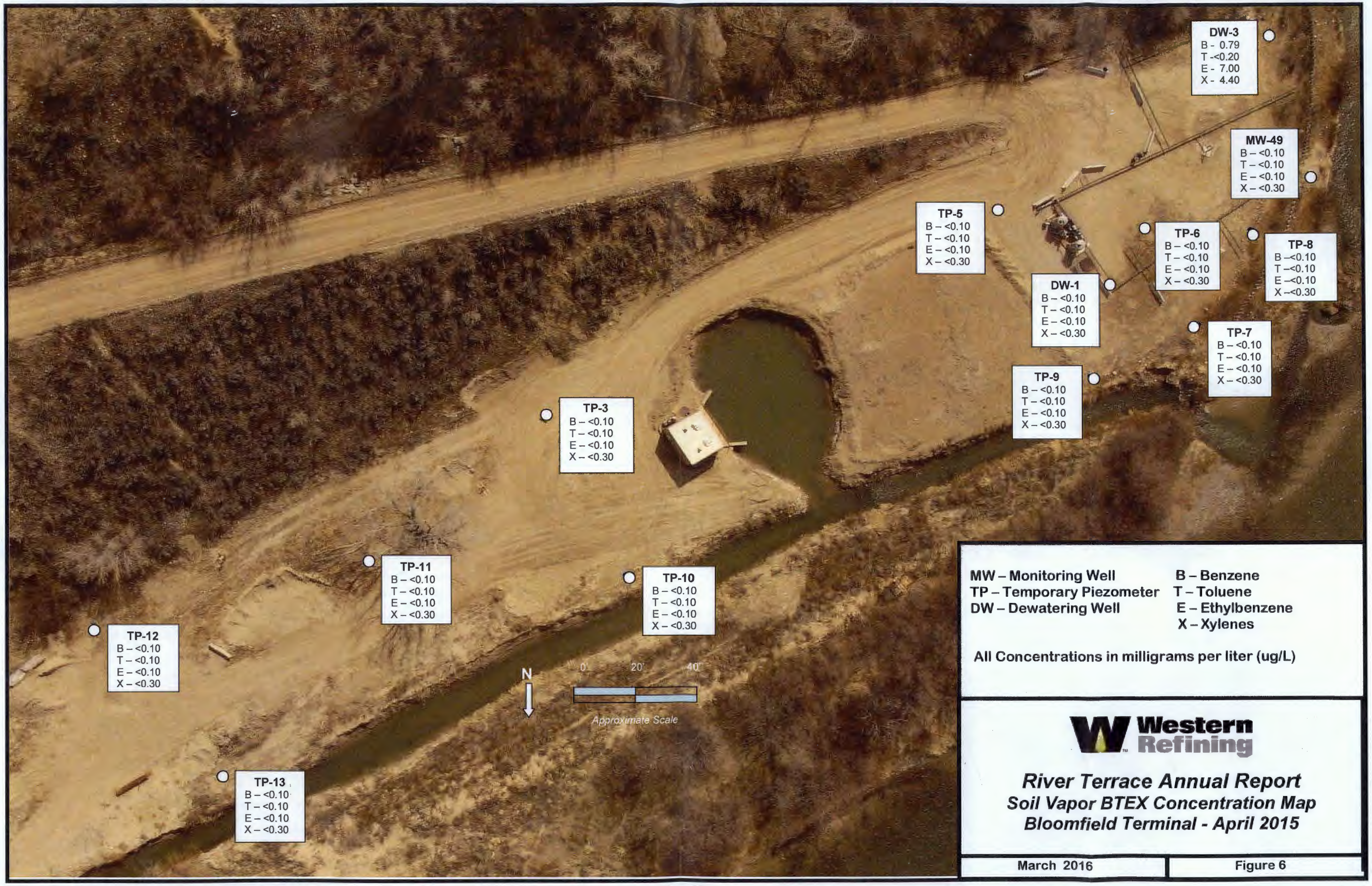
All Concentrations in milligrams per liter (ug/L)

Western Refining

River Terrace Annual Report
Groundwater Concentration Map
Bloomfield Terminal - April 2015

March 2016

Figure 5



MW – Monitoring Well
TP – Temporary Piezometer
DW – Dewatering Well

B – Benzene
T – Toluene
E – Ethylbenzene
X – Xylenes

All Concentrations in milligrams per liter (ug/L)

Western Refining

River Terrace Annual Report

Soil Vapor BTEX Concentration Map

Bloomfield Terminal - April 2015

March 2016

Figure 6

Appendix A

20.6.2.3103 STANDARDS FOR GROUND WATER OF 10,000 mg/l TDS CONCENTRATION OR LESS: The following standards are the allowable pH range and the maximum allowable concentration in ground water for the contaminants specified unless the existing condition exceeds the standard or unless otherwise provided in Subsection D of Section 20.6.2.3109 NMAC. Regardless of whether there is one contaminant or more than one contaminant present in ground water, when an existing pH or concentration of any water contaminant exceeds the standard specified in Subsection A, B, or C of this section, the existing pH or concentration shall be the allowable limit, provided that the discharge at such concentrations will not result in concentrations at any place of withdrawal for present or reasonably foreseeable future use in excess of the standards of this section. These standards shall apply to the dissolved portion of the contaminants specified with a definition of dissolved being that given in the publication "*methods for chemical analysis of water and waste of the U.S. environmental protection agency,*" with the exception that standards for mercury, organic compounds and non-aqueous phase liquids shall apply to the total unfiltered concentrations of the contaminants.

A. **Human Health Standards**-Ground water shall meet the standards of Subsection A and B of this section unless otherwise provided. If more than one water contaminant affecting human health is present, the toxic pollutant criteria as set forth in the definition of toxic pollutant in Section 20.6.2.1101 NMAC for the combination of contaminants, or the Human Health Standard of Subsection A of Section 20.6.2.3103 NMAC for each contaminant shall apply, whichever is more stringent. Non-aqueous phase liquid shall not be present floating atop of or immersed within ground water, as can be reasonably measured.

(1)	Arsenic (As)	0.1 mg/l
(2)	Barium (Ba)	1.0 mg/l
(3)	Cadmium (Cd)	0.01 mg/l
(4)	Chromium (Cr)	0.05 mg/l
(5)	Cyanide (CN)	0.2 mg/l
(6)	Fluoride (F)	1.6 mg/l
(7)	Lead (Pb)	0.05 mg/l
(8)	Total Mercury (Hg)	0.002 mg/l
(9)	Nitrate (NO_3 as N)	10.0 mg/l
(10)	Selenium (Se)	0.05 mg/l
(11)	Silver (Ag)	0.05 mg/l
(12)	Uranium (U)	0.03 mg/l
(13)	Radioactivity: Combined Radium-226 & Radium-228	30 pCi/l
(14)	Benzene	0.01 mg/l
(15)	Polychlorinated biphenyls (PCB's)	0.001 mg/l
(16)	Toluene	0.75 mg/l
(17)	Carbon Tetrachloride	0.01 mg/l
(18)	1,2-dichloroethane (EDC)	0.01 mg/l
(19)	1,1-dichloroethylene (1,1-DCE)	0.005 mg/l
(20)	1,1,2,2-tetrachloroethylene (PCE)	0.02 mg/l
(21)	1,1,2-trichloroethylene (TCE)	0.1 mg/l
(22)	ethylbenzene	0.75 mg/l
(23)	total xylenes	0.62 mg/l
(24)	methylene chloride	0.1 mg/l
(25)	chloroform	0.1 mg/l
(26)	1,1-dichloroethane	0.025 mg/l
(27)	ethylene dibromide (EDB)	0.0001 mg/l
(28)	1,1,1-trichloroethane	0.06 mg/l
(29)	1,1,2-trichloroethane	0.01 mg/l
(30)	1,1,2,2-tetrachloroethane	0.01 mg/l
(31)	vinyl chloride	0.001 mg/l
(32)	PAHs: total naphthalene plus monomethylnaphthalenes	0.03 mg/l
(33)	benzo-a-pyrene	0.0007 mg/l

B. **Other Standards for Domestic Water Supply**

(1)	Chloride (Cl)	250.0 mg/l
(2)	Copper (Cu)	1.0 mg/l
(3)	Iron (Fe)	1.0 mg/l
(4)	Manganese (Mn)	0.2 mg/l
(6)	Phenols	0.005 mg/l
(7)	Sulfate (SO_4)	600.0 mg/l
(8)	Total Dissolved Solids (TDS)	1000.0 mg/l
(9)	Zinc (Zn)	10.0 mg/l
(10)	pH	between 6 and 9

C. **Standards for Irrigation Use - Ground water shall meet the standards of Subsection A, B, and C of**

this section unless otherwise provided.

(1) Aluminum (Al)..5.0 mg/l
(2) Boron (B)..0.75 mg/l
(3) Cobalt (Co)..0.05 mg/l
(4) Molybdenum (Mo)...1.0 mg/l
(5) Nickel (Ni)..0.2 mg/l

[2-18-77, 1-29-82, 11-17-83, 3-3-86, 12-1-95; 20.6.2.3103 NMAC - Rn, 20 NMAC 6.2.III.3103, 1-15-01; A, 9-26-04]
[Note: For purposes of application of the amended numeric uranium standard to past and current water discharges (as of 9-26-04), the new standard will not become effective until June 1, 2007. For any new water discharges, the uranium standard is effective 9-26-04

Table of New Mexico and USEPA Groundwater Standards

Metals	**(mg/l)**
Antimony	0.006 [2]
Arsenic	0.01 [2]
Barium	1.0
Beryllium	0.004 [2]
Cadmium	0.005 [2]
Chromium	0.05
Cobalt	0.05
Copper	1.0
Cyanide	0.2
Lead	0.015[2]
Mercury	0.002
Nickel	0.200
Selenium	0.05
Silver	0.05
Uranium	0.03
Vanadium	0.26[3]
Zinc	10.0

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Semivolatiles	**(ug/l)**
1,2,4-Trichlorobenzene	70 [2]
1,2-Dichlorobenzene	600[2]
1,3-Dichlorobenzene	Ne
1,4-Dichlorobenzene	75[2]
2,4,5-Trichlorophenol	3,700 [3]
2,4,6-Trichlorophenol	6.1 [3]
2,4-Dichlorophenol	110 [3]
2,4-Dimethylphenol	730 [3]
2,4-Dinitrophenol	73 [3]
2,4-Dinitrotoluene	0.22[3]
2,6-Dinitrotoluene	37 [3]
2-Chloronaphthalene	2900[3]
2-Chlorophenol	180[3]
2-Methylnaphthalene	150[3]
2-Methylphenol	1,800 [3]
2-Nitroaniline	110 [3]
2-Nitrophenol	Ne
3,3′-Dichlorobenzidine	0.15[3]
3+4-Methylphenol	180 [3]
3-Nitroaniline	Ne
4,6-Dinitro-2-methylphenol	Ne
4-Bromophenyl phenyl ether	Ne
4-Chloro-3-methylphenol	Ne
4-Chloroaniline	0.34[3]
4-Chlorophenyl phenyl ether	Ne
4-Nitroaniline	3.4[3]
4-Nitrophenol	Ne
Acenaphthene	2200[3]
Acenaphthylene	Ne

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Semivolatiles	**(ug/l)**
Aniline	12[3]
Anthracene	1100[3]
Azobenzene	0.12[3]
Benz(a)anthracene	0.029[3]
Benzo(a)pyrene	0.2[2]
Benzo(b)fluoranthene	0.029[3]
Benzo(g,h,i)perylene	Ne
Benzo(k)fluoranthene	0.29[3]
Benzoic acid	150,000[3]
Benzyl alcohol	1800[3]
Bis(2-chloroethoxy)methane	110[3]
Bis(2-chloroethyl)ether	0.012[3]
Bis(2-chloroisopropyl)ether	Ne
Bis(2-ethylhexyl)phthalate	6[2]
Butyl benzyl phthalate	35[3]
Carbazole	Ne
Chrysene	2.9[3]
Dibenz(a,h)anthracene	0.0029[3]
Dibenzofuran	Ne
Diethyl phthalate	29,000[3]
Dimethyl phthalate	Ne
Di-n-butyl phthalate	Ne
Di-n-octyl phthalate	Ne
Fluoranthene	1,500[3]
Fluorene	1500[3]
Hexachlorobenzene	1.0[2]
Hexachlorobutadiene	0.86[3]
Hexachlorocyclopentadiene	50[2]
Hexachloroethane	4.8[3]

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Semivolatiles	**(ug/l)**
Indeno(1,2,3-cd)pyrene	0.029[3]
Isophorone	71[3]
Naphthalene	0.14[3]
Nitrobenzene	0.12[3]
N-Nitrosodimethylamine	0.00042[3]
N-Nitrosodi-n-propylamine	0.0096[3]
N-Nitrosodiphenylamine	14[3]
Pentachlorophenol	1[2]
Phenanthrene	Ne
Phenol	5[3]
Pyrene	1100[3]
Pyridine	37[3]

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Volatiles	**(ug/l)**
1,1,1,2-Tetrachloroethane	0.52[3]
1,1,1-Trichloroethane	60
1,1,2,2-Tetrachloroethane	10
1,1,2-Trichloroethane	5[2]
1,1-Dichloroethane	25
1,1-Dichloroethene	5
1,1-Dichloropropene	Ne
1,2,3-Trichlorobenzene	Ne
1,2,3-Trichloropropane	0.0096[3]
1,2,4-Trichlorobenzene	70.0[2]
1,2,4-Trimethylbenzene	15.0 [3]
1,2-Dibromo-3-chloropropane	0.2 [2]
1,2-Dibromoethane (EDB)	0.05[2]
1,2-Dichlorobenzene	600.0 [2]
1,2-Dichloroethane (EDC)	5[2]
1,2-Dichloropropane	5.0 [2]
1,3,5-Trimethylbenzene	12[3]
1,3-Dichlorobenzene	Ne
1,3-Dichloropropane	730 [3]
1,4-Dichlorobenzene	75.0 [2]
1-Methylnaphthalene	2.3[3]
2,2-Dichloropropane	Ne
2-Butanone	710.0 [3]
2-Chlorotoluene	730.0 [3]
2-Hexanone	Ne
2-Methylnaphthalene	150[3]
4-Chlorotoluene	2600[3]
4-Isopropyltoluene	Ne
4-Methyl-2-pentanone	Ne

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Volatiles	**(ug/l)**
Acetone	22000[3]
Benzene	5 [2]
Bromobenzene	20[3]
Bromodichloromethane	0.12[3]
Bromoform	8.5 [3]
Bromomethane	8.7 [3]
Carbon disulfide	1,000 [3]
Carbon Tetrachloride	5[2]
Chlorobenzene	100.0 [2]
Chloroethane	Ne
Chloroform	100
Chloromethane	190 [3]
cis-1,2-DCE	70 [2]
cis-1,3-Dichloropropene	0.4 [3]
Dibromochloromethane	0.15[3]
Dibromomethane	370[3]
Dichlorodifluoromethane	390 [3]
Ethylbenzene	700 [2]
Hexachlorobutadiene	0.86 [3]
Isopropylbenzene	680[3]
Methyl tert-butyl ether (MTBE)	12[3]
Methylene Chloride	5[2]
Naphthalene	0.14[3]
n-Butylbenzene	Ne
n-Propylbenzene	Ne
sec-Butylbenzene	Ne
Styrene	100[2]
tert-Butylbenzene	Ne
Tetrachloroethene (PCE)	5 [2]

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Volatiles	**(ug/l)**
Toluene	750
trans-1,2-DCE	100 [2]
trans-1,3-Dichloropropene	0.4 [3]
Trichloroethene (TCE)	5 [2]
Trichlorofluoromethane	1,300 [3]
Vinyl chloride	1
Xylenes, Total	620

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

General Chemistry	**(mg/l)**
Alkalinity, Total (As CaCO3)	Ne
Bicarbonate	Ne
Calcium	Ne
Carbonate	Ne
Chloride	250
Fluoride	1.6
Iron	1
Magnesium	Ne
Manganese	0.2
Nitrogen, Nitrate (As N)	10
Nitrogen, Nitrite (As N)	1^2
Nitrate (As N)+Nitrite (As N)	10
Potassium	Ne
Sodium	Ne
Sulfate	600

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

NEW MEXICO ENVIRONMENT DEPARTMENT

Risk Assessment Guidance for Site Investigations and Remediation

July 2015

EXECUTIVE SUMMARY

This guidance document is being developed in coordination with the New Mexico Environment Department's (NMED) Hazardous Waste Bureau (HWB) and the Ground Water Quality Bureau.

This guidance document sets forth recommended approaches based on current State and Federal practices and intended for used as guidance for employees of NMED and for facilities within the State of New Mexico.

In the past, the material contained within this document existed in three separate guidance and/or position papers. In order to streamline the risk assessment process and ensure consistency between guidance/position papers, these documents have been combined into one document: *Risk Assessment Guidance for Site Investigations and Remediation.*

The *Risk Assessment Guidance for Site Investigations and Remediation* dated July 2014 replaces and supersedes previous versions of this document as well as the following documents:

- *Technical Background Document for Development of Soil Screening Levels*, Revision 6.0, 2012,
- *New Mexico Environment Department TPH Screening Guidelines*, October 2006, and
- *Risk-Based Remediation of Polychlorinated Biphenyls at RCRA Corrective Action Sites*, NMED Position Paper, March 2000.

This *Risk Assessment Guidance for Site Investigations and Remediation* is organized into two volumes.

- Volume I – Tier 1: Soil Screening Guidance Technical Background Document
- Volume II - Screening-Level Ecological Risk Assessments

Volume I contains information related to conducting screening level human health risk assessments. Previously, the soil screening levels (SSLs) were available in the *Technical Background Document for Development of Soil Screening Levels* while the screening levels for total petroleum hydrocarbons (TPH) were found in the *New Mexico Environment Department TPH Screening Guidelines*. Now both are contained in Volume I. Volume I also summarizes SSLs for select Aroclors and congeners of polychlorinated biphenyls (PCBs). Additional details for derivation of more site-specific SSLs for PCBs are contained within Appendix D.

Volume II provides guidance for conducting a scoping assessment for ecological risk as previously contained within the *Technical Background Document for Development of Soil Screening Levels.*

SUMMARY OF CHANGES

The following table summarizes changes to the "Risk Assessment Guidance for Investigations and Remediation," Volumes I and II. Specific changes are as follows:

Item	Section	Change	Date
VOLUME I TIER 1: SOIL SCREENING GUIDANCE TECHNICAL BACKGROUND DOCUMENT			
1	Global	Update default exposure parameters; includes changes to text, tables, equations, and soil screening levels in Appendix A	November 2014
2	Global	General edits and clarifications	November 2014
3	Table of Acronyms	Updated	November 2014
4	Table of Contents	Updated	November 2014
5	Summary of Changes	Added new section summarizing changes to document by revision number and date	November 2014
6	Section 1.2.1 and Table 1-1	Addition of tap-water exposure, vapor intrusion and beef ingestion pathways	November 2014
7	Section 2.1	Additional chemical-specific information added for clarification. Includes changes or additions to dioxin/furans, polychlorinated biphenyls (PCBs), hexavalent and total chromium, vanadium, xylene, phenanthrene, and polycyclic aromatic hydrocarbons (PAHs)	November 2014
8	Section 2.1.7	Section added addressing emerging contaminants	November 2014
9	Section 2.2.1 and Equations 12-17	Incorporated carcinogenic and mutagenic effects to calculation of trichloroethylene (TCE) specific soil screening levels	November 2014
10	Section 2.4	Modified to include dermal exposure	November 2014
11	Equations 24-26	Equations were modified and added to include dermal contact with tap water pathway	November 2014
12	Equation 27	Changed noncarcinogenic exposure parameters from adult exposure to child exposure (tap water)	November 2014
13	Equations 29-30 and Equations 31-35	Added dermal pathway to equations for vinyl chloride and mutagens	November 2014
14	Section 2.5	Section added addressing the vapor	November

Item	Section	Change	Date
		intrusion pathway and derivation of vapor screening levels	2014
15	Section 2.6	Section added describing the evaluation of the beef ingestion pathway	November 2014
16	Section 2.7.2	Section added describing background threshold values	November 2014
17	Section 2.7.3	Clarification added on determination of constituents of potential concern	November 2014
18	Section 2.7.7	Section added providing guidance for calculation of exposure-point concentrations	November 2014
19	Section 3.4	Added list of sources used for deriving chemical property information	November 2014
20	Section 5.0	Clarification added to text on the use of the SSLs	November 2014
21	Section 5.1	Section added describing chromium speciation and tiered approach to using chromium screening levels	November 2014
22	Section 5.2	Section added describing derivation of screening levels for essential nutrients	November 2014
23	Section 6.0	Updated Total Petroleum Hydrocarbon (TPH) methodology; removed groundwater screening levels.	November 2014
24	Section 7.0	Updated references	November 2014
25	Table A-1	Updated NMED screening levels	November 2014
26	Table A-2	Updated default exposure parameters	November 2014
27	Table A-3	Table added displaying vapor intrusion screening levels	November 2014
28	Tables B-1 and B-2	Updated chemical property information with references added	November 2014
29	Table B-3	Table added showing input parameters and chemical properties for dermal tap-water pathway	November 2014
30	Table C-1	Updated toxicity data	November 2014
31	Section 2.7.7	Update prefrerred method for handling non-detects	March 2015
VOLUME 2 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENTS			
1	Global	Updating of reference	November 2014
2	Global	General editorial corrections	November

Item	**Section**	**Change**	**Date**
			2014
3	Section 3	Additional clarification of Screening Level Ecological Risk Assessments (SLERA) for Phase I – revised Tier 1 assessments and added updated methodologies and equations	November 2014
4	Section 4	Added Tier 2 SLERA methodologies and equations	November 2014
5	Section 5	Site-specific ecological risk assessments added as Tier 3 process	November 2014
6	Section 4	Added references to the toxicity reference values (TRVs) and Ecological Screening Levels (ESLs) provided in Attachment c	July 2015
7	Section 4	Added Equation 8 for derivation of the screening level hazard quotient (SLHQ)using site concentrations and the ESLs (added as Attachment C)	July 2015
8	Attachment C	Added new tables listing TRVs for Tier 1 and Tier 2 key ecological receptors and ESLs for Tier 1 key receptors.	July 2015

VOLUME I

TIER 1: SOIL SCREENING GUIDANCE TECHNICAL BACKGROUND DOCUMENT

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LIST OF ACRONYMS

AI	Adequate Intake
ASTDR	Agency for Toxic Substances and Disease Registry
BGS	Below Ground Surface
BTV	Background Threshold Value
C	Celsius
CalEPA	California Environmental Protection Agency
CMTP	Composite Model for Leachate Migration with Transformation Products
COPC	Contaminants of Potential Concern
CSM	Conceptual Site Model
DAF	Dilution Attenuation Factor
DQO	Data Quality Objectives
EPA/ORD	Environmental Protection Agency Office of Research and Development
EPC	Exposure Point Concentration
EPH	Extractable Petroleum Hydrocarbons
EPI	Estimation Program Interface
GWQB	Groundwater Quality Bureau
HEAST	Health Effects Assessment Summary Tables
HWB	Hazardous Waste Bureau
IEUBK	Integrated Exposure Uptake Biokinetic
IRIS	Integrated Risk Information System
IUPAC	International Union of Pure and Applied Chemistry
IUR	Inhalation Unit Risk
J&E	Johnson and Ettinger
MADEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MDL	Minimum Detection Limit
MRL	Minimum Risk Level
NAPL	Non-aqueous Phase Liquid
NHL	Non-Hodgkin's Lymphoma
NJDEP	New Jersey Department of Environmental Protection
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NRCS	National Resource Conservation Service
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PEF	Particulate Emission Factor
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane Sulfonate
PPRTV	Provisional Peer-reviewed Toxicity Value
PRG	Preliminary Remediation Goal
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
RCRA	Resource Conservation and Recovery Act

LIST OF ACRONYMS, Cont.

RDA	Recommended Daily Allowance
RfC	Reference Concentration
RfD	Reference Dose
RSL	Regional Screening Level
SCEM	Site Conceptual Exposure Model
SL	Screening Level
SQL	Sample Quantitation Level
SSG	Soil Screening Guidance
SSL	Soil Screening Level
SVOC	Semi-volatile Organic Compound
TCDD	Tetrachlorodibenzo-p-dioxin
TCE	Tricholorethylene
TEF	Toxicity Equivalency Factor
TEQ	Toxicity Equivalent
TPH	Total Petroleum Hydrocarbon
UCL	Upper Confidence Limit
UL	Upper Intake Limit
US EPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
UTL	Upper Tolerance Limit
VF	Volatilization Factor
VISL	Vapor Intrusion Screening Level
VOC	Volatile Organic Compound
VPH	Volatile Petroleum Hydrocarbons
WHO	World Health Organization
WQCC	Water Quality Control Commission

1.0 INTRODUCTION

The New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) and the Ground Water Quality Bureau (GWQB) have developed this soil screening guidance (SSG) for internal department use within corrective action programs. The SSG discusses the methodology used to derive chemical-specific soil screening levels (SSLs), tap water screening levels, and vapor intrusion screening levels (VISLs). In addition, guidance is provided to assist in identifying and evaluating appropriate exposure pathways and receptors. Finally, this document provides generic SSLs, tap water SLs, and VISLs for chemicals commonly found at contaminated sites based on default exposure parameters under residential and non-residential land-use scenarios.

The SSG provides site managers with a framework for developing and applying the SSLs, and is likely to be most useful for determining whether areas or entire sites are contaminated to an extent that warrants further investigation. It is intended to assist and streamline the site investigation and corrective action process by focusing resources on those sites or areas that pose the greatest risk to human health and the environment. Implementation of the methodologies outlined within this SSG may significantly reduce the time necessary to complete site investigations and cleanup actions at certain sites, as well as improve the consistency of these investigations.

Between various sites there can exist a wide spectrum of contaminant types and concentrations. The level of concern associated with those concentrations depends on several factors, including the likelihood of exposure to concentrations that could impact human health or ecological receptors. At one end of the spectrum are levels that clearly warrant a response action; at the other end are levels that are below regulatory concern. Appropriate cleanup goals for a site may fall anywhere within this range depending on site-specific conditions. Screening levels such as SSLs identify the lower end of this spectrum – levels below which there is generally no need for further concern—provided the conditions associated with the development of the SSLs are consistent with the site being evaluated. It is important to note that SSLs do not in themselves represent cleanup standards, and the SSLs alone do not trigger the need for a response action or define "unacceptable" levels of contamination in soil.

1.1 Organization of the Document

The NMED SSG is organized into five major sections with supporting appendices. The remainder of Section 1 addresses the purpose of the NMED SSLs and outlines the scope of the document. Section 2 outlines the receptors, exposure pathways, and exposure assumptions used in calculating the NMED SSLs. It also discusses the risk levels on which the SSLs are predicated and presents the SSL model assumptions. Finally, Section 2 discusses site assessment/characterization activities that should be completed prior to comparing site contaminant concentrations with SSLs. These activities include development of data quality objectives, conducting site sampling, preparation of a preliminary conceptual site model (CSM), and identification of contaminants of potential concern (COPCs). Section 3 provides a detailed description of the process used to develop pathway-specific SSLs. Included in this section is a discussion of the human health basis for the SSLs, additive risk, and acute exposures. Additional topics discussed in Section 3 include chemical specific parameters used to develop the SSLs and calculation of volatilization factors, particulate emission factors and soil saturation limits. Section 4 presents methodologies for assessing the potential for migration of contaminants to groundwater from contaminated soil in concert with generic and site-specific leaching models. Section 5 addresses special use considerations for addressing contaminant concentrations in soil and notes specific problems that can arise when applying the SSLs to specific sites. Finally, Section 6 addresses the screening criteria that should be applied at sites with potential petroleum releases. Soil and tap water screening levels for contaminants are presented in Table A-1 of Appendix A. Table A-2 of Appendix A presents the default exposure factor values used in the generation of the NMED SSLs. Screening levels for the vapor intrusion pathway are presented in Table A-3 of Appendix A. Physical-chemical values used in the calculation of the SSLs are presented in Tables B-1, B-2, and B-3 of Appendix B. Toxicity criteria are presented in Table C-1 of Appendix C. Additional discussion of polychlorinated biphenyls (PCBs) is provided in Appendix D.

1.2 Scope of the Soil Screening Guidance

The SSG incorporates readily obtainable site data and utilizes methods from various United States Environmental Protection Agency (US EPA) risk assessment guidance and derives site-specific screening levels for selected contaminants and exposure pathways. Key attributes of the SSG include default values for generic SSLs where site-specific information is unavailable, and the identification of parameters for which site-specific information is needed for the development of site-specific SSLs. The goal of the SSG is to provide a consistent approach for developing site-specific SSLs for evaluating facilities under the auspices of the corrective action process within NMED.

The NMED SSLs are based on a 1E-05 target risk for carcinogens, or a hazard quotient of 1.0 for noncarcinogens. In instances where an individual contaminant has the capacity to elicit both types of responses, the SSLs preferentially report the screening value representative of the lowest (most stringent) contaminant concentration in environmental media. SSLs for migration to groundwater are based on NMED-specific tap water SSLs. As such, the NMED SSLs serve as a generic benchmark for screening level comparisons of contaminant concentrations in soil. NMED anticipates that the SSLs will be used as a tool to facilitate prompt identification of those contaminants and areas that represent the greatest risks to human health and the environment. While concentrations above the NMED SSLs presented in this document do not automatically designate a site as "contaminated" or trigger the need for a response action, detected concentrations in site soils exceeding screening levels suggest that further evaluation is appropriate. Further evaluation may include additional sampling to better characterize the nature and extent of contamination, consideration of background levels, reevaluation of COPCs or associated risk and hazard using site-specific parameters, and/or a reassessment of the assumptions associated with the generic SSLs (e.g., appropriateness of route-to-route extrapolations, use of chronic toxicity values to evaluate childhood and construction-worker exposures).

<u>Prior to calculating site-specific SSLs, each relevant chemical specific parameter value and toxicological datum should be checked against the most recent version of its source to determine</u>

if updated data are available.

In the event that a NMED SSL is not listed for a given chemical, other sources of screening levels should be consulted, such as the US EPA Regional Screening Levels (RSLs) (US EPA, 2014a or most current), or a review of toxicological data should be conducted and if available, a screening level calculated for that given chemical. Care should be used when other sources of screening levels are used to ensure that target risk/levels used in development of the levels are consistent with those applied by NMED. For example, the US EPA carcinogenic RSLs are based on a 1E-06 risk level and must be adjusted to a 1E-05 risk level for use. RSLs for noncarcinogens are provided for hazards of 1.0 and 0.1; the RSLs based on a hazard quotient of 1.0 should be applied.

1.2.1 Exposure Pathways

A complete exposure pathway consists of (1) a source, (2) a mechanism of contaminant release, (3) a receiving or contact medium, (4) a potential receptor population, and (5) an exposure route. All five elements must be present for the exposure pathway to be considered complete.
SSLs have been developed for use in evaluating several exposure scenarios representing a variety of potential land uses: residential, commercial/industrial, and construction. The SSG presents lists of potential pathways for each scenario, though these lists are not intended to be exhaustive. Instead, each list represents a set of typical exposure pathways likely to account for the majority of exposure to contaminants in soil or other media at a given site. These include:

- Direct (and incidental) ingestion of soil,
- Dermal contact with soil,
- Inhalation of volatiles and fugitive dusts from contaminated soil,
- Migration of chemicals through soil to an underlying potable aquifer or water-bearing unit,
- Ingestion of tap water during domestic use,
- Dermal contact with tap water during domestic use,
- Inhalation of volatile organic compounds (VOCs) volatilized from tap water into indoor air during domestic use,
- Inhalation of volatiles in indoor air via the subsurface vapor intrusion pathway, and
- Ingestion of potentially contaminated beef.

Under some site-specific situations, additional complete exposure pathways may be identified. In these cases, a site-specific evaluation of risk is warranted under which additional exposure pathways can be considered. If other land uses and exposure scenarios are determined to be more appropriate for a site (e.g., home gardening, recreational land use, hunting, and/or Native American land use), the exposure pathways addressed in this document should be modified or augmented accordingly or a site-specific risk assessment should be conducted. Early identification of the need for additional information is important because it facilitates development of a defensible sampling and analysis strategy.

The exposure pathways addressed in this guidance are presented by land-use scenario in Table 1-1.

Table 1-1. Exposure Pathways Evaluated in Soil Screening Guidance

Potential Exposure Pathway	Residential	Commercial /Industrial	Construction
Direct ingestion of soil	✓	✓	✓
Dermal contact with soil	✓	✓	✓
Inhalation of dust and volatiles from soil	✓	✓	✓
Inhalation of VOCs from vapor intrusion	✓	✓	--
Ingestion of tap water	✓	--	--
Dermal contact with tap water	✓	--	--
Inhalation of VOCs volatilized from tap water during domestic use	✓	--	--
Ingestion of beef	✓	--	--

1.2.2 Exposure Assumptions

SSLs represent risk-based concentrations in soil derived from equations combining exposure assumptions with toxicity criteria following the US EPA's preferred tiered hierarchy of toxicological data. The models and assumptions used were developed to be consistent with the Superfund concept of "reasonable maximum exposure" (US EPA 1989 and 2009). This is intended to provide an upper-bound estimate of chronic exposure by combining both average and conservative (i.e., 90th to 95th percentile) values in the calculations. The default intake and duration assumptions presented here are intended to be protective of all potentially exposed populations for each land use consideration. Exposure point concentrations in soil should reflect either directly measured or estimated values using fate and transport models. When assessing chronic, long-term exposures, the maximum detected site concentration should be used for an initial screen against the SSLs. A more refined assessment may include use of an estimate of the average [95 percent upper confidence level (UCL) of the mean] concentration if sufficient site data are available to allow for an accurate estimation of the UCL. Where the potential for acute toxicity may be of concern, estimates based on the maximum exposure may be more appropriate.

The resulting estimate of exposure is then compared with chemical-specific toxicity criteria. To calculate the SSLs, the exposure equations and pathway models are rearranged to back calculate an "acceptable level" of a contaminant in soil corresponding to a specific level of target risk or hazard.

1.2.3 Target Risk and Hazard

Target risk and hazard levels for human health are risk management-based criteria for carcinogenic and non-carcinogenic responses, respectively, to determine: (1) whether site-related contamination poses an unacceptable risk to human health and requires corrective action or (2) whether implemented corrective action(s) sufficiently protects human health. If an estimated risk or hazard falls within the target range, the risk manager must decide whether or not the site poses an unacceptable risk. This decision should take into account the degree of inherent conservatism or level of uncertainty associated with the site-specific estimates of risk and hazard. An estimated risk that exceeds these targets, however, does not necessarily indicate that current conditions are not safe or that they present an unacceptable risk. Rather, a site risk calculation that exceeds a target value may simply indicate the need for further evaluation or refinement of the exposure model.

For cumulative exposure via the ingestion, inhalation, and dermal pathways, toxicity criteria are used to calculate an acceptable level of contamination in soil. SSLs are based on a carcinogenic risk level of one-in-one-hundred thousand (1E-05) and a non-carcinogenic hazard quotient of 1.0. A carcinogenic risk level is defined as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The non-carcinogenic hazard quotient assumes that there is a level of exposure below which it is unlikely for even sensitive populations to experience adverse health effects.

1.2.4 SSL Model Assumptions

The models used to calculate inhalation exposure and protection of groundwater based on potential migration of contaminants in soil are intended to be utilized at an early stage in the site investigation process when information regarding the site may be limited. For this reason, the models incorporate a number of simplifying assumptions. For instance, the models assume an infinite contaminant source, i.e. a constant concentration is maintained for the duration of the exposure period. Although this is a highly conservative assumption, finite source models require accurate data regarding source size and volume. Such data are unlikely to be available from limited sampling efforts. The models also assume that contamination is homogeneous throughout the source and that no biological or chemical degradation occurs. Where sufficient site-specific data are available, more detailed finite-source models may be used in place of the default model assumptions presented in this SSG.

2.0 DEVELOPMENT OF PATHWAY SPECIFIC SOIL SCREENING LEVELS

The following sections present the technical basis and limitations used to calculate SSLs, tap water screening levels (SLs), VISLs, and beef ingestion SLs for residential, commercial/industrial, and construction land use scenarios. The equations used to evaluate inhalation and migration to groundwater include a number of easily obtainable site-specific input parameters. Where site-specific data are not available, conservative default values are presented. The equations used are presented in Sections 2.2 through 2.6. Generic SSLs and tap water screening levels are calculated using these default values and are presented in Table A-1 of Appendix A. Vapor intrusion screening levels were calculated for chemicals considered toxic and volatile and are presented in Table A-3.

2.1 Human Health Basis

The toxicity criteria used for calculating the SSLs are presented in Table C-1 of Appendix C. The selected toxicity values were based on chronic exposure. The primary sources for the human health benchmarks follow the US EPA Superfund programs tiered hierarchy of human health toxicity values (US EPA 2003). Although the US EPA 2003 identified several Tier 3 sources, a hierarchy among the Tier 3 sources was not assigned by the US EPA. For the calculation of NMED SSLs, the following hierarchy of sources was applied in the order listed, and is similar to the hierarchy utilized in the calculation of US EPA's RSLs (US EPA, 2014a):

1) Integrated Risk Information System (IRIS) (US EPA, 2014c) (www.epa.gov/iris),

2) Provisional peer reviewed toxicity values (PPRTVs) (http://hhpprtv.ornl.gov/) and appendices,

3) Agency for Toxic Substances and Disease Registry (ATSDR) (http://www.atsdr.cdc.gov/) and minimal risk levels (MRLs) (http://www.atsdr.cdc.gov/mrls/index.asp),

4) California EPA's Office of Environmental and Health Hazard Assessment values (CalEPA) (http://www.oehha.ca.gov/air/allrels.html and http://www.oehha.ca.gov/risk/pdf/tcdb072109alpha.pdf), and

5) Health Effects Assessment Summary Tables (HEAST) (US EPA 1997a).

Special assumptions were also applied in determining appropriate toxicological data for certain chemicals.

Dioxins/Furans. Toxicity data for the dioxin and furan congeners were assessed using the 2005 World Health Organization's (WHO) toxicity equivalency factors (TEF) (Van den berg, et al 2006) and are summarized in Table 2-1. When screening risk assessments are performed for dioxins/furans at a site, the following TEFs should be applied to the analytical results and summed for each sample location; the sum, or toxicity equivalent (TEQ), should be compared to the NMED SSL for 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD).

Table 2-1. Dioxin and Furan Toxicity Equivalency Factors

Dioxin and Furan Congeners	**TEF**
Chlorinated dibenzo-p-dioxins	
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0003
Chlorinated dibenzofurans	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.03
2,3,4,7,8-PeCDF	0.3
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1

Dioxin and Furan Congeners	TEF
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.0003

Polychlorinated biphenyls (PCBs). Toxicity data for Aroclors were taken from the IRIS database. Aroclor 1016 is considered low risk; therefore, toxicity values deemed as "lowest risk" were applied. It was assumed that all of the other Aroclors were considered high risk; as such, toxicity values deemed as "highest risk" were applied.

Toxicity data for the dioxin-like PCBs were calculated relative to 2,3,7,8-TCDD toxicity. TEFs for non-ortho [International Union of Pure and Applied Chemistry (IUPAC) numbers 77, 81, 126, and 169)] and mono-ortho congeners (IUPAC numbers 105, 114, 118, 123, 156, 157, 167, and 189) were assessed using the 2005 WHO TEFs (Van den Berg, et al 2006) while TEFs for di-ortho congeners (IUPAC numbers 170 and 180) are taken from Ahlborg, et al, 1993 (see Table 2-2).

Table 2-2. PCB TEFs

IUPAC No.	Structure	TEF
77	3,3',4,4'-TetraCB	0.0001
81	3,4,4',5-TetraCB	0.0003
105	2,3,3',4,4'-PeCB	0.00003
114	2,3,4,4',5-PeCB	0.00003
118	2,3',4,4',5-PeCB	0.00003
123	2',3,4,4',5-PeCB	0.00003
126	3,3',4,4',5-PeCB	0.1
156	2,3,3',4,4',5-HxCB	0.00003
157	2,3,3',4,4',5'-HxCB	0.00003
167	2,3',4,4',5,5'-HxCB	0.00003
169	3,3',4,4',5,5'-HxCB	0.03
189	2,3,3',4,4',5,5'-HpCB	0.00003
170	2,2',3,3',4,4',5-HpCB	0.0001
180	2,2',3,4,4',5,5'-HpCB	0.00001

Cadmium. IRIS provides an oral reference dose (RfD) for both water and food. For deriving the tap water SSL, the RfD for water was applied and for the soil-based SSL, the RfD for food was applied.

Vanadium. The oral reference dose (RfD) for vanadium was calculated based on the RfDo for vanadium pentoxide and factoring out the molecular weight of the oxide ion.

Lead. The US EPA recommended levels for lead, based on blood-lead modeling (Integrated Exposure Uptake Biokinetic Model, IEUBK) were applied.

Total Chromium. Toxicity data for total chromium were adjusted based on a ratio of 1:6 (hexavalent chromium:trivalent chromium). If there is reason to believe that this ratio for total chromium is not representative of site conditions, then valence-specific site concentrations and SSLs for trivalent chromium (chromium (III)) and hexavalent chromium (chromium (VI)) should be applied. See Section 5.1 for further information on the use of chromium screening levels.

Chromium (VI). The oral cancer slope factor selected for chromium (VI) is based on a publication by the New Jersey Department of Environmental Protection (NJDEP) entitled *Derivation of Ingestion-Based Soil Remediation Criterion for* Cr^{+6} *Based on the NTP Chronic Bioassay Data for Sodium Dichromate Dihydrate* (April 8, 2009). This publication presents cancer potency values derived from a two-year dose-response study conducted by the National Toxicology Program (2008). NJDEP derived an oral cancer potency value of 0.5 mg/kg-day for chromium (VI). See Section 5.1 for further information on the use of chromium screening levels.

The inhalation unit risk (IUR) factor for chromium (VI) was derived by multiplying the total chromium IUR by seven (7) to account for a chrome speciation ratio of 1:6 (chromium (VI):chromium (III)). See Section 5.1 for further information on the use of chromium screening levels.

Xylenes. Toxicity criteria for xylenes (mixture) from US EPA's IRIS were used as surrogate values for the three isomers of xylenes (o-xylene, m-xylene, and p-xylene) based on structural similarity.

Phenanthrene. Based on structural similarity, toxicity data for pyrene were used as surrogate values for phenanthrene.

Polycyclic aromatic hydrocarbons (PAHs). Toxicity data for PAHs were calculated by applying TEFs relative to benzo(a)pyrene. The selected TEFs presented in US EPA (1993) were applied in the calculation of NMED SSLs and are listed in Table 2-3.

Table 2-3. Polycyclic Aromatic Hydrocarbon Toxicity Equivalency Factors

Poylycyclic Aromatic Hydrocarbon	TEF
Benzo(a)pyrene	1.0
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(a,h)anthracene	1.0
Indeno(1,2,3-cd)pyrene	0.1

2.1.1 Additive Risk

It is important to note that no consideration is provided in the calculation of individual NMED SSLs for additive risk when exposures to multiple chemicals occur. The SSG addresses this issue in Section 5. Because the NMED SSLs for carcinogenic effects correspond to a 1E-05 risk level individually, exposure to multiple contaminants may result in a cumulative site risk that is above the anticipated risk management range. While carcinogenic risks of multiple chemicals are simply added together, the issue of additive hazard is more complex for noncarcinogens because of the theory that a threshold exists for noncarcinogenic effects. This threshold is defined as the level below which adverse effects are not expected to occur, and represents the basis for the RfD and reference concentration (RfC). Since adverse effects are not expected to occur at the RfD or RfC and the SSLs are derived by setting the potential exposure dose to the RfD or RfC, the SSLs do not address the risk of exposure to multiple chemicals at levels where the individual chemicals alone would not be expected to cause any adverse effects. In such cases, the SSLs may not provide an accurate indicator for the likelihood of harmful effects. As a first-tier screening approach, noncarcinogenic effects should be considered additive. In the event that the hazard index results in a value above the target level of 1, noncarcinogenic effects may be evaluated for those chemicals with the same toxic endpoint and/or mechanism of action. The sources provided in Section 2.1 should be consulted to determine the endpoint and/or target organ system prior to attempting to evaluate the additive health effects resulting from simultaneous exposure to multiple non-carcinogenic contaminants.

2.1.2 Acute Exposures

The exposure assumptions used to develop the SSLs are based on a chronic exposure scenario and do not account for situations where high-level exposures may result in acute toxic effects. Such situations may arise when contaminant concentrations are very high, or may result from specific site-related conditions and/or behavioral patterns (e.g., pica behavior in children). Such exposures may be of concern for those contaminants that primarily exhibit acute health effects. For example, toxicological information regarding cyanide and phenol indicate that acute effects may be of concern for children exhibiting pica behavior. Pica is typically described as a compulsive craving to ingest non-food items (such as clay or paint). Although it can be exhibited by adults as well, it is typically of greatest concern in children because they often exhibit behavior (e.g., outdoor play activities and greater hand-to-mouth contact) that results in greater exposure to soil than for a typical adult. In addition, children also have a lower overall body weight relative to the predicted intake.

2.1.3 Early-Life Exposures to Carcinogens

US EPA's (2005a) Supplemental Guidance states that early life exposures (i.e., neonatal and early life) to certain carcinogens can result in an increase in cancer risk later in life. US EPA's (2005a) suggests that age-specific factors be applied to the estimated cancer risks. These factors should address four life stages: 1) children under 2 years of age; 2) children aged 2 to 6 years; 3) children 6 years to 16 years of age; and 4) children over 16 years of age. Effects of mutagenicity have been incorporated into the SSLs for those contaminants which are considered carcinogenic by a mutagenic mode of action.

2.1.4 Direct Ingestion

Exposure to contaminants through incidental ingestion of soil can result from the inadvertent consumption of soils adhering to the hands, food items, or objects that are placed into the mouth. It can also result from swallowing dust particles that have been inhaled and deposited in the mouth. Commercial/industrial, construction workers, and residential receptors may inadvertently ingest soil that adheres to their hands while involved in work- or recreation-related activities. Calculation of SSLs for direct ingestion are based on the methodology presented in US EPA's *Risk Assessment Guidance for Superfund (RAGS): Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), Interim* (US EPA 1991), *Soil Screening Guidance: Technical Background Document* (US EPA 1996a), and *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (US EPA 2002a).

2.1.5 Dermal Absorption

Exposure to soil contaminants may result from dermal contact with contaminated soil and the subsequent absorption of contaminants through the skin. Contact with soil is most likely to occur as a result of digging, gardening, landscaping, or outdoor recreation activities. Excavation activities may also be a potential source of exposure to contaminants, particularly for construction workers. Calculation of the SSLs for dermal contact with soil under the residential exposure scenario is based on the methodology presented in US EPA's *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), Interim* (1991), and *Soil Screening Guidance: Technical Background Document* (US EPA 1996a). The suggested default input values used to develop the NMED SSLs are consistent with US EPA's interim *RAGS, Part E, Supplemental Guidance for Dermal Risk Assessment* (US EPA 2004a).

2.1.6 Inhalation

US EPA toxicity data indicate that risks from exposure to some chemicals via the inhalation pathway far outweigh the risk via ingestion or dermal contact; therefore, the NMED SSLs have been designed to address inhalation of volatiles and fugitive dusts. To address the soil/sediment-to-air pathways, the SSL calculations incorporate a volatilization factor (VF) for volatile contaminants (See Section 3.1) and a particulate emission factor (PEF) (See Section 3.3) for semi-volatile and inorganic contaminants. The SSLs follow the procedures for evaluating inhalation soil, VOCs, and fugitive dust particles presented in US EPA's *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment), Final (US EPA 2009), Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), Interim* (US EPA 1991), *Soil Screening Guidance: Technical Background Document* (US EPA 1996a), *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (US EPA 2005a), and *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (US EPA 2002a).

VOCs may adhere to soil particles or be present in interstitial air spaces in soil, and may volatilize into ambient air. This pathway may be particularly significant if the VOC emissions are concentrated in indoor spaces of onsite buildings, or buildings that may be built in the future. If volatiles are present in subsurface media (e.g., soil-gas or groundwater), volatilization through the vadose zone and into indoor air could occur. NMED VISLs were calculated to address this type of exposure using the methods outlined in Section 2.5. VOCs are considered those chemicals having a Henry's Law constant greater than 1E-05 atmospheres – cubic meter per mole (atm-m^3/mole) and a molecular weight less than 200 grams per mole (g/mole).

Inhalation of contaminants via inhalation of fugitive dusts is assessed using a PEF that relates the contaminant concentration in soil/sediment with the concentration of respirable particles in the air due to fugitive dust emissions. It is important to note that the PEF used to address residential and commercial/industrial exposures evaluates only windborne dust emissions and does not consider emissions from traffic or other forms of mechanical disturbance which could lead to a greater level of exposure. The PEF used to address construction worker exposures evaluates windborne dust emissions and emissions from vehicle traffic associated with construction activities. Therefore, the fugitive dust pathway should be considered carefully when developing the CSM at sites where receptors may be exposed to fugitive dusts by other mechanisms. The development of the PEF for both residential and non-residential land uses is discussed further in Section 3.3.

2.1.7 Contaminants of Emerging Concern

Contaminants of emerging concern are those contaminants possibly present in environmental media that are suspected to elicit adverse effects to human and ecological receptors, but do not have established health standards or established analytical methods. These contaminants may include but are not limited to perfluorinated compounds, such as perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). As many agencies, including the US EPA, are working to understand the types of effects and levels of concern in environmental media, it is important to consider whether emerging contaminants may be present at facilities in New Mexico. For facilities where contaminants of emerging concern are detected in site media, and specifically PFOAs and PFOSs, a qualitative discussion of potential exposure and impact on overall risk/hazard must be included in the risk assessment.

2.2 Soil Screening Levels for Residential Land Uses

Residential exposures are assessed based on child and adult receptors. As discussed below, the child forms the basis for evaluation of noncarcinogenic effects incurred under residential exposures, while carcinogenic responses are modeled based upon age-adjusted values to account for exposures averaged over a lifetime. Under most circumstances, onsite residential receptors are expected to be the most conservative receptor basis for risk assessment purposes due to the assumption that exposure occurs 24 hours (hr) a day, 350 days per year (yr), extending over a 26-year exposure duration. Table 2-4 provides a summary of the exposure characteristics and parameters associated with a residential land use receptor (US EPA, 2014b).

Table 2-4. Summary of the Residential Land Use Receptors

Exposure Characteristics	• Substantial soil exposure (esp. children) • High soil ingestion rate (esp. children) • Significant time spent indoors • Long-term exposure • Surface and subsurface soil exposure (0-10 feet below ground surface, bgs)
Default Exposure Parameters	
Exposure frequency (days/yr)	350
Exposure duration (yr)	6 (child) 20 (adult)
Soil ingestion rate (mg/day)	200 (child) 100 (adult)
Body Weight (kg)	15 (child) 80 (adult)
Skin surface area exposed (cm^2)	2,690 (child) 6,032(adult)
Skin-soil adherence factor (mg/cm^2)	0.2 (child) 0.07 (adult)
cm^2 – square centimeters kg - kilograms mg – milligrams	

2.2.1 Residential Receptors

A residential receptor is assumed to be a long-term receptor occupying a dwelling within the site boundaries, and thus, is exposed to contaminants 24 hours per day, and is assumed to live at the site for 26 years [representing the 90th percentile of the length of time someone lives in a single location (US EPA, 2014b)], remaining onsite for 350 days per year. Exposure to soil (to depths of zero to 10 feet below ground surface) is expected to occur during home maintenance activities, yard work and landscaping, and outdoor play activities. The SSLs do not take into consideration ingestion of homegrown produce/meat/dairy or inhalation of volatiles migrating indoors via vapor intrusion. If these pathways are complete, analysis of risks resulting from these additional exposure pathways must be determined (refer to Sections 2.5 and 2.6) and added to the risks determined using the SSL screen (Equations 55 and 56).

Contaminant intake is assumed to occur via three exposure pathways – direct ingestion, dermal absorption, and inhalation of volatiles and fugitive dusts. For the residential scenario, both adult and child receptors were evaluated because children often exhibit behavior (e.g., greater hand-to-mouth contact) that can result in greater exposure to soils than those associated with a typical adult. In addition, children also have a lower overall body weight relative to the predicted intake.

Equations 1 and 2 are used to calculate cumulative SSLs for a residential receptor exposed to non-carcinogenic and carcinogenic contaminants via all three exposure pathways (ingestion of soil, inhalation of soil, and dermal contact with soil). Default exposure parameters are provided for use when site-specific data are not available.

Noncarcinogenic contaminants are evaluated based solely on childhood exposures using Equation 1. By combining the higher contaminant intake rates with the lower relative body weight, "childhood only" exposures lead to a lower, or more conservative, risk-based concentration compared to an adult-only exposure. In addition, this approach is considered conservative because it combines the higher 6-year exposure for children with chronic toxicity criteria.

Unlike non-carcinogens, the duration of exposure to carcinogens is averaged over the lifetime of the receptor because of the assumption that cancer may develop even after actual exposure has ceased. As a result, the total dose received is averaged over a lifetime of 70 years. In addition, to be protective of exposures in a residential setting, the carcinogenic exposure parameter values are age-adjusted to account for exposures incurred in children (1-6 years of age) and adults (26 years, 90th percentile for current resident time, US EPA, 2014b). Carcinogenic exposures are age-adjusted to account for the physiological differences between children and adults as well as behavioral differences that result in markedly different relative rates of exposure. Equations 3 and 4 are used to calculate age-adjusted ingestion, dermal and inhalation factors which account for the differences in soil ingestion rate, skin surface area, soil adherence factors, inhalation rate, and body weight for children versus adults. The age-adjusted factors calculated using these equations are applied in Equation 2 to develop generic NMED SSLs for carcinogenic effects.

Equation 1
Combined Exposures to Noncarcinogenic Contaminants in Soil, Residential Scenario

$$C_{oral} = \frac{THQ \times AT_r \times BW_c}{EF_r \times ED_c \times (1/RfD_o) \times IRS_c \times (10^{-6})}$$

$$C_{inh} = \frac{THQ \times AT_r}{EF_r \times ED_c \times ET_{rs} \times (1/RfC) \times [(1/VF_s) + (1/PEF_w)]}$$

$$C_{dermal} = \frac{THQ \times AT_r \times BW_c}{EF_r \times ED_c \times [1/(RfD_o \times GIABS)] \times SA_c \times AF_c \times ABS_d \times 10^{-6}}$$

Combined Exposures:

$$SSL_{res} = \frac{1}{\frac{1}{C_{oral}} + \frac{1}{C_{inh}} + \frac{1}{C_{dermal}}}$$

Parameter	Definition (units)	Default
C_{oral}	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
C_{dermal}	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
C_{inh}	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{res}	Soil screening level, all pathways (mg/kg)	Chemical-specific
THQ	Target hazard quotient	1
BW_c	Body weight, child (kg)	15
AT_r	Averaging time, noncarcinogens (days)	ED_c x 365
EF_r	Exposure frequency, resident (day/yr)	350
ED_c	Exposure duration, child (yr)	6
ET_{rs}	Exposure time, resident (hr/day x day/hr)	1
IRS_c	Soil ingestion rate, child (mg/day)	200
RfD_o	Oral reference dose (mg/kg-day)	Chemical-specific
SA_c	Dermal surface area, child (cm^2/day)	2,690
AF_c	Soil adherence factor, child (mg/cm^2)	0.2
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
ABS_d	Skin absorption factor (unitless)	Chemical-specific
RfC	Inhalation reference concentration (mg/m^3)	Chemical-specific
10^{-6}	Unit conversion factor (kg/mg)	10^{-6}
VF_s	Volatilization factor for soil (m^3/kg)	See Equation 45
PEF_w	Particulate emission factor (m^3/kg)	See Equation 48

Equation 2
Combined Exposures to Carcinogenic Contaminants in Soil, Residential Scenario

$$C_{oral} = \frac{TR \times AT_r}{CSF_o \times IFS_{adj} \times 10^{-6}}$$

$$C_{inh} = \frac{TR \times AT_r}{IUR \times 1000 \times EF_r \times \left(\frac{1}{VF_s} + \frac{1}{PEF_w} \right) \times ED_r \times ET_{rs}}$$

$$C_{dermal} = \frac{TR \times AT_r}{DFS_{adj} \times \frac{CSF_o}{GIABS} \times ABS_d \times 10^{-6}}$$

Combined Exposures:

$$SSL_{res} = \frac{1}{\frac{1}{C_{oral}} + \frac{1}{C_{inh}} + \frac{1}{C_{dermal}}}$$

Parameter	Definition (units)	Default
C_{oral}	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
C_{dermal}	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
C_{inh}	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{res}	Soil screening level, all pathways (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
EF_r	Exposure frequency, resident (day/yr)	350
IFS_{adj}	Age-adjusted soil ingestion factor (mg/kg)	See Equation 3
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
DFS_{adj}	Age-adjusted dermal factor (mg/kg)	See Equation 4
ABS_d	Skin absorption factor (unitless)	Chemical-specific
1000	Unit conversion factor (µg/mg)	1000
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific
ED_r	Exposure duration, resident (yr)	26
ET_{rs}	Exposure time, resident (hr/day x day/hr)	1
10^{-6}	Unit conversion factor (kg/mg)	10^{-6}
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
VF_s	Volatilization factor for soil (m^3/kg)	See Equation 45
PEF	Particulate emission factor (m^3/kg)	See Equation 48

Equation 3
Calculation of Age-Adjusted Soil Ingestion Factor

$$IFS_{adj} = \frac{EF \times ED_c \times IRS_c}{BW_c} + \frac{EF \times (ED_r - ED_c) \times IRS_a}{BW_a}$$

Parameter	**Definition (units)**	**Default**
IFS_{adj}	Age-adjusted soil ingestion factor for carcinogens (mg/kg)	36,750
EF	Exposure frequency (day/yr)	350
ED_c	Exposure duration, child (yr)	6
IRS_c	Soil ingestion rate, child (mg/day)	200
BW_c	Body weight, child (kg)	15
ED_r	Exposure duration, resident (yr)	26
IRS_a	Soil ingestion rate, adult (mg/day)	100
BW_a	Body weight, adult (kg)	80

Equation 4
Calculation of Age-Adjusted Soil Dermal Factor

$$DFS_{adj} = \frac{EF \times ED_c \times SA_c \times AF_c}{BW_c} + \frac{EF \times (ED_r - ED_c) \times SA_a \times AF_a}{BW_a}$$

Parameter	**Definition (units)**	**Default**
DFS_{adj}	Age-adjusted dermal factor for carcinogens (mg /kg)	112,266
EF	Exposure frequency (day/yr)	350
ED_c	Exposure duration, child (yr)	6
AF_c	Soil adherence factor, child (mg/cm^2)	0.2
SA_c	Dermal surface area, child (cm^2/day)	2,690
BW_c	Body weight, child (kg)	15
ED_r	Exposure duration, resident (yr)	26
AF_a	Soil adherence factor, adult (mg/cm^2)	0.07
SA_a	Dermal surface area, adult (cm^2/day)	6,032
BW_a	Body weight, adult (kg)	80

Equations 1 and 2 are appropriate for all chemcials with the exception of vinyl chloride, trichloroethylene, and those carcinogens exhibiting mutegenic toxicity. For vinyl chloride, the US EPA IRIS database provides cancer slope factors for both a child and an adult. The child-based cancer slope factor takes into consideration potential risks during the developmental stages of childhood, and thus, is more protective than the adult cancer slope factor. The equations used to derive the SSLs for vinyl chloride incorporate age adjustments for exposure and are presented in Equation 5. As vinyl chloride does not have an adsorption factor, dermal risks are not assessed.

Equation 5
Combined SSL for Vinyl Chloride
Residential Scenario

$$C_{vc-oral} = \frac{TR}{\left(\frac{CSF_o \times IFS_{adj} \times 10^{-6}}{AT_r}\right) + \left(\frac{CSF_o \times IRS_c \times 10^{-6}}{BW_c}\right)}$$

$$C_{vc-inh} = \frac{TR}{\left(\frac{IUR \times EF_r \times ED \times ET_{rs} \times 1000}{AT_r \times VF} + \left(\frac{IUR}{VF} \times 1000\right)\right)}$$

Combined Exposures:

$$SSL_{res-vc} = \frac{1}{\frac{1}{C_{vc-oral}} + \frac{1}{C_{vc-inh}}}$$

Parameter	Definition (units)	Default
$C_{vc-oral}$	Contaminant concentration (mg/kg)	Chemical-specific
C_{vc-inh}	Contaminant concentration (mg/kg)	Chemical-specific
C_{res-vc}	Combined SSL for vinyl chloride (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
BW_c	Body weight, child (kg)	15
AT_r	Averaging time, carcinogens (days)	25,550
EF_r	Exposure frequency, resident (day/yr)	350
IFS_{adj}	Age-adjusted soil ingestion factor (mg/kg)	See Equation 3
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
IRS_c	Child soil ingestion factor (mg/day)	200
10^{-6}	Unit conversion factor (kg/mg)	10^{-6}
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific
EF_r	Exposure frequency, resident (day/yr)	350
ED	Exposure duration (yr)	26
ET_{rs}	Exposure time (hr/day x day/hr)	1
1000	Conversion factor (µg/mg)	1000
VF	Volatilization factor for soil (m^3/kg)	See Equation 43

Equations 6 through 11 show the derivation of the SSLs for carcinogenic chemicals exhibiting mutagenic properties. Mutagenicity is only assessed for the residential scenario.

Equation 6
SSL for Ingestion of Soil- Mutagens

$$C_{mu\text{-}oral} = \frac{TR \times AT_r}{CSF_o \times IFSM_{adj} \times 10^{-6}}$$

Parameter	Definition (units)	Default
$C_{mu\text{-}oral}$	Contaminant concentration (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
CSF_o	Oral cancer slope factor (mg/kg-day)$^{-1}$	Chemical-specific
$IFSM_{adj}$	Age-adjusted soil ingestion rate, mutagens (mg/kg)	See Equation 7
10^{-6}	Conversion factor (kg/mg)	10^{-6}

Equation 7
Calculation of Age-Adjusted Soil Ingestion Factor, Mutagens

$$IFSM_{adj} = \frac{EF_c \times ED_{0-2} \times IRS_c \times 10}{BW_c} + \frac{EF_c \times ED_{2-6} \times IRS_c \times 3}{BW_c} + \frac{EF_a \times ED_{6-16} \times IRS_a \times 3}{BW_a} + \frac{EF_a \times ED_{16-26} \times IRS_a \times 1}{BW_a}$$

Parameter	Definition (units)	Default
$IFSM_{adj}$	Age-adjusted soil ingestion factor for mutagens (mg/kg)	166,833
$ED_{0\text{-}2}$	Exposure duration, child (yr)	2
$ED_{2\text{-}6}$	Exposure duration, child (yr)	4
$ED_{6\text{-}16}$	Exposure duration, adult (yr)	10
$ED_{16\text{-}26}$	Exposure duration, adult (yr)	10
EF_c	Exposure frequency, child (days/yr)	350
EF_a	Exposure frequency, adult (days/yr)	350
IRS_c	Soil ingestion rate, child (mg/day)	200
IRS_a	Soil ingestion rate, adult (mg/day)	100
BW_c	Body weight, child (kg)	15
BW_a	Body weight, adult (kg)	80

Equation 8
SSL for Inhalation of Soil- Mutagens

$$C_{mu-inh} = \frac{TR \times AT_r}{(ET_{rs} \times 1000) \times [(ED_{0-2} \times EF \times IUR \times 10) + (ED_{2-6} \times EF \times IUR \times 3) + (ED_{6-16} \times EF \times IUR \times 3) + (ED_{16-26} \times EF \times IUR \times 1)] \times \left(\frac{1}{VF_s} + \frac{1}{PEF_w} \right)}$$

Parameter	Definition (units)	Default
C_{mu-inh}	Contaminant concentration (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
IUR	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Chemical-specific
EF	Exposure frequency, (day/yr)	350
ED	Exposure duration (yr)	
	ED_{0-2} (yr)	2
	ED_{2-6} (yr)	4
	ED_{6-16} (yr)	10
	ED_{16-26} (yr)	10
ET_{rs}	Exposure time (hr/day x day/hr)	1
1000	Conversion factor (µg/mg)	1000
VF_s	Volatilization factor for soil (m^3/kg)	See Equation 45
PEF	Particulate emission factor (m^3/kg)	See Equation 48

Equation 9
SSL for Dermal Contact with Soil- Mutagens

$$C_{mu-dermal} = \frac{TR \times AT_r}{\frac{CSF_o}{GIABS} \times DFSM_{adj} \times ABS_d \times 10^{-6}}$$

Parameter	Definition (units)	Default
$C_{mu-dermal}$	Contaminant concentration (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
$DFSM_{adj}$	Age-adjusted soil contact factor, mutagens (mg/kg)	See Equation 10
ABS_d	Skin absorption factor (unitless)	Chemical-specific
10^{-6}	Conversion factor (kg/mg)	10^{-6}

Equation 10
Calculation of Age-Adjusted Soil Contact Factor, Mutagens

$$DFSM_{adj} = \frac{ED_{0-2} \times AF_c \times SA_c \times 10}{BW_c} + \frac{ED_{2-6} \times AF_c \times SA_c \times 3}{BW_c} + \frac{ED_{6-16} \times AF_a \times SA_a \times 3}{BW_a} + \frac{ED_{16-26} \times AF_a \times SA_a \times 1}{BW_a}$$

Parameter	Definition (units)	Default
$DFSM_{adj}$	Age-adjusted soil contact factor for mutagens (mg/kg)	475,599
ED_{0-2}	Exposure duration, child (yr) x EF (350 days/yr))	700
ED_{2-6}	Exposure duration, child (yr) x EF (350 days/yr))	1,400
ED_{6-16}	Exposure duration, adult (yr) x EF (350 days/yr))	3,500
ED_{16-26}	Exposure duration, adult (yr) x EF (350 days/yr))	3,500
AF_c	Soil adherence factor, child (mg/cm^2)	0.02
AF_a	Soil adherence factor, adult (mg/ cm^2)	0.07
SA_c	Exposed skin area, child, (cm^2/day)	2,690
SA_a	Exposed skin area, adult, (cm^2/day)	6,032
BW_c	Body weight, child (kg)	15
BW_a	Body weight, adult (kg)	80

The overall SSL for the residential scenario for mutagens is determined following Equation 11.

Equation 11
Determination of the Combined SSL
Mutagens

$$SSL_{res-mu} = \frac{1}{\frac{1}{C_{mu-oral}} + \frac{1}{C_{mu-inh}} + \frac{1}{C_{mu-dermal}}}$$

Parameter	Definition (units)	Default
SSL_{res-mu}	Cumulative SSL for mutagens (mg/kg)	Chemical-specific
$C_{mu-oral}$	Concentration from soil ingestion (mg/kg)	See Equation 6
C_{mu-inh}	Concentration from inhalation (mg/kg)	See Equation 8
$C_{mu-dermal}$	Concentration from dermal exposure (mg/kg	See Equation 9

For trichloroethylene (TCE), the US EPA IRIS (US EPA, 2014c) database provides data on both carcinogenity and mutagenicity. Mutagenic effects assessed include Non-Hodgkin's lymphoma (NHL), and impact to the liver and kidneys. The SSL equations for TCE present in Equations 12 through 17 allow assessment of both cancer and mutagenic effects.

Equation 12
SSL for Ingestion of Soil - Trichloroethylene (TCE)
Residential Scenario

$$C_{TCE-oral} = \frac{TR \times AT}{\left(CSF_o \times 10^{-6} \times \left(\left(CAF_o \times IFS_{adj}\right) + \left(MAF_o \times IFSM_o\right)\right)\right)}$$

Parameter	Definition (units)	Default
$C_{TCE\text{-}oral}$	Contaminant concentration, ingestion soil (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
AT	Averaging time, carcinogens (days)	25,550
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
10^{-6}	Unit conversion factor (kg/mg)	10^{-6}
CAF_o	Adjusted oral cancer slope factor (mg/kg-day$)^{-1}$	See Equation 13
IFS_{adj}	Age-adjusted soil ingestion factor for carcinogens (mg/kg)	See Equation 6
MAF_o	Adjusted oral mutagenic slope factor (mg/kg-day$)^{-1}$	See Equation 13
$IFSM_o$	Age-adjusted soil ingestion factor for mutagens (mg/kg)	See Equation 7

Equation 13
Adjusted Oral Slope Factors - TCE
Residential Scenario

$$CAF_o = \frac{CSF_{o-NHL+Liver}}{CSF_{adult}}$$

$$MAF_o = \frac{CSF_{o-kidney}}{CSF_{adult}}$$

Parameter	Definition (units)	Default
CAF_o	Adjusted oral cancer slope factor	0.804
CSF_{adult}	Oral cancer slope factor (mg/kg-day$)^{-1}$	0.046
$CSF_{o\text{-}NHL+liver}$	Oral cancer slope factor, NHL (2.16E-02) and Liver (1.55E-02), $(mg/kg\text{-}day)^{-1}$	0.0370
MAF_o	Adjusted oral mutagenic slope factor	0.202
$CSF_{o\text{-}kidney}$	Oral cancer slope factor, kidney (mg/kg-day$)^{-1}$	0.00933

Equation 14
SSL for Inhalation of Soil- TCE

$$C_{mu-inh} = \frac{TR \times AT_r}{IUR \times \left(\frac{1}{VF_s} + \frac{1}{PEF}\right) \times 1000 \times (1/24) \times \left[(CAF_i \times EF \times ED_r \times ET_r) + (seebelow)\right]}$$

$$\left[(ED_{0-2}EF_{0-2} \times ET_{0-2} \times MAF_i \times 10) + (ED_{2-6}EF_{2-6} \times ET_{2-6} \times MAF_i \times 3) + (ED_{6-16}EF_{6-16} \times ET_{6-16} \times MAF_i \times 3) + (ED_{16-26}EF_{16-26} \times ET_{16-26} \times MAF_i \times 1)\right]$$

Parameter	Definition (units)	Default
$C_{TCE\text{-}inh}$	Contaminant concentration (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
IUR	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Chemical-specific
EF	Exposure frequency, (day/yr)	350
ED	Exposure duration (day)	
	ED_{0-2} (yr)	2
	ED_{2-6} (yr)	4
	ED_{6-16} (yr))	10
	ED_{16-26} (yr)	10
	ED_r (yr)	26
ET_r	Exposure time (hr/day)	1
1000	Conversion factor (µg/mg)	1000
1/24	Conversion factor (day/hr)	1/24
CAF_i	Adjusted inhalation cancer unit risk $(\mu g/m^3)^{-1}$	See Equation 15
MAF_i	Adjusted inhalation mutagenic unit risk $(\mu g/m^3)^{-1}$	See Equation 15
VF_s	Volatilization factor for soil (m^3/kg)	See Equation45
PEF	Particulate emission factor (m^3/kg)	See Equation 48

Equation 15
Adjusted Inhalation Unit Risks - TCE
Residential Scenario

$$CAF_i = \frac{IUR_{NHL+Liver}}{IUR_{adult}}$$

$$MAF_i = \frac{IUR_{kidney}}{IUR_{adult}}$$

Parameter	Definition (units)	Default
CAF_i	Adjusted carcinogenic inhalation unit risk $(\mu g/m^3)^{-1}$	0.756
IUR_{adult}	Inhalation unit risk, $(\mu g/m^3)^{-1}$	4.1E-06
$IUR_{NHL+liver}$	Inhalation unit risk, NHL (2E-06) and Liver (1E-06), $(\mu g/m^3)^{-1}$	3.1E-06
MAF_i	Adjusted mutagenic inhalation unit risk $(\mu g/m^3)^{-1}$	0.244
IUR_{kidney}	Inhalation unit risk, kidney, $(\mu g/m^3)^{-1}$	1E-06

Equation 16
SSL for Dermal Contact with Soil - Trichloroethylene (TCE)
Residential Scenario

$$C_{TCE-der} = \frac{TR \times AT}{\frac{CSF_o}{GIABS} \times 10^{-6} \times \left(\left(CAF_o \times DFS_{adj} \times ABS\right) + \left(MAF_o \times DFSM_{adj} \times ABS\right)\right)}$$

Parameter	Definition (units)	Default
$C_{TCE-der}$	Contaminant concentration (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
AT	Averaging time, carcinogens (days)	25,550
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
GIABS	Fraction of contaminant absorbed in gastrointestinal tract (unitless)	Chemical-specific
10^{-6}	Unit conversion factor (kg/mg)	1E-06
CAF_o	Adjusted oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	See Equation 13
DFS_{adj}	Resident soil dermal contact factor- age-adjusted (mg/kg)	See Equation 4
ABS	Skin absorption factor (unitless)	Chemical-specific
MAF_o	Oral mutagenic slope factor $(mg/kg\text{-}day)^{-1}$	See Equation 13
$DFSM_{adj}$	Resident Mutagenic soil dermal contact factor- age-adjusted (mg/kg)	See Equation 10

Equation 17
Determination of the Combined SSL
TCE

$$SSL_{res-TCE} = \frac{1}{\dfrac{1}{C_{TCE-oral}} + \dfrac{1}{C_{TCE-inh}} + \dfrac{1}{C_{TCE-der}}}$$

Parameter	Definition (units)	Default
$SSL_{res\text{-}TCE}$	Cumulative SSL for mutagens (mg/kg)	Chemical-specific
$C_{TCE\text{-}oral}$	Concentration from soil ingestion (mg/kg)	See Equation 12
$C_{TCE\text{-}inh}$	Concentration from inhalation (mg/kg)	See Equation 14
$C_{TCE\text{-}der}$	Concentration from dermal exposure (mg/kg)	See Equation 16

2.3 Soil Screening Levels for Non-residential Land Uses

Non-residential land uses encompass all commercial and industrial land uses and focus on two very different receptors – a commercial/industrial worker and a construction worker. Unlike those calculated for residential land-uses, NMED SSLs for non-residential land uses are based solely on exposures to adults. Consequently, exposures to carcinogens are not age-adjusted. Due to the wide range of activities and exposure levels a non-residential receptor may be exposed to during various work-related activities, it is important to ensure that the default exposure parameters are representative of site-specific conditions. Table 2-5 provides a summary of the exposure characteristics and parameters for non-residential land use receptors (USEPA, 2014b).

Table 2-5. Summary of Non-Residential Land Use Receptors

Receptor	Commercial/Industrial Worker	Construction Worker
Exposure Characteristics	• Substantial soil exposures • High soil ingestion rate • Long-term exposure • Exposure to surface and shallow subsurface soils (0-1 foot bgs) • Adult-only exposure	• Exposed during construction activities only • Short-term exposure • Very high soil ingestion and dust inhalation rates • Exposure to surface and subsurface soils (0-10 feet bgs)
Default Exposure Parameters		
Exposure frequency (days/yr)	225	250
Exposure duration (yr)	25	1
Soil ingestion rate (mg/day)	100	330
Body Weight (kg)	80	80
Skin surface area exposed (cm^2)	3,470	3,470
Skin-soil adherence factor (mg/ cm^2)	0.12	0.3

2.3.1 Commercial/Industrial Worker

The commercial/industrial scenario is considered representative of on-site workers who spend all or most of their workday outdoors. A commercial/industrial worker is assumed to be a long-term receptor exposed during the course of a work day as either (1) a full time employee of a company operating on-site who spends most of the work day conducting maintenance or manual labor activities outdoors or (2) a worker who is assumed to regularly perform grounds-keeping activities as part of his/her daily responsibilities. Exposure to surface and shallow subsurface soils (i.e., at depths of zero to 1 ft below ground surface) is expected to occur during moderate digging associated with routine maintenance and grounds-keeping activities. A commercial/industrial receptor is expected to be the most highly exposed receptor in the outdoor environment under generic or day-to-day commercial/industrial conditions. Thus, the screening levels for this receptor are expected to be protective of other reasonably anticipated indoor and outdoor workers at a commercial/industrial facility. However, screening levels developed for the commercial/industrial worker may not be protective of a construction worker due to the latter's increased soil contact rate during construction activities. In addition, the SSLs for the commercial/industrial worker do not account for inhalation of volatiles indoors via vapor intrusion.

Equations 18 and 19 were used to develop generic SSLs for cumulative exposure to carcinogenic and non-carcinogenic contaminants by all exposure pathways. Default exposure parameters (US EPA 2002a and US EPA 2014b) are provided and were used in calculating the NMED SSLs.

Equation 18
Combined Exposures to Carcinogenic Contaminants in Soil Commercial/Industrial Scenario

$$C_{CI-oral} = \frac{TR \times AT_{CI} \times BW_{CI}}{CSF_o \times EF_{CI} \times ED_{CI} \times IR_{CI} \times 10^{-6}}$$

$$C_{CI-inh} = \frac{TR \times AT_{CI}}{IUR \times 1000 \times EF_{CI} \times \left(\frac{1}{VF_s} + \frac{1}{PEF_w} \right) \times ED_{CI} \times ET_{CI}}$$

$$C_{CI-dermal} = \frac{TR \times AT_{CI} \times BW_{CI}}{EF_{CI} \times ED_{CI} \times \frac{CSF_o}{GIABS} \times SA_{CI} \times AF_{CI} \times ABS_d \times 10^{-6}}$$

<u>Combined Exposures:</u>

$$SSL_{CI} = \frac{1}{\frac{1}{C_{CI-oral}} + \frac{1}{C_{CI-inh}} + \frac{1}{C_{CI-dermal}}}$$

Parameter	**Definition (units)**	**Default**
$C_{CI\text{-oral}}$	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
$C_{CI\text{-dermal}}$	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
$C_{CI\text{-inh}}$	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{CI}	Contaminant concentration, all pathways (mg/kg)	Chemical-specific
TR	Target Risk	1E-05
BW_{CI}	Body weight, adult (kg)	80
AT_{CI}	Averaging time, carcinogens (days)	25,550
EF_{CI}	Exposure frequency, commercial/industrial (day/yr)	225
ED_{CI}	Exposure duration, commercial/industrial (yr)	25
IR_{CI}	Soil ingestion rate, commercial/industrial (mg/day)	100
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
SA_{CI}	Dermal surface area, commercial/industrial (cm^2/day)	3,470
AF_{CI}	Soil adherence factor, commercial/industrial (mg/cm^2)	0.12
ABS_d	Skin absorption factor (unitless)	Chemical-specific
ET_{CI}	Exposure time, commercial/industrial (8 hr/per 24 hr)	0.33
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific
1000	Unit conversion (µg/mg)	1000
VF_s	Volatilization factor for soil (m^3/kg)	See Equation 45
PEF	Particulate emission factor (m^3/kg)	See Equation 48

Equation 19
Combined Exposures to Noncarcinogenic Contaminants in Soil Commercial/Industrial Scenario

$$C_{CI-oral} = \frac{THQ \times AT_{CI} \times BW_a}{EF_{CI} \times ED_{CI} \times \left(1/RfD_o\right) \times IR_{CI} \times (10^{-6})}$$

$$C_{CI-inh} = \frac{THQ \times AT_{CI}}{EF_{CI} \times ED_{CI} \times ET_{CI} \times \left(1/RfC\right) \times \left[\left(1/VF_s\right) + \left(1/PEF_w\right)\right]}$$

$$C_{CI-dermal} = \frac{THQ \times AT_{CI} \times BW_a}{EF_{CI} \times ED_{CI} \times \left[1/\left(RfD_o \times GIABS\right)\right] \times SA_{CI} \times AF_{CI} \times ABS_d \times 10^{-6}}$$

Combined Exposures:

$$SSL_{CI} = \frac{1}{\dfrac{1}{C_{CI-oral}} + \dfrac{1}{C_{CI-inh}} + \dfrac{1}{C_{CI-dermal}}}$$

Parameter	Definition (units)	Default
$C_{CI-oral}$	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
$C_{CI-dermal}$	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
C_{CI-inh}	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{CI}	Soil screening level, all pathways (mg/kg)	Chemical-specific
THQ	Target hazard quotient	1
BW_a	Body weight, adult (kg)	80
AT_{CI}	Averaging time, noncarcinogens (days)	ED x 365
EF_{CI}	Exposure frequency, commercial/industrial (day/yr)	225
ED_{CI}	Exposure duration, commercial/industrial (yr)	25
IR_{CI}	Soil ingestion rate, commercial/industrial (mg/day)	100
10^{-6}	Unit conversion factor (kg/mg)	10^{-6}
RfD_o	Oral reference dose (mg/kg-day)	Chemical-specific
SA_{CI}	Dermal surface area, commercial/industrial (cm^2/day)	3,470
AF_{CI}	Soil adherence factor, commercial/industrial (mg/cm^2)	0.12
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
ABS_d	Skin absorption factor (unitless)	Chemical-specific
ET_{CI}	Exposure time(8 hr/day per 1 day/24 hr)	0.33
RfC	Reference concentration (mg/m^3)	Chemical-specific
VF_s	Volatilization factor for soil (m^3/kg)	See Equation 45
PEF	Particulate emission factor (m^3/kg)	See Equation 48

2.3.2 Construction Worker

A construction worker is assumed to be a receptor that is exposed to contaminated soil during the work day for the duration of a single on-site construction project. If multiple construction projects are anticipated, it is assumed that different workers will be employed for each project. The activities for this receptor typically involve substantial exposures to surface and subsurface soils (i.e., at depths of zero to 10 feet bgs) during excavation, maintenance, and building construction projects (intrusive operations). A construction worker is assumed to be exposed to contaminants via the following pathways: incidental soil ingestion, dermal contact with soil, and inhalation of contaminated outdoor air (volatile and particulate emissions). While a construction worker receptor is assumed to have a higher soil ingestion rate than a commercial/industrial worker due to the type of activities performed during construction projects, the exposure frequency and duration are assumed to be significantly shorter due to the short-term nature of construction projects. However, chronic toxicity information was used when developing screening levels for a construction worker receptor. This approach is significantly more conservative than using sub-chronic toxicity data because it combines the higher soil exposures for construction workers with chronic toxicity criteria. Equations 20 and 21 were used to develop generic SSLs for cumulative exposure to carcinogenic and non-carcinogenic contaminants by all exposure pathways for a construction worker. Default exposure parameters (US EPA 2002a and US EPA 2014b) are provided and were used in calculating the NMED SSLs.

Equation 20
Combined Exposures to Carcinogenic Contaminants in Soil Construction Worker Scenarios

$$C_{CW-oral} = \frac{TR \times AT_{CW} \times BW_{CW}}{CSF_o \times EF_{CW} \times ED_{CW} \times IR_{CW} \times 10^{-6}}$$

$$C_{CW-inh} = \frac{TR \times AT_{CW}}{IUR \times 1000 \times EF_{CW} \times \left(\frac{1}{VF_{cw}} + \frac{1}{PEF_{cw}} \right) \times ED_{CW} \times ET_{CW}}$$

$$C_{CW-dermal} = \frac{TR \times AT_{CW} \times BW_{CW}}{EF_{CW} \times ED_{CW} \times \frac{CSF_o}{GIABS} \times SA_{CW} \times AF_{CW} \times ABS_d \times 10^{-6}}$$

Combined Exposures:

$$SSL_{CW} = \frac{1}{\frac{1}{C_{CW-oral}} + \frac{1}{C_{CW-inh}} + \frac{1}{C_{CW-dermal}}}$$

Parameter	Definition (units)	Default
$C_{CW\text{-oral}}$	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
$C_{CW\text{-dermal}}$	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
$C_{CW\text{-inh}}$	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{CW}	Contaminant concentration, all pathways (mg/kg)	Chemical-specific
TR	Target Risk	1E-05
BW_{CW}	Body weight, adult (kg)	80
AT_{CW}	Averaging time, carcinogens (days)	25,550
EF_{CW}	Exposure frequency, construction worker (day/yr)	250
ED_{CW}	Exposure duration, construction worker (years)	1
IR_{CW}	Soil ingestion rate, construction worker (mg/day)	330
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
SA_{CW}	Dermal surface area, construction worker (cm^2/day)	3,470
AF_{CW}	Soil adherence factor, construction worker (mg/cm^2)	0.3
ABS_d	Skin absorption factor (unitless)	Chemical-specific
ET_{CW}	Exposure time, construction worker (8 hours/day per 1 day/24 hours)	0.33
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific
1000	Unit conversion (µg/mg)	1000
VF_{cw}	Volatilization factor for soil, construction worker (m^3/kg)	See Equation 46
PEF_{cw}	Particulate emission factor, construction worker (m^3/kg)	See Equation 49

Equation 21
Combined Exposures to Noncarcinogenic Contaminants in Soil Construction Worker Scenario

$$C_{CW-oral} = \frac{THQ \times AT_{CW} \times BW_{CW}}{EF_{CW} \times ED_{CW} \times \left(1 / RfD_o\right) \times IR_{CW} \times (10^{-6})}$$

$$C_{CW-inh} = \frac{THQ \times AT_{CI}}{EF_{CW} \times ED_{CW} \times ET_{CW} \times \left(1 / RfC\right) \times \left[\left(1 / VF_{cw}\right) + \left(1 / PEF_{cw}\right)\right]}$$

$$C_{CW-dermal} = \frac{THQ \times AT_{CW} \times BW_{cw}}{EF_{CW} \times ED_{CW} \times \left[1 / \left(RfD_o \times GIABS\right)\right] \times SA_{CW} \times AF_{CW} \times ABS_d \times 10^{-6}}$$

Combined Exposures:

$$SSL_{CW} = \frac{1}{\dfrac{1}{C_{CW-oral}} + \dfrac{1}{C_{CW-inh}} + \dfrac{1}{C_{CW-dermal}}}$$

Parameter	Definition (units)	Default
$C_{CW\text{-oral}}$	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
$C_{CW\text{-dermal}}$	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
$C_{CW\text{-inh}}$	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{CW}	Soil screening level, all pathways (mg/kg)	Chemical-specific
THQ	Target hazard quotient	1
BW_{cw}	Body weight, adult (kg)	80
AT_{CW}	Averaging time, noncarcinogens (days)	ED x 365
EF_{CW}	Exposure frequency, construction worker (day/yr)	250
ED_{CW}	Exposure duration, construction worker (years)	1
IR_{CW}	Soil ingestion rate, construction worker (mg/day)	330
10^{-6}	Unit conversion factor (kg/mg)	10^{-6}
RfD_o	Oral reference dose (mg/kg-day)	Chemical-specific
SA_{CW}	Dermal surface area, construction worker (cm^2/day)	3,470
AF_{CW}	Soil adherence factor, construction worker (mg/cm^2)	0.3
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
ABS_d	Skin absorption factor (unitless)	Chemical-specific
ET_{CW}	Exposure time(8 hours/day per 1 day/24 hour)	0.33
RfC	Reference concentration (mg/m^3)	Chemical-specific
VF_{cw}	Volatilization factor for soil, construction worker (m^3/kg)	See Equation 46
PEF_{cw}	Particulate emission factor, construction worker (m^3/kg)	See Equation 49

2.3.3 Alternative Evaluation for Lead

Exposure to lead can result in neurotoxic and developmental effects. The primary receptors of concern are children, whose nervous systems are still undergoing development and who also exhibit behavioral tendencies that increase their likelihood of exposure (e.g., pica). These effects may occur at exposures so low that they may be considered to have no threshold, and are evaluated based on a blood lead level (rather than the external dose as reflected in the RfD/RfC methodology). Therefore, US EPA views it to be inappropriate to develop noncarcinogenic "safe" exposure levels (i.e., RfDs) for lead. Instead, US EPA's lead assessment workgroup has recommended the use of the IEUBK model that relates measured lead concentrations in environmental media with an estimated blood-lead level (US EPA 1994 and 1998). The model is used to calculate a blood lead level in children when evaluating residential land use and in adults (based on a pregnant mother's capacity to contribute to fetal blood lead levels). It is also used for adults in evaluating occupational scenarios at sites where access by children is reliably restricted. The NMED SSLs presented in Appendix A include values for lead that were calculated by using the IEUBK to back-calculate a soil concentration for each receptor that would not result in an estimated blood-lead concentration of 10 micrograms per deciliter (µg/dL) or greater (residential adult of 400 mg/kg and industrial and construction worker of 800 mg/kg).

2.4 Tap Water Screening Levels

Exposure to contaminants can occur through the ingestion of and dermal contact with domestic/household water and inhalation of volatiles in domestic/household water. NMED tap water screening levels were developed for residential land-use only. If it is determined that commercial/industrial receptors are potentially exposed to contaminated water through ingestion, dermal contact, and/or inhalation, these pathways must be evaluated via the methods outlined in this document and utilizing appropriate exposure parameters. The calculations of the NMED tap water screening levels for domestic water are based upon the methodology presented in RAGS, Part B (US EPA 1991), Part E (US EPA, 2004) and the revised default exposure factors (US EPA, 2014b). The screening levels are based upon ingestion of and dermal contact with contaminants in water, and inhalation of volatile contaminants volatilized from water during domestic use. To estimate the exposure dose from dermal contact with tap water, the skin permeability coefficient (K_p) and absorbed dose per event (DA_{event}) were considered, as outlined in US EPA's (2004a) RAGS Part E. While ingestion and dermal contact were considered for all chemicals, inhalation of volatiles from water was considered for those chemicals with a minimum Henry's Law constant of approximately 1E-05 atm-m^3/mole and with a maximum molecular weight of approximately 200 g/mole. To address the groundwater-to-air pathways, the tap water screening levels incorporate a volatilization factor (K) of 0.5 liters per cubic meter (L/m^3) for volatile contaminants (US EPA, 1991); this derived value defines the relationship between the concentration of a contaminant in household water and the average concentration of the volatilized contaminant in air as a result of all uses of household water (i.e., showering, laundering, dish washing).

As ingestion, dermal contact, and inhalation rates may be different for children and adults, carcinogenic risks were calculated using age-adjusted factors, which were obtained from RAGS, Part B (US EPA 1991) and Part E (US EPA, 2004a). Equations 22 through 28 show how SLs for carcinogenic and non-carcinogenic contaminants were developed. Similar to soil, separate equations are used for vinyl chloride (Equations 29 and 30) and carcinogens exhibiting mutagenic toxicity (Equations 31-35) such as trichloroethylene.

Equation 22
Combined Exposures to Carcinogenic Contaminants in Tap Water
Residential Scenario

$$C_{oral} = \frac{TR \times AT_c \times 1000}{CSF_o \times IFW_{adj}}$$

C_{derm} = See Equations 24 - 26

$$C_{inh} = \frac{TR \times AT_c}{EF_r \times ED_r \times ET_{rw} \times IUR \times K}$$

Combined Exposures:

$$SL_{tap} = \frac{1}{\frac{1}{C_{oral}} + \frac{1}{C_{derm}} + \frac{1}{C_{inh}}}$$

Parameter	Definition (units)	Default
C_{oral}	Contaminant concentration, ingestion (µg/L)	Chemical-specific
C_{derm}	Contaminant concentration, dermal (µg/L) (See Equations 24-26)	Chemical-Specific
C_{inh}	Contaminant concentration, inhalation (µg/L)	Chemical-specific
SL_{tap}	Tap water screening level (µg/L)	Chemical-specific
TR	Target risk	1E-05
AT_c	Averaging time, carcinogens (days)	25,550
EF_r	Exposure frequency, resident (day/yr)	350
1000	Unit conversion (µg/mg)	1000
IFW_{adj}	Age-adjusted water ingestion rate, resident (L /kg) (See Equation 23)	328
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
ED_r	Exposure duration (yr)	26
ET_{rw}	Exposure time, resident, tap water (24 hr/day per 1day/24 hr)	1
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific
K	Andelman volatilization factor (L/m^3)	0.5

Equation 23
Calculation of Age-Adjusted Tap Water Ingestion Factor

$$IFW_{adj} = \frac{EF \times ED_c \times IRW_c}{BW_c} + \frac{EF \times (ED_r - ED_c) \times IRW_a}{BW_a}$$

Parameter	Definition (units)	Default
IFW_{adj}	Age-adjusted water ingestion factor for carcinogens (L/kg)	328
EF	Exposure frequency (day/yr)	350
ED_c	Exposure duration, child (yr)	6
IRW_c	Water ingestion rate, child (L/day)	0.78
BW_c	Body weight, child (kg)	15
ED_r	Exposure duration, resident adult (yr)	26
ED_c	Exposure duration, resident child (yr)	6
IRW_a	Water ingestion rate, adult (L/day)	2.5
BW_a	Body weight, adult (kg)	80

Equation 24
Dermal Exposure to Carcinogenic Contaminants in Tap Water
Residential Scenario

For inorganic constituents:

$$C_{derm} = \frac{DA_{event\_carc} \times 1000\ (cm^3/L)}{K_p \times t_{event\_adj}}$$

For organic constituents:

If $t_{event\_adj} \leq t^*$, then:

$$C_{derm} = \frac{DA_{event\_carc} \times 1000\ (cm^3/L)}{2 \times FA \times K_p \times \sqrt{\frac{6\tau_{event} \times t_{event\_adj}}{\pi}}}$$

If $t_{event\_adj} > t^*$, then:

$$C_{derm} = \frac{DA_{event\_carc} \times 1000\ (cm^3/L)}{FA \times K_p \times \left[\frac{t_{event\_adj}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

Where:

$$DA_{event\_carc} = \frac{TR \times AT_c \times 1000(\mu g/mg)}{\left(\frac{CSF_o}{GIABS}\right) \times DFW_{adj}}$$

Parameter	Definition (units)	Default
C_{derm}	Contaminant concentration, dermal (µg/L)	Chemical-specific
DA_{event_carc}	Absorbed dose per event, carcinogens (mg/cm^2-event)	Chemical-specific
K_p	Dermal permeability coefficient of compound in water (cm/hr)	Chemical-specific
$t_{event-adj}$	Age-adjusted dermal exposure time per event, resident (hr/event)	See Equation 25
t*	Time to reach steady state (hr)	2.4 x τ_{event}
FA	Fraction absorbed water (unitless)	Chemical-specific
τ_{event}	Lag time per event (hr/event)	Chemical-specific
B	Ratio of permeability coefficient through the stratum corneum to permeability coefficient across the viable epidermis (unitless)	Chemical-specific
TR	Target risk	1E-05
AT_c	Averaging time, resident, carcinogens (days)	25,550
CSF_o	Oral cancer slope factor (mg/kg-day)$^{-1}$	Chemical-specific
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
EF_r	Exposure frequency, resident (day/yr)	350
DFW_{adj}	Age-adjusted dermal exposure factor, water, resident (cm^2-event /kg)	See Equation 26

Equation 25
Calculation of Age-adjusted Dermal Exposure Time per Event, Tap Water Residential Scenario

$$t_{event\_adj} = \frac{\left(t_{event\_c} \times ED_c\right) + \left(t_{event\_a} \times (ED_r - ED_c)\right)}{ED_r}$$

Parameter	Definition (units)	Default
t_{event_adj}	Age-adjusted dermal exposure time per event, resident (hr/event)	0.6708
t_{event_c}	Dermal exposure time per event, child (hr/event)	0.54
t_{event_a}	Dermal exposure time per event, adult (hr/event)	0.71
ED_c	Exposure duration, child (yr)	6
ED_r	Exposure duration, resident (yr)	26

Equation 26
Calculation of Age-adjusted Dermal Exposure Factor, Tap Water Residential Scenario

$$DFW_{adj} = \left(\frac{EF \times EV_c \times ED_c \times SA_c}{BW_c}\right) + \left(\frac{EF \times EV_a \times ED_a \times SA_a}{BW_a}\right)$$

Parameter	Definition (units)	Default
DFW_{adj}	Age-adjusted dermal exposure factor, tap water, resident (cm^2-event /kg)	2,721,670
EF	Exposure frequency (day/yr)	350
EV_c	Event frequency, child (events/day)	1
ED_c	Exposure duration, child (yr)	6
SA_c	Skin surface area available for water contact, child (cm^2)	6,378
BW_c	Body weight, child (kg)	15
EV_a	Event frequency, adult (events/day)	1
ED_a	Exposure duration, adult (yr)	20
SA_a	Skin surface area available for water contact, adult (cm^2)	20,900
BW_a	Body weight, adult (kg)	80

Equation 27
Combined Exposures to Noncarcinogenic Contaminants in Tap Water
Residential Scenario

$$C_{oral} = \frac{THQ \times BW_c \times 1000 \times AT_{nc}}{EF_r \times ED_c \times \left(\frac{1}{RfD_o}\right) \times IRW_c}$$

$$C_{derm} = See\ Equation\ 22$$

$$C_{inh} = \frac{THQ \times AT_{nc} \times 1000}{EF_r \times ED_c \times ET_{rw} \times \left(\frac{1}{RfC}\right) \times K}$$

Combined Exposures:

$$SL_{tap} = \frac{1}{\frac{1}{C_{oral}} + \frac{1}{C_{inh}} + \frac{1}{C_{derm}}}$$

Parameter	Definition (units)	Default
C_{oral}	Contaminant concentration, ingestion (µg/L)	Chemical-specific
C_{derm}	Contaminant concentration, dermal (µg/L)	See Equation 28
C_{inh}	Contaminant concentration, inhalation (µg/L)	Chemical-specific
SL_{tap}	Tap water screening level (µg/L)	Chemical-specific
THQ	Target hazard quotient	1
BW_c	Body weight, child (kg)	15
AT_{nc}	Averaging time, noncarcinogens (days)	ED_c x 365
1000	Unit conversion (µg/mg)	1000
EF_r	Exposure frequency, resident (day/yr)	350
ED_c	Exposure duration, child resident (yr)	6
IRW_a	Water ingestion rate, child resident (L/day)	0.78
RfD_o	Oral reference dose(mg/kg-day)	Chemical-specific
ET_{rw}	Exposure time (24 hr/day per 1day/24 hr)	1
RfC	Reference concentration (mg/m^3)	Chemical-specific
K	Andelman volatilization factor (L/m^3)	0.5

Equation 28
Dermal Exposure to Non-carcinogenic Contaminants in Tap Water Residential Scenario

For inorganic constituents:

$$C_{derm} = \frac{DA_{event\_nc} \times 1000\ (cm^3/L)}{K_p \times t_{event\_c}}$$

For organic constituents:

If $t_{event\_c} \leq t^*$, then:

$$C_{derm} = \frac{DA_{event\_nc} \times 1000\ (cm^3/L)}{2 \times FA \times K_p \times \sqrt{\frac{6\tau_{event} \times t_{event\_c}}{\pi}}}$$

If $t_{event\_c} > t^*$, then:

$$C_{derm} = \frac{DA_{event\_nc} \times 1000\ (cm^3/L)}{FA \times K_p \times \left[\frac{t_{event\_c}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

Where:

$$DA_{event\_nc} = \frac{THQ \times AT_{nc} \times 1000(\mu g/mg) \times BW_c}{\left(\frac{1}{RfD_o \times GIABS}\right) \times EV_c \times ED_c \times EF_r \times SA_c}$$

Parameter	**Definition (units)**	**Default**
C_{derm}	Contaminant concentration, dermal (µg/L)	Chemical-specific
DA_{event_nc}	Absorbed dose per event, noncarcinogens (µg/cm^2-event)	Chemical-specific
K_p	Dermal permeability coefficient of compound in water (cm/hr)	Chemical-specific
t_{event_c}	Dermal exposure time per event, child (hr/event)	1
t*	Time to reach steady state (hr)	2.4 x τ_{event}
FA	Fraction absorbed water (unitless)	Chemical-specific
τ_{event}	Lag time per event (hr/event)	Chemical-specific
B	Ratio of permeability coefficient through the stratum corneum to permeability coefficient across the viable epidermis (unitless)	Chemical-specific
THQ	Target hazard quotient	1
AT_{nc}	Averaging time, resident, non-carcinogens (days)	365 x ED_c
BW_c	Body weight, child (kg)	15
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
RfD_o	Oral reference dose (mg/kg-day)	Chemical-specific
EV_c	Event frequency, child (events/day)	1
ED_c	Exposure duration, child (yr)	6
EF_r	Exposure frequency, resident (day/yr)	350
SA_c	Skin surface area available for contact, child (cm^2)	6,378

Equation 29
Combined Carcinogenic Exposures to Vinyl Chloride in Tap Water Residential Scenario

$$C_{oral} = \frac{TR}{\left(\frac{CSF_o \times IFW_{adj} \times 0.001}{AT} + \frac{CSF_o \times IRW_c \times 0.001}{BW_c}\right)}$$

$$C_{derm} = See\ Equation\ 30$$

$$C_{inh} = \frac{TR}{\left(\frac{IUR \times EF_r \times ED_r \times ET_{rw} \times K}{AT} + (IUR \times K)\right)}$$

<u>Combined Exposures:</u>

$$SL_{tap} = \frac{1}{\frac{1}{C_{oral}} + \frac{1}{C_{inh}} + \frac{1}{C_{derm}}}$$

Parameter	Definition (units)	Default
C_{oral}	Contaminant concentration, ingestion (µg/L)	Chemical-specific
C_{derm}	Contaminant concentration, dermal (µg/L)	See Equation 30
C_{inh}	Contaminant concentration, inhalation (µg/L)	Chemical-specific
SL_{tap}	Tap water screening level (µg/L)	Chemical-specific
TR	Target risk	1E-05
AT	Averaging time, carcinogens (days)	25,550
EF_r	Exposure frequency, resident (day/yr)	350
0.001	Unit conversion (mg/µg)	0.001
IFW_{adj}	Age-adjusted water ingestion rate, resident (L/kg)	See Equation 23
IRW_c	Child water ingestion rate, resident (L/day)	1
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
ED_r	Exposure duration (yr)	26
ET_{rw}	Exposure time (24 hours/day per 1day/24 hr)	1
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific
K	Andelman volatilization factor (L/m^3)	0.5

Equation 30
Carcinogenic Dermal Exposure to Vinyl Chloride in Tap Water Residential Scenario

If $t_{event\_adj} \leq t^*$, then:

$$C_{derm} = \frac{DA_{event\_vc} \times 1000\ (cm^3/L)}{2 \times FA \times K_p \times \sqrt{\frac{6\tau_{event} \times t_{event\_adj}}{\pi}}}$$

If $t_{event\_adj} > t^*$, then:

$$C_{derm} = \frac{DA_{event\_vc} \times 1000\ (cm^3/L)}{FA \times K_p \times \left[\frac{t_{event\_adj}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

Where:

$$DA_{event\_vc} = \frac{TR}{\left[\frac{\left(\frac{CSF_o}{GIABS}\right) \times DFW_{adj}}{AT_r \times 1000\frac{\mu g}{mg}}\right] + \left[\frac{\left(\frac{CSF_o}{GIABS}\right) \times EV_c \times SA_c}{BW_c \times 1000\frac{\mu g}{mg}}\right]}$$

Parameter	Definition (units)	Default
t_{event_adj}	Age-adjusted dermal exposure time per event, resident (hr/event)	See Equation 25
t^*	Time to reach steady state (hr)	2.4 x τ_{event}
τ_{event}	Lag time per event (hr/event)	Chemical-specific
C_{derm}	Contaminant concentration, dermal (µg/L)	Chemical-specific
DA_{event_vc}	Absorbed dose per event, vinyl chloride (µg/cm^2-event)	Chemical-specific
FA	Fraction absorbed water (unitless)	Chemical-specific
K_p	Dermal permeability coefficient of compound in water (cm/hr)	Chemical-specific
B	Ratio of permeability coefficient through the stratum corneum to permeability coefficient across the viable epidermis (unitless)	Chemical-specific
TR	Target risk	1E-05
AT_r	Averaging time, resident, carcinogens (days)	25,550
EF_r	Exposure frequency, resident (day/yr)	350
CSF_o	Oral cancer slope factor (mg/kg-day)$^{-1}$	Chemical-specific
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
DFW_{adj}	Age-adjusted dermal exposure factor, tap water, resident (cm^2-event /kg)	See Equation 26
EV_c	Event duration, child (events/day)	1
SA_c	Skin surface area available for contact, child (cm^2)	6,378
BW_c	Body weight, child (kg)	15

Equation 31
Combined Exposures to Mutagenic Contaminants in Tap Water Residential Exposure

$$C_{mu-oral} = \frac{TR \times AT_r \times 1000}{CSF_o \times IFWM_{adj}}$$

$$C_{mu-derm} = See\ Equations\ 27 - 29$$

$$C_{mu-inh} = \frac{TR \times AT_r}{(EF_r \times ET_{rs} \times K) \times [(ED_{0-2} \times IUR \times 10) + (ED_{2-6} \times IUR \times 3) + (ED_{6-16} \times IUR \times 3) + (ED_{16-26} \times IUR \times 1)]}$$

<u>Combined Exposures:</u>

$$SL_{tap-mu} = \frac{1}{\frac{1}{C_{mu-oral}} + \frac{1}{C_{mu-inh}} + \frac{1}{C_{mu-derm}}}$$

Parameter	**Definition (units)**	**Default**
$C_{mu-oral}$	Contaminant concentration, ingestion (µg/L)	Chemical-specific
$C_{mu-derm}$	Contaminant concentration, dermal (µg/L	See Equations 33-35
C_{mu-inh}	Contaminant concentration, inhalation (µg/L)	Chemical-specific
SL_{tap-mu}	Tap water screening level (µg/L)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
CSF_o	Oral cancer slope factor (mg/kg-day$)^{-1}$	Chemical-specific
EF_r	Exposure frequency, resident (day/yr)	350
ET_{rw}	Exposure time (24 hr/day per 1day/24 hr)	1
K	Andelman volatilization factor (L/m^3)	0.5
$IFWM_{adj}$	Age-adjusted water ingestion rate, mutagens (L/kg)	See Equation 32
1000	Conversion factor (µg/mg)	1000
ED_{0-2}	Exposure duration, child (yr)	2
ED_{2-6}	Exposure duration, child (yr)	4
ED_{6-16}	Exposure duration, adult (yr)	10
ED_{16-26}	Exposure duration, adult (yr)	10
IUR	Inhalation unit risk (µg/m^3)$^{-1}$	Chemical-specific

Equation 32
Calculation of Age-Adjusted Tap Water Ingestion Factor, Mutagens

$$IFWM_{adj} = \frac{EF \times ED_{0-2} \times IRW_c \times 10}{BW_c} + \frac{EF \times ED_{2-6} \times IRW_c \times 3}{BW_c} + \frac{EF \times ED_{6-16} \times IRW_a \times 3}{BW_a} + \frac{EF \times ED_{16-26} \times IRW_a \times 1}{BW_a}$$

Parameter	**Definition (units)**	**Default**
$IFWM_{adj}$	Age-adjusted water ingestion factor for mutagens (L/kg)	1,019.9
ED_{0-2}	Exposure duration, child (yr)	2
ED_{2-6}	Exposure duration, child (yr)	4
ED_{6-16}	Exposure duration, adult (yr)	10
ED_{16-26}	Exposure duration, adult (yr)	10
EF	Exposure frequency (days/yr)	350
IRW_c	Water ingestion rate, child (L/day)	0.78
IRW_a	Water ingestion rate, adult (L/day)	2.5
BW_c	Body weight, child (kg)	15
BW_a	Body weight, adult (kg)	80

Equation 33
Dermal Exposure to Mutagenic Contaminants in Tap Water
Residential Scenario

For inorganic constituents:

$$C_{mu-derm} = \frac{DA_{event\_mu} \times 1000\ (cm^3/L)}{K_p \times t_{event\_mu\_adj}}$$

For organic constituents:

If $t_{event\_mu\_adj} \leq t^*$, then:

$$C_{mu-derm} = \frac{DA_{event\_mu} \times 1000\ (cm^3/L)}{2 \times FA \times K_p \times \sqrt{\frac{6\tau_{event} \times t_{event\_mu\_adj}}{\pi}}}$$

If $t_{event\_mu\_adj} > t^*$, then:

$$C_{mu-derm} = \frac{DA_{event\_mu} \times 1000\ (cm^3/L)}{FA \times K_p \times \left[\frac{t_{event\_mu\_adj}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

Where:

$$DA_{event\_mu} = \frac{TR \times AT_r \times 1000(\mu g/mg)}{\left(\frac{CSF_o}{GIABS}\right) \times DFW_{mu\_adj}}$$

Parameter	Definition (units)	Default
$C_{mu\text{-}derm}$	Contaminant concentration, mutagens, dermal (μg/L)	Chemical-specific
DA_{event_mu}	Absorbed dose per event, mutagens ($\mu g/cm^2$-event)	Chemical-specific
K_p	Dermal permeability coefficient of compound in water (cm/hr)	Chemical-specific
$t_{event\text{-}mu\_adj}$	Age-adjusted dermal exposure time per event, mutagens, resident (hr/event)	See Equation 34
t*	Time to reach steady state (hr)	2.4 x τ_{event}
FA	Fraction absorbed water (unitless)	Chemical-specific
τ_{event}	Lag time per event (hr/event)	Chemical-specific
B	Ratio of permeability coefficient through the stratum corneum to permeability coefficient across the viable epidermis (unitless)	Chemical-specific
TR	Target risk	1E-05
AT_r	Averaging time, resident, carcinogens (days)	25,550
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
EF_r	Exposure frequency, resident (day/yr)	350
DFW_{mu_adj}	Age-adjusted dermal tap water exposure factor, mutagens, resident (cm^2-event /kg)	See Equation 35

Equation 34
Calculation of Age-Adjusted Tap Water Dermal Exposure Time per Event, Mutagens Residential Scenario

$$t_{event\_mu\_adj} = \frac{t_{event_{0-2}} \times ED_{0-2} + t_{event_{2-6}} \times ED_{2-6} + t_{event_{6-16}} \times ED_{6-16} + t_{event_{16-26}} \times ED_{16-26}}{ED_{0-2} + ED_{2-6} + ED_{6-16} + ED_{16-26}}$$

Parameter	**Definition (units)**	**Default**
$t_{event\_mu\_adj}$	Age-adjusted dermal exposure time per event, mutagens, tap water, resident (hr/event)	0.671
t_{event_0-2}	Dermal exposure time per event, tap water, resident 0-2 years (hr/event)	0.54
ED_{0-2}	Exposure duration, resident 0-2 years (yr)	2
t_{event_2-6}	Dermal exposure time per event, tap water, resident 2-6 years (hr/event)	0.54
ED_{2-6}	Exposure duration, resident 2-6 years (yr)	4
t_{event_6-16}	Dermal exposure time per event, tap water, resident 6-16 years (hr/event)	0.71
ED_{6-16}	Exposure duration, resident 6-16 years (yr)	10
t_{event_16-26}	Dermal exposure time per event, tap water, resident 16-26 years (hr/event)	0.71
ED_{16-26}	Exposure duration, resident 16-26 years (yr)	10

Equation 35
Calculation of Age-Adjusted Tap Water Dermal Exposure Factor, Mutagens

$$DFW_{mu\_adj} = \left[\frac{EF \times EV_{0-2} \times ED_{0-2} \times SA_c \times 10}{BW_c}\right] + \left[\frac{EF \times EV_{2-6} \times ED_{2-6} \times SA_c \times 3}{BW_c}\right] + \left[\frac{EF \times EV_{6-16} \times ED_{6-16} \times SA_a \times 3}{BW_a}\right] + \left[\frac{EF \times EV_{16-30} \times ED_{16-26} \times SA_a \times 1}{BW_a}\right]$$

Parameter	**Definition (units)**	**Default**
DFW_{mu_adj}	Age-adjusted tap water dermal exposure factor, mutagens, resident (cm^2-event /kg)	8,419,740
EV_{0-2}	Event frequency, resident 0-2 years (events/day)	1
ED_{0-2}	Exposure duration, resident 0-2 years (yr)	2
SA_c	Skin surface area available for contact, child (cm^2)	6,378
EV_{2-6}	Event frequency, resident 2-6 years (events/day)	1
ED_{2-6}	Exposure duration, resident 2-6 years (yr)	4
EV_{6-16}	Event frequency, resident 6-16 years (events/day)	1
ED_{6-16}	Exposure duration, resident 6-16 years (yr)	10
EF	Event frequency (days/yr)	350
SA_a	Skin surface area available for contact, adult (cm^2)	20,900
EV_{16-26}	Event frequency, resident 16-26 yr (events/day)	1
ED_{16-26}	Exposure duration, resident 16-26 (yr)	10
BW_c	Body weight, child (kg)	15
BW_a	Body weight, adult (kg)	80

Equation 36
Combined Exposures to TCE in Tap Water
Residential Exposure

$$C_{TCE-oral} = \frac{TR \times AT_r \times 1000}{CSF_o \times \left(\left(CAF_o \times IFW_{adj}\right) + \left(MAF_o \times IFWM_{adj}\right)\right)}$$

$$C_{TCE-derm} = See\ Equation\ 37$$

$$C_{TCE-inh} = \frac{TR \times AT_r}{\left(ET_{rs} \times K \times IUR\right) \times \left[\left(EF_r \times ED_{rs} \times CAF_i\right) + AgeTerms\right]}$$

$$Age\ Terms$$
$$= \left(\left(\left[\left(ED_{0-2} \times EF_{rx} \times MAF_i \times 10\right) + \left(ED_{2-6} \times EF_{rx} \times MAF_i \times 3\right) + \left(ED_{6-16} \times EF_{rx} \times MAF_i \times 3\right) + \left(ED_{16-26} \times EF_{rx} \times MAF_i \times 1\right)\right]\right)\right)$$

Combined Exposures:

$$SL_{tap-TCE} = \frac{1}{\frac{1}{C_{TCE-oral}} + \frac{1}{C_{TCE-inh}} + \frac{1}{C_{TCE-derm}}}$$

Parameter	Definition (units)	Default
$C_{TCE\text{-}oral}$	Contaminant concentration, ingestion (µg/L)	Chemical-specific
$C_{TCE\text{-}derm}$	Contaminant concentration, dermal (µg/L) (See Equations 37-39)	Chemical-specific
$C_{TCE\text{-}inh}$	Contaminant concentration, inhalation (µg/L)	Chemical-specific
$SL_{tap\text{-}TCE}$	Tap water screening level (µg/L)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
CSF_o	Oral cancer slope factor (mg/kg-day)$^{-1}$	Chemical-specific
CAF_o	Adjusted oral cancer slope factor (µg/m^3)$^{-1}$	See Equation 13
IFW_{adj}	Age-adjusted ingestion oral ingestion factor (L/kg)	See Equation 23
MAF_o	Age-adjusted mutagenic slope factor (µg/m^3)$^{-1}$	See Equation 13
$IFWM_{adj}$	Age-adjusted water ingestion rate, mutagens (L/kg)	See Equation 32
EF_r	Exposure frequency, resident (day/yr)	350
ET_{rw}	Exposure time (24 hr/day per 1day/24 hr)	1
K	Andelman volatilization factor (L/m^3)	0.5
IUR	Inhalation unit risk (µg/m^3)$^{-1}$	Chemical-specific
CAF_i	Adjusted inhalation cancer unit risk (µg/m^3)$^{-1}$	See Equation 15
MAF_i	Adjusted inhalation mutagenic unit risk (µg/m^3)$^{-1}$	See Equation 15
1000	Conversion factor (µg/mg)	1000
ED_{0-2}	Exposure duration, child (yr)	2
ED_{2-6}	Exposure duration, child (yr)	4
ED_{6-16}	Exposure duration, adult (yr)	10
ED_{16-26}	Exposure duration, adult (yr)	10

Equation 37
Dermal Exposure to TCE in Tap Water
Residential Scenario

If $t_{event\_adj} \leq t^*$, then:

$$C_{TCE-derm} = \frac{DA_{event\_TCE} \times 1000\ (cm^3/L)}{2 \times FA \times K_p \times \sqrt{\frac{6\tau_{event} \times t_{event\_mu\_adj}}{\pi}}}$$

If $t_{event\_adj} > t^*$, then:

$$C_{TCE-derm} = \frac{DA_{event\_TCE} \times 1000\ (cm^3/L)}{FA \times K_p \times \left[\frac{t_{event\_mu\_adj}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

Where:

$$DA_{event\_TCE} = \frac{TR \times AT_r \times 1000(\mu g/mg)}{\left(\frac{CSF_o}{GIABS}\right) \times \left(\left(CAF_o \times DFW_{adj}\right) + \left(MAF_o \times DFWM_{adj}\right)\right)}$$

Parameter	Definition (units)	Default
$C_{mu\text{-}derm}$	Contaminant concentration, mutagens, dermal (µg/L)	Chemical-specific
DA_{event_mu}	Absorbed dose per event, mutagens (µg/cm^2-event)	Chemical-specific
K_p	Dermal permeability coefficient of compound in water (cm/hr)	Chemical-specific
t_{event_adj}	Age-adjusted dermal exposure time per event, resident (hr/event)	See Equation 25
t*	Time to reach steady state (hr)	2.4 x τ_{event}
$t_{event\_mu\_adj}$	Age-adjusted dermal exposure time per event, mutagens, resident (hr/event)	See Equation 34
FA	Fraction absorbed water (unitless)	Chemical-specific
τ_{event}	Lag time per event (hr/event)	Chemical-specific
B	Ratio of permeability coefficient through the stratum corneum to permeability coefficient across the viable epidermis (unitless)	Chemical-specific
TR	Target risk	1E-05
AT_r	Averaging time, resident, carcinogens (days)	25,550
CSF_o	Oral cancer slope factor (mg/kg-day)$^{-1}$	Chemical-specific
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
CAF_o	Adjusted oral cancer slope factor	See Equation 13
MAF_o	Adjusted oral mutagenic slope factor	See Equation 13
DFW_{adj}	Age-adjusted dermal tap water exposure factor, resident (cm^2-event /kg)	See Equation 26
$DFWM_{adj}$	Age-adjusted dermal tap water exposure factor, mutagens, resident (cm^2-event /kg)	See Equation 35

2.5 Vapor Intrusion Screening Levels

Residential receptors and commercial/industrial workers could be exposed to volatile compounds vaporized from subsurface media (soil gas and/or groundwater) through pore spaces in the vadose zone and building foundations (or slabs) into indoor air. Per US EPA guidance (US EPA, 2002d), this pathway must be evaluated if: 1) there are compounds present in subsurface media that are sufficiently volatile and toxic, and 2) there are existing or planned buildings where exposure could occur. A chemical is considered to be sufficiently volatile if its Henry's law constant is 1 x 10^{-5} atm-m^3/mole or greater and its molecular weight is approximately 200 g/mole or less. A chemical is considered to be sufficiently toxic if the vapor concentration of the pure component poses an incremental life time cancer risk greater than 1E-05 or the noncancer hazard index is greater than 1.0. VISLs were calculated for chemicals which are sufficiently volatile and toxic for evaluation of the vapor intrusion pathway following the guidance in the VISL User's Guide (US EPA, 2014d) and NMED-specific input parameters and are summarized in Table A-3. The list of chemicals included in Table A-3 is not comprehensive of all potential volatile and toxic compounds that may be present in site media. If volatile and toxic constituents are detected in site media and are not listed in Table A-3, VISLs should be calculated following the methodologies herein and risks addressed..

The US EPA (2002d) vapor intrusion guidance does not support the use of bulk soil data for evaluation of the vapor intrusion pathway; active soil gas and/or groundwater data must be used as appropriate. As such, VISLs are neither available nor recommended for soil. It is noted, however, that bulk soil data can be used in a qualitative sense to determine delineation of a vapor source or in determining if soil has been impacted and additional evaluation (e.g., soil gas) is needed. Conversely, it must not be assumed that non-detect results of volatile compounds in soil equates to an absence of a vapor source.

The NMED VISLs should be used as a first tier screening assessment. However, if site concentrations exceed the VISLs, it is recommended that the assumptions underlying the NMED VISL calculations be reviewed and a determination made as to whether they are applicable at each site. Site-specific factors may result in unattenuated or enhanced transport of vapors towards a receptor, and consequently are likely to render the VISLs target subsurface concentrations overly or underly conservative.

Application of the VISLs is appropriate as a first tier screening assessment for all sites except those where the following conditions apply. If any of the below are applicable to a site, a site specific evaluation must be conducted:

- Very shallow groundwater sources [e.g., depth to water is less than five (5) ft below foundation level];
- Shallow soil contamination resulting in vapor sources (e.g., VOCs are found at significant levels within 10 ft of the base of the foundation);
- Buildings with significant openings to the subsurface (e.g., sumps, unlined crawlspaces, earthen floors) or significant preferential pathways, either naturally-occurring or anthropogenic (not including typical utility perforations present in most buildings);
- Vapor sources originating in landfills where methane is generated in sufficient quantities to induce advective transport into the vadose zone;
- Vapor sources originating in commercial or industrial settings where vapor-forming chemicals can be released within an enclosed space and the vapor density of a chemical

may result in significant advective transport of the vapors downward through cracks and openings in floors and into the vadose zone; and/or

- Leaking vapors from gas transmission lines.

It is emphasized that the NMED VISLs are not meant to be used as action standards or cleanup levels. Rather, they should be used as a tool to estimate potential cumulative risks and/or hazards from exposure to volatile and toxic chemicals at a site where the underlying assumptions are deemed appropriate and if further evaluation is required (See Section 2.5.2, Evaluation of the Vapor Intrusion Pathway).

2.5.1 Calculation of Vapor Intrusion Screening Levels

NMED VISLs were calculated per US EPA (2002d, 2009, and 2013b) methods and guidance. A risk-based target indoor air concentration was used as a basis for back-calculating an allowable amount of a contaminant in soil-gas and/or groundwater assuming a certain amount of attenuation and dilution through the vadose zone and into the building.

Attenuation is the reduction in concentrations that occurs through migration in the subsurface combined with the dilution that occurs when vapor enters a building and mix with indoor air. The attenuation factor is expressed as the ratio of concentrations of chemicals in indoor air to the concentrations in subsurface vapor. Although attenuation factors are site specific and can vary depending on a number of variables (e.g. soil type, depth of contamination, building characteristics and indoor air exchange rates), NMED VISLs were calculated utilizing US EPA default attenuation factors which are based on conservative assumptions and empirical data. As recommended by US EPA (2002d and 2013b), a default attenuation factor of 0.1[1] was applied to establish soil-gas VISLs, and a default attenuation factor of 0.001[2] was applied in establishing groundwater VISLs. Soil-gas VISLs were calculated by dividing the risk-based target indoor air concentration by the default attenuation factor, as shown in Equation 38. Equation 39 also shows that groundwater VISLs were calculated by dividing the risk-based target indoor air concentration by the default attenuation factor, and converting the vapor phase concentration to a groundwater concentration utilizing a conversion factor and Henry's Law Constants to estimate partitioning between the aqueous phase and vapor phase, assuming equilibrium between the two phases.

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[1] The USEPA's draft guidance for vapor intrusion (November 2012) proposes a new value of 0.03 for the attenuation of soil gas. This guidance is under review; upon finalization of the guidance, the default attenutation factor for soil gas will be evaluated and if warranted, new generic VISLs will be evaluated and a revision to this NMED guidance issued.

[2] The USEPA's draft guidance for vapor intrusion (November 2012) proposes no change to the groundwater attenuation factor (0.001) as presented herein.

Equation 38
Calculation of Vapor Intrusion Screening Levels

$$VISL_{sg} = \frac{C_{indoor}}{\alpha}$$

$$VISL_{gw} = \frac{C_{indoor}}{HLC \times \alpha \times 1000L/m^3}$$

Parameter	**Definition (units)**	**Default**
$VISL_{sg}$	Vapor intrusion screening level for soil-gas ($\mu g/m^3$)	Chemical and receptor-specific
$VISL_{gw}$	Vapor intrusion screening level for groundwater ($\mu g/L$)	Chemical and receptor-specific
C_{indoor}	Target indoor air concentration ($\mu g/m^3$)	Chemical and receptor-specific
α	Attenuation coefficient (unitless)	0.1 (soil-gas) 0.001 (groundwater)
HLC	Henry's Law Constant at standard temperature of 25 C (unitless)	Chemical-specific

The NMED groundwater VISLs were calculated based on a default standard temperature of 25 degrees Celsius (C). Although groundwater temperatures at many sites in New Mexico would likely be lower than 25 degrees C, this default value was selected in order to be protective of all sites in New Mexico.

The risk-based target indoor air concentrations were calculated using US EPA (2009, 2013b, and 2014b) algorithms, current toxicity data, and exposure factors used in the evaluation of other exposure pathways outlined in this document. Equations 39 through 42 present the formulas and exposure parameters used for calculating risk-based target indoor air concentrations for residential receptors. Separate indoor air concentrations were calculated for carcinogenic and noncarcinogenic contaminants, and alternate methods were utilized for vinyl chloride and other compounds that are carcinogenic via a mutagenic mode of action. Equations 43 through 55 present the formulas and exposure parameters used for calculating carcinogenic and noncarcinogenic target indoor air concentrations for the commercial/industrial scenario. Target indoor air concentrations for ecological receptors and the construction worker scenario were not calculated as the vapor intrusion exposure pathway is typically incomplete for receptors that spend their time outdoors. Under unique circumstances, such as work being conducted in a trench or other low lying areas where vapors could accumulate, special assessment of the vapor intrusion pathway may be required for the construction worker. The need for evaluation of the construction worker will be made on a case-by-case basis.

Equation 39
Calculation of Target Indoor Air Concentrations – Carcinogens
Residential Scenario

$$C_{indoor} = \frac{TR \times AT_c}{EF \times ED \times ET \times IUR}$$

Parameter	Definition (units)	Default
C_{indoor}	Target indoor air concentration ($\mu g/m^3$)	Chemical-specific
TR	Target risk level	1E-05
AT_c	Averaging time for carcinogens (days)	25,550
EF	Exposure frequency (days)	350
ED	Exposure duration (yr)	26
ET	Exposure time (24 hr/day x 1 day/24 hr)	1
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific

Equation 40
Calculation of Target Indoor Air Concentrations – Noncarcinogens
Residential Scenario

$$C_{indoor} = \frac{THQ \times AT_{nc} \times 1000 \mu g/mg}{EF \times ED \times ET \times \left(\frac{1}{RfC}\right)}$$

Parameter	Definition (units)	Default
C_{indoor}	Target indoor air concentration ($\mu g/m^3$)	Chemical-specific
THQ	Target hazard quotient	1
AT_{nc}	Averaging time for noncarcinogens (days)	ED x 365
EF	Exposure frequency (days)	350
ED	Exposure duration (yr)	26
ET	Exposure time (24 hr/day x 1 day/24 hr)	1
RfC	Inhalation reference concentration (mg/m^3)	Chemical-specific

Equation 41
Calculation of Target Indoor Air Concentrations – Vinyl Chloride
Residential Scenario

$$C_{indoor} = \frac{TR}{IUR + \left(\frac{EF \times ED \times ET \times IUR}{AT_c}\right)}$$

Parameter	Definition (units)	Default
C_{indoor}	Target indoor air concentration ($\mu g/m^3$)	Chemical-specific
TR	Target risk level	1E-05
AT_c	Averaging time for carcinogens (days)	25,550
EF	Exposure frequency (days)	350
ED	Exposure duration (yr)	26
ET	Exposure time (24 hr/day x 1 day/24 hr)	1
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific

Equation 42
Calculation of Target Indoor Air Concentrations – Mutagens Residential Scenario

$$C_{indoor} = \frac{TR \times AT_c}{EF \times ET \times [(ED_{0-2} \times IUR \times 10) + (ED_{2-6} \times IUR \times 3) + (ED_{6-16} \times IUR \times 3) + (ED_{16-26} \times IUR \times 1)]}$$

Parameter	**Definition (units)**	**Default**
C_{indoor}	Target indoor air concentration ($\mu g/m^3$)	Chemical-specific
TR	Target risk level	1E-05
AT_c	Averaging time for carcinogens (days)	25,550
EF	Exposure frequency (days)	350
ED_{0-2}	Exposure duration (0-2 yr)	2
ED_{2-6}	Exposure duration (2-6 yr)	4
ED_{6-16}	Exposure duration (6-16 yr)	10
ED_{16-26}	Exposure duration (16-26 yr)	10
ET	Exposure time (24 hr/day x 1 day/24 hr)	1
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific

Equation 43
Calculation of Target Indoor Air Concentrations – Carcinogens Commercial/Industrial Scenario

$$C_{indoor} = \frac{TR \times AT_c}{EF \times ED \times ET \times IUR}$$

Parameter	**Definition (units)**	**Default**
C_{indoor}	Target indoor air concentration ($\mu g/m^3$)	Chemical-specific
TR	Target risk level	1E-05
AT_c	Averaging time for carcinogens (days)	25,550
EF	Exposure frequency (days)	225
ED	Exposure duration (yr)	25
ET	Exposure time (8 hr/day x 1 day/24 hr)	0.33
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific

Equation 44
Calculation of Target Indoor Air Concentrations – Noncarcinogens Commercial/Industrial Scenario

$$C_{indoor} = \frac{THQ \times AT \times 1000 \mu g/mg}{EF \times ED \times ET \times \left(\frac{1}{RfC}\right)}$$

Parameter	**Definition (units)**	**Default**
C_{indoor}	Target indoor air concentration ($\mu g/m^3$)	Chemical-specific
THQ	Target hazard quotient	1
AT	Averaging time for noncarcinogens (days)	ED x 365
EF	Exposure frequency (days)	225
ED	Exposure duration (yr)	25

ET	Exposure time (8 hr/day x 1 day/24 hr)	0.33
RfC	Inhalation reference concentration (mg/m^3)	Chemical-specific

2.5.2 Evaluation of the Vapor Intrusion Pathway

During the investigation phase, if VOCs are detected in soil and/or site history indicate the potential for VOCs in site media, soil gas samples and groundwater sampling are likely to be required. The need for collection of soil gas data will be made on a case-by-case basis with input from NMED.

The assessment of the soil gas and groundwater data should include evaluation of the vapor intrusion pathway. Two types of soil gas data are collected: passive and active. Passive soil gas results are used for nature and extent purposes only; to determine the absence or presence of VOCs. Active soil gas data are required for quantitative risk assessments.

Chemicals that should be considered for the vapor intrusion pathway include those with a Henry's law constant of approximately 1 x 10^{-5} atm-m^3/mole or greater, a molecular weight of approximately 200 g/mole or less, and known to pose a potential cancer risk or noncancer hazard through the inhalation pathway. If all three of these criteria are met, the constituent is considered volatile and toxic. Table A-3 contains the VISLs for chemicals which met these three criteria. However, this list in Table A-3 is not comprehensive and any additional compounds meeting the above three criteria not listed in Table A-3 and present in site media will require additional analyses following the methods contained herein.

For each site investigation conducted in New Mexico, one of the following three designations shall be made for the vapor intrusion pathway: 1) incomplete pathway and no action required; 2) potentially complete pathway and a qualitative evaluation required; or 3) complete pathway and quantitative evaluation required.

2.5.2.1 Incomplete Pathway; No Action Required

If volatile and toxic compounds are not detected in soil gas and/or groundwater, meaning all the results were 100% non-detects, then the vapor intrusion pathway is considered incomplete. The risk assessment must include a brief discussion of this determination.

2.5.2.2 Potentially Complete Pathway; Qualitative Discussion

If all of the following criteria are met during investigation sampling, the pathway is considered potentially complete and a qualitative discussion of the vapor intrusion pathway will be required:

- Detections of volatile and toxic compounds are minimally detected (e.g., once or twice) in site media (soil, soil gas, and/or groundwater);
- Concentrations are below screening levels (i.e., VISLs for soil-gas and/or groundwater Table A-3);
- There is no suspected source(s) for volatile and toxic compounds; and

- Concentrations are decreasing with depth (for soil).

In addition, if volatile and toxic compounds were present at a site but the source(s) and associated contaminated soil have been removed and the following criteria have been met, only a qualitative assessment of the vapor intrusion pathway will be required:

- Confirmation sampling indicates removal of the source with minimal volatile and toxic compounds detected in soil/soil gas or groundwater data,
- Concentrations are below screening levels (i.e., VISLs for soil-gas and/or groundwater; Table A-3),
- No evidence to suggest dense/sinking vapors, and
- Concentrations decrease with depth.

2.5.2.3 Complete Pathway; Quantitative Assessment

If volatile and toxic compounds are detected consistently in site media during investigation or confirmation sampling, concentrations are detected at depth or show increasing concentrations with depth in soil, and/or there is potentially a source(s) for the volatile and toxic compounds based on site history, a quantitative assessment of the vapor intrusion pathway is required following a tiered approach, until the conditions of a given step are met.

Step 1. Compare the maximum detected concentration for soil gas or groundwater against the NMED VISLs. If active soil gas data are collected from soils located outside of a structure or below a slab, the VISL target sub slab and exterior soil gas concentrations for a target cancer risk of 1E-05 and a target hazard quotient of 1.0 should be applied. The VISL target groundwater concentrations for a target cancer risk of 1E-05 and a target hazard quotient of 1.0 should be applied for groundwater data. It is important to note that cumulative risk and hazard estimates from the vapor intrusion pathway must be added to the cumulative risk and hazard from other exposures at the site (e.g., soil and tap water exposure pathways) per Equations 57 and 58. The NMED VISLs may be modified using additional site-specific data and as approved by NMED. If the risks/hazards are acceptable, no additional evaluation is needed; otherwise, procede to Step 2.

Step 2. Under previous guidance, more refined modeling for the vapor intrusion pathway was typically conducted using the Johnson and Ettinger (J&E) model (US EPA, 2004b). However, in looking at new (draft) USEPA guidance, if initial screening using VISLs results in excess risk, USEPA is leaning away from use of the J&E model and is proposing a lines of evidence and additional data collection approach. If the screening analyses following the approach in Step 1 results in excess risk/hazard, the following should be conducted.

Evaluation of the vapor intrusion pathway should be based on multiple lines of evidence developed to support a refined and technically defensible CSM and a thorough characterization of potential subsurface vapor sources. This can be accomplished by gathering and interpreting information on:

- Subsurface vapor sources. This should include a thorough review of the site history and identification of potential subsurface vapor sources. This information should be accompanied by media specific data to confirm the presence of a vapor source at the site. The media-specific data should reflect spatial and temporal variations. Groundwater and soil gas concentrations should be compared to NMED VISLs to evaluate source strength and the potential for impacts to human health, if the vapor intrusion pathway is complete.
- Vapor migration and attenuation in the vadose zone. This should include soil gas data that represents spatial and vertical variations in soil gas concentrations, information on site geology and hydrogeology, and identification of any preferential pathways (e.g., utility conduits in the subsurface) for chemical vapors between the source and building.
- The building foundation. This should include information on construction materials, preferential pathways (i.e., openings) in the foundation, heating/cooling/ventilation system characteristics, photoionization detector readings at potential openings to the subsurface, grab samples of indoor air close to potential vapor entry points, and information on building pressure gradients.
- The building interior. This should include coinciding subslab soil gas and indoor air measurements, results of site-specific transport modeling, and comparisons of subslab soil gas and indoor air sampling results to determine site-specific attenuation factors.
- Sources of VOCs within the building and in ambient air. Information is needed to identify sources of VOCs, inside and outside of the building that could potentially impact indoor air concentrations of VOCs. Note that outdoor air samples should be taken at the same time that coinciding subslab soil gas and indoor air samples are taken.
- Additional lines of evidence, such as statistical analysis of the gathered data.

The collected lines of evidence should be assessed for concordance. If concordance can be reached, decisions regarding the vapor intrusion pathway can be made with confidence. However, some lines of evidence may not be definitive. Indoor air and subsurface soil gas concentrations can vary greatly both temporally and spatially. Some individual lines of evidence may be inconsistent with other lines of evidence and lead to the need for additional evaluation. If concordance among the lines of evidence cannot be determined, the evaluation of the vapor intrusion pathway should move to Step 3.

<u>Step 3</u>: When lines of evidence are not concordant and the weight of evidence does not support a confident decision, additional sampling or collecting additional lines of evidence may be appropriate, depending upon the CSM.

Step 4: If it is determined that vapor intrusion can potentially impact human health, NMED generally recommends that a human health risk assessment be conducted to determine whether the potential for human health risks posed to building occupants is within or exceeds acceptable NMED levels. The risk posed to building occupants by vapor intrusion depends upon chemical toxicity, vapor concentration in indoor air, the amount of time the occupants spend in the building, and other variables. NMED recommends that risk assessment guidance be used to identify, develop, and combine information about these variables to characterize health risks stemming from vapor intrusion from subsurface vapor sources.

2.6 Beef Ingestion Soil Screening Levels

For those sites greater than two acres in size, grazing of cattle must be evaluated to determine if beef ingestion is a plausible and complete exposure pathway. If grazing is not permitted (or could not be permitted due to land use restrictions), or the land does not support grazing (e.g., insufficient forage and/or water availability, terrain, or highly industrialized area), a qualitative assessment of this pathway must be provided. However, if grazing is viable or if a facility may potentially allow grazing on lands at some time in the future, a quantitative assessment of the pathway, ingestion of beef from cattle grazing on potentially contaminated sites, is required. The preliminary remediation goals (PRGs) for beef ingestion from the Risk Assessment Information System (RAIS) on-line tool should be used to assess this pathway. The steps to determine the beef ingestion PRGs are listed below:

- Access the on-line PRG calculator (http://rais.ornl.gov/cgi-bin/prg/PRG_search?select=chem),
- Select farmer scenario,
- Select site-specific PRG type and chronic toxicity,
- Select chemical(s) of concern,
- Select "Retrieve",
- Under "Common parameters for ingestion of Produce, Milk, and Beef", update the following parameters:
  - BWa (body weight - adult) 80 kg
  - EDag (exposure duration - resident) 26 yr
  - TR (target cancer risk) 1E-05 unitless
- Under "PRG for Contaminated Food Products", obtain the PRG for ingestion of beef (cancer and non-cancer as appropriate).

Once the beef ingestion PRGs have been determined, site concentrations should be compared with the beef ingestion PRGs and estimated risks and hazards should be added to the cumulative risk/hazards as shown in Equations 57 and 58.

2.7 Site Assessment and Characterization

The Site Assessment/Site Characterization phase is intended to provide additional spatial and contextual information about the site, which may be used to determine if there is any reason to believe that receptors and/or complete exposure pathways may exist at or in the locality of the site where a release of hazardous waste/constituents has occurred. In addition, the site assessment phase serves as the initial information gathering phase to determine whether potential exposures are sufficiently similar to those upon which the NMED SSLs are predicated to support comparison. Finally, this phase can help to identify sites in need of a more detailed assessment of potential risk. A CSM providing a list of the potentially exposed receptors and potentially complete exposure pathways in the scoping report is used to determine whether further assessment (i.e., a screening level assessment) and/or interim measures are required or whether the site poses minimal threat to human and ecological receptors at or near the site.

The ultimate purpose of the site assessment phase is to address the question: Are exposure pathways complete with regard to contaminant contact by receptors? A complete site assessment will consists of several steps:

- Develop data quality objectives and conduct site sampling;
- Determine background threshold values (BTVs);
- Identify preliminary COPCs;
- Develop a preliminary site conceptual exposure model (SCEM);
- Determine exposure intervals;
- Compare maximum COPC concentrations for consideration of complete exposure pathways with SSLs; and
- If the site maximums are above the SSLs, a Tier 2 approach may be deemed appropriate by NMED using the 95% UCL value for contaminant concentrations (or detection/quantitation limits for non-detect results).

2.7.1 Development of Data Quality Objectives

Before any additional environmental samples are collected, data quality objectives (DQOs) should be developed. The DQOs should address the qualitative and quantitative nature of the sampling data, in terms of relative quality and intent for use, to ensure that any data collected will be appropriate for the intended purpose. Development of the DQOs should consider not only precision, accuracy, representativeness, completeness, and comparability of the data, but also the sampling locations, types of laboratory analyses used, sensitivity of detection limits of the analytical techniques, the resulting data quality, and the employment of adequate quality assurance/quality control measures.

2.7.2 Determination of Background Threshold Values

Site-specific BTVs ahould be established during a site-specific soil background study, as approved by NMED. Sample size, locations, other site-specific parameters for background data sets should be outlined during the DQO process as presented in the work plan. Guidance on the process of conducting a background soil study is beyond the scope of this document. However, the following criteria are representative of a defensible background data set:

- Includes a sufficient number of data for statistical analyses;
- Free of outliers;
- Reliably representative of the variations in background media (e.g., soil types or groundwater horizons);
- Collected from areas where there is no potential for site contamination based on site history;
- Areas are not impacted by neighboring areas of contamination (off-site migration);
- Collected from areas that are upwind of contaminated soil;
- Collected from areas that are upgradient of site contamination;
- Collected from soil types that are lithologically comparable to the samples that will be collected from contaminated areas; and
- Collected from depths that correspond to the exposure intervals that will be evaluated during human and ecological risk assessments.

An adequate sample size will likely capture a reliable representation of the background population while meeting the minimum sample size requirements for calculating BTVs and conducting hypothesis testing. US EPA (2013a) recommends 10 to 15 samples for each background data set, but more are preferable. While it is possible to calculate BTVs with small data sets containing as few as three samples, these results are not considered representative and reliable enough to make cleanup or remediation decisions. Therefore, a minimum sample size of 10 is required in order to calculate BTVs and conduct hypothesis testing. The size of the background area and size of the site or facility under study should also be considered in determining sample size. That is, if the background and site areas are relatively large, then a larger background data set (e.g., > 10 samples) should be considered (US EPA, 2013a). Background soil data are often grouped according to depth (e.g., surface vs. subsurface) or soil type. It is important to note that the minimum sample size of 10 should be met for each grouping of data in order to compute BTVs for each soil horizon or soil type.

Determination of BTVs should be conducted using current ProUCL software and guidance. In general, BTVs should be based on 95% upper tolerance limits (UTLs) with 95% coverage. The exception to this would be on a case-by-case basis where the estimated 95% UTL is significantly greater (more than 1.5 times) than the maximum detected concentration. This may be an indication that the 95% UTL is based on the accommodation of low-probability outliers (which may or may not be attributable to the background population) or highly skewed data sets and/or possibly inadequate sample size. In these cases, the project team may choose to evaluate the possibility of additional potential outliers or collection of more data. In lieu of collection of additional data to resolve the elevated UTL issue, the maximum detected concentration should be used as the BTV.

2.7.3 Identification of COPCs

COPCs are those substances (including transformation or breakdown compounds and companion products) likely to be present in environmental media affected by a release. Identification of COPCs should begin with existing knowledge of the process, product, or waste from which the release originated. For example, if facility operations deal primarily with pesticide manufacturing then pesticides should be considered COPCs. Contaminants identified during current or previous site investigation activities should also be evaluated as COPCs. A site-specific COPC list for soil may be generated based on maximum detected (or, if deemed appropriate by NMED, the 95% UCL value) concentrations (US EPA 2002b) and a comparison of detection/quantitation limits for non-detect results to the NMED SSLs. This list may be refined through a site-specific risk assessment.

Per US EPA guidance (US EPA 1989), if there is site history to indicate a chemical was potentially used/present at a site or if there is insufficient site history to demonstrate that a chemical could not be present, and the chemical was detected in at least one sample, this chemical must be included as a COPC and evaluated in the screening assessment.

For inorganics, a comparison of site concentrations to appropriate background concentrations may be conducted prior to evaluation against SSLs. Those inorganics that are present at levels indicative of natural background may be eliminated as COPCs. Comparison to background must be conducted following current US EPA Guidance and as outlined herein. The general process is a tiered approach.

<u>Step 1.</u> Compare the maximum detected site concentration to the site-specific background reference values (upper tolerance limit) determined for each soil type at the site. If the site maximum is less than the background reference value, it is assumed that the site concentrations are representative of background and the metal/inorganic is not retained as a COPC. If there is no background value for a constituent, then it will be retained as a COPC.

<u>Step 2:</u> If the maximum site concentration is greater than the background reference value, then a two-sample hypothesis test should be used to compare the distributions of the site data to the distributions of background data to determine if site concentrations are elevated compared with background. A simple comparison to the range of background is not acceptable. Background can vary across a site (especially larger sites) and not allow for soil type to be taken into consideration. Further, a range can mask low level contamination.

The most recent version of US EPA's ProUCL statistical software will be used for hypothesis testing. ProUCL will also be used to determine the most appropriate test (parametric or nonparametric) based on the distribution of the data. Appropriate methods in ProUCL will also be used to compute site-to-background comparisons based on censored data sets containing non-detect values. In addition, a review of graphical displays (e.g., box plots and Q-Q plots) may also be provided in order to provide further justification in determining whether site concentrations are elevated compared with background. These graphical plots can be also be generated by ProUCL software.

Note that the above two-sample test can only be used for site data sets that have a sufficient number of samples (i.e., n ≥ 8) and number of detections (i.e, ≥ 5 detected observations). While a minimum of 10 background data samples are now required, there may be sites where background has been previously conducted and may contain fewer than 10 samples. Site-to-background point-by-point comparisons will be conducted for site data sets containing fewer than eight samples and fewer than five detected observations. As stated in the current version of ProUCL User's Guide (US EPA, 2013a), hypothesis testing is only considered to be reliable with sufficient sample size (n ≥ 8) and frequency of detection (≥ 5 detected observations). If there are not at least eight samples in the site data set and at least five detections, then the site maximum detected concentrations will be compared to the corresponding background value (i.e., 95% upper tolerance limit) as noted in Step 1 or additional data must be collected to conduct a two-tailed test.

Step 3: Additional lines of evidence may be used to justify exclusion of an inorganic as being site related, such as site history, number of non-detects, etc. For areas where a hotspot may be present, additional actions are required and the constuent(s) must be retained as a COPC. Comparison of site data to regional data (such as US Geological Survey (USGS) databases not specific to the site) or simple comparison to a range of data are not acceptable lines of evidence.

2.7.4 Development of a Preliminary Conceptual Site Model

A CSM is a graphical representation of three-dimensional site conditions that conveys what is known or suspected, at a discrete point in time, about the site-specific sources, releases, release mechanisms, contaminant fate and transport, exposure routes, and potential receptors. The CSM is generally documented by written descriptions and supported by maps, geological cross-sections, tables, diagrams and other illustrations to communicate site conditions. When preparing a CSM, the facility should decide the scope, quantity, and relevance of the information to be included, balancing the need to present as complete a picture as possible to document current site conditions and justify risk management actions, with the need to keep the information focused and exclude extraneous data.

As a final check, the CSM should answer the following questions:

- Are there potential land uses present (now or in the foreseeable future) other than those covered by the SSLs? (refer to US EPA 1989).
- Are there other likely human exposure pathways that were not considered in development of the SSLs (e.g. vapor intrusion, direct exposure to groundwater, local fish consumption,

raising homegrown produce, beef, dairy, or other livestock)? (refer to US EPA 1989).

- Are there potential ecological concerns? (*Guidance for Assessing Ecological Risks Posed by Chemicals: Screening Level Ecological Risk Assessment*; NMED 2014).

If any conditions such as these exist, the SSLs may need to be adjusted to reflect this new information.

2.7.5 Determine Exposure Intervals

Based on current and potential land-use scenarios, receptors for completed exposure pathways can be exposed to varying depths of soil, or soil exposure intervals. Per US EPA (US EPA 1989), depth of samples should be considered and surface soils should be evaluated separately from subsurface soils due to possible differences in exposure levels that would be encountered by different receptors. Exposure intervals for each receptor are based on the types of activities in which each receptor is likely to be involved. Default exposure intervals are summarized in Table 2-6.

It is assumed that commercial/industrial workers would only be exposed to surface soils (0-1 feet bgs). As stated in Section 2.3.1, this receptor may be involved in moderate digging associated with routine maintenance and grounds keeping activities. Therefore, COPC concentrations in soil in the surface soil interval (0-1 feet bgs) should be considered when evaluating exposure by a commercial/industrial worker receptor.

As stated in Section 2.3.2, a construction worker is assumed to be exposed to surface and subsurface soils up to depths of 0-10 ft bgs. Construction workers are involved in digging, excavation, maintenance and building construction projects and could be exposed to surface as well as subsurface soil. Therefore, a soil exposure interval of 0-10 feet bgs should be considered when evaluating exposure to soil by a construction worker.

Residents could be exposed to surface and subsurface soils during home maintenance activities, yard work, landscaping, and outdoor play activities. Therefore, an exposure soil interval of 0-10 feet bgs should be assumed when evaluating soil exposure by a residential receptor.

Exposure to COPCs in soil by ecological receptors should be addressed separately in a tiered approach as outlined in Volume 2 of this document and by NMED (2014). However, a discussion of soil exposure intervals for ecological receptors is warranted here because ecological receptors are considered in the CSM and depending on the types of ecological receptors, there can be a differential in exposure levels due to soil exposure intervals. Burrowing animals would be exposed to deeper soils, whereas all other animals would only be exposed to surface and shallow subsurface soils. Therefore, maximum concentrations of COPCs in soil 0-10 feet bgs should be assessed for burrowing animals. Maximum COPC concentrations in soil 0-5 ft bgs should be assessed for all other animals.

Table 2-6. Soil Exposure Intervals

Receptor	Exposure Intervals (Soil)
Resident (adult and child)	0 – 10 ft bgs
Commercial/Industrial Worker	0 – 1 ft bgs
Construction Worker	0 – 10 ft bgs
Vapor Intrusion	Depth of maximum detection
Ecological Receptors (non-burrowing)	0 – 5 ft bgs
Ecological Receptors (burrowing)	0 – 10 ft bgs

2.7.6 Compare COPC Maximum Concentrations with SSLs

The final step in the site assessment phase is to compare maximum detected COPC concentrations in soil with SSLs based on the complete exposure pathways identified by the preliminary CSM and assessing total risk/hazard from all constituents (refer to Section 5). These concentrations should also be compared against the SSL leaching values to determine which contaminants present in soil have the capacity to leach to underlying groundwater and impact these resources adversely. As stated earlier, those contaminants exhibiting concentrations in excess of the SSLs represent the initial soil COPC list for a given site. Refinement of this list may be necessary based on a host of factors, including elevated detection or quantitation limits.

2.7.7 Calculation of Exposure Point Concentrations

If it is determined that further assessment is warranted (see Section 5), refinement of EPCs should be conducted. US EPA (1989) recommends using the average concentration to represent "a reasonable estimate of the concentration likely to be contacted over time". US EPA's (1992b) *Supplemental Guidance to RAGS: Calculating the Concentration Term* states that, "because of the uncertainty associated with estimating the true average concentration at a site, the 95 percent upper confidence limit (UCL) of the arithmetic mean should be used for this variable."

Upper confidence limits should only be calculated for data sets that meet the US EPA (2013a) minimum requirements for calculating UCLs. The minimum requirements for calculating UCLs are: 1) each data set must contain at least eight samples (i.e., $n \geq 8$) for the analyte being evaluated; and 2) there must be a minimum of six detections (i.e., ≥ 5 detected observations) for the analyte being evaluated. Although it is possible to calculate UCLs with small datasets (i.e., $n \leq 8$) and low frequencies of detection (i.e., ≤ 5 detected observations), these estimates are not considered reliable and representative enough to make defensible and correct cleanup and remediation decisions (US EPA, 2013a). Therefore, UCLs should only be calculated for data sets that meet the minimum requirements for calculation UCLs.

UCLs should be calculated using the most current version of US EPA's ProUCL statistical software package. Statistical methods for calculating UCLs are dependent on the distribution of the data. Therefore, when calculating UCLs, ProUCL should be used to perform statistical tests in order to determine the distribution of the site data. If assumptions about the distribution cannot be made, then nonparametric methods can be utilized. ProUCL recommends a computational method for calculation of the 95% UCL based on the assumed distribution.

Using parametric and nonparametric methods, ProUCL will typically return several possible values for the UCL. Professional judgment should be used in selecting the most appropriate UCL; however, the UCL recommended by ProUCL is based on the data distribution and is typically the most appropriate value to be adopted as the EPC for use in risk assessments. It is important to note that the UCL should not be greater than the maximum detected concentration.

Non-detects (censored datasets) should be evaluated following the appropriate methodology outlined in the most recent version of US EPA's ProUCL Technical Guide. Currently, the ProUCL Technical Guide indicates that the Kaplan-Meier (KM) method yields more precise and accurate estimate of decision characteristics than those based upon substitution and regression on order statistics. Use of one-half the minimum detection limit (MDL) or sample quantitation limit (SQL), or other simple substitution methods, are not considered appropriate methods for handling non-detects.

3.0 CHEMICAL-SPECIFIC AND PHYSICAL-CHEMICAL PARAMETERS

Chemical-specific parameters required for calculating SSLs include the organic carbon normalized soil-water partition coefficient for organic compounds (K_{oc}), the soil-water partition coefficient (K_d), water solubility (S), octanol-water partition coefficient (K_{ow}), Henry's Law constant (H), diffusivity in air (D_a), and diffusivity in water (D_w). The following sections describe these values and present methodologies for calculating additional values necessary for calculating the NMED SSLs.

3.1 Volatilization Factor for Soil

Volatile chemicals, defined as those chemicals having a Henry's Law constant greater than 1E-05 atm-m^3/mole and a molecular weight less than 200 g/mole, were screened for inhalation exposures using a volatilization factor (VF) for soils. The soil-to-air VF_s is used to define the relationship between the concentration of the contaminant in soil and the flux of the volatilized contaminant to ambient air. The emission terms used in the VF are chemical-specific and were calculated from physical-chemical information obtained from several sources including: US EPA's *Soil Screening Guidance: Technical Background Document* (US EPA, 1996a), *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (US EPA 2002a), US EPA Master Physical and Chemical Parameter table for development of US EPA Regional Screening Levels (refer to US EPA 2014a), US EPA's *Basics of Pump and Treat Groundwater Remediation Technology* (US EPA 1990), US EPA's *Dermal Exposure Assessment* (US EPA 1992a), *Superfund Public Health Evaluation Manual* (US EPA 1986), US EPA's *Additional Environmental Fate Constants* (US EPA 1995), Hazardous Substance Release/Health Effects Database (ATSDR 2003), the RAIS database (DOE 2005), and the CHEMFACTS database (US EPA 2000). The VF_s for the residential and commercial/industrial scenarios is calculated using Equation 45 while the $VF_{s\text{-}cw}$ for the construction worker is calculated using Equation 46.

Equation 45
Derivation of the Volatilization Factor for Residential and Commercial/Industrial Scenarios

$$VF_s = \frac{Q/C_{vol} \times (3.14 \times D_A \times T)^{0.5} \times 10^{-4}}{(2 \times \rho_b \times D_A)}$$

Where:

$$D_A = \frac{\left[\frac{(\theta_a^{10/3} D_a H' + \theta_w^{10/3} D_w)}{n^2}\right]}{\rho_b K_d + \theta_w + \theta_a H'}$$

Parameter	Definition (units)	Default
VF_s	Volatilization factor for soil (m^3/kg)	Chemical-specific
D_A	Apparent diffusivity (cm^2/s)	Chemical-specific
Q/C_{vol}	Inverse of the mean concentration at the center of a 0.5- acre-square source (g/m^2-s per kg/m^3)	68.18
T	Exposure interval (s)	9.5E+08
ρ_b	Dry soil bulk density (g/cm^3)	1.5
n	Total soil porosity $1 - (\rho_b/\rho_s)$	0.43
θ_a	Air-filled soil porosity $(n - \theta_w)$	0.17
θ_w	Water-filled soil porosity	0.26
ρ_s	Soil particle density (g/cm^3)	2.65
D_a	Diffusivity in air (cm^2/s)	Chemical-specific
H'	Dimensionless Henry's Law constant	Chemical-specific
D_w	Diffusivity in water (cm^2/s)	Chemical-specific
K_d	Soil-water partition coefficient (cm^3/g) = $K_{oc} \times f_{oc}$ (organics)	Chemical-specific
K_{oc}	Soil organic carbon partition coefficient (cm^3/g)	Chemical-specific
f_{oc}	Fraction organic carbon in soil (g/g)	0.0015

Equation 46
Derivation of the Volatilization Factor for Construction Worker Scenario

$$VF_{s-cw} = \left(\frac{(3.14 \times D_A \times T)^{0.5}}{2 \times \rho_b \times D_A}\right) \times 10^{-4} \times Q/C \times (1/F_D)$$

Where:

$$D_A = \frac{\left[\frac{(\theta_a^{10/3} D_a H' + \theta_w^{10/3} D_w)}{n^2}\right]}{\rho_b K_d + \theta_w + \theta_a H'}$$

Parameter	**Definition (units)**	**Default**
$VF_{s\text{-}cw}$	Volatilization factor for soil, construction worker (m^3/kg)	Chemical-specific
D_A	Apparent diffusivity (cm^2/s)	Chemical-specific
Q/C	Inverse of the mean concentration at the center of a 0.5- acre-square source (g/m^2-s per kg/m^3)	14.31
T	Exposure interval (s)	3.15E+07
10^{-4}	Conversion factor (m^2/cm^2)	1E-04
F_D	Dispersion correction factor (unitless)	0.185
ρ_b	Dry soil bulk density (g/cm^3)	1.5
n	Total soil porosity $1 - (\rho_b/\rho_s)$	0.43
θ_a	Air-filled soil porosity ($n - \theta_w$)	0.17
θ_w	Water-filled soil porosity	0.26
ρ_s	Soil particle density (g/cm^3)	2.65
D_a	Diffusivity in air (cm^2/s)	Chemical-specific
H'	Dimensionless Henry's Law constant	Chemical-specific
D_w	Diffusivity in water (cm^2/s)	Chemical-specific
K_d	Soil-water partition coefficient (cm^3/g) = K_{oc} x f_{oc} (organics)	Chemical-specific
K_{oc}	Soil organic carbon partition coefficient (cm^3/g)	Chemical-specific
f_{oc}	Fraction organic carbon in soil (g/g)	0.0015

While most of the parameters used to calculate apparent diffusivity (D_A) are either chemical-specific or default values, several state-specific values were used which are more representative of soil conditions found in New Mexico. The default values for θ_w, θ_a, and ρ_b in Equations 45 and 46 are 0.26, 0.17 and 1.5 g/cm^3, respectively. These values represent mean values from a National Resources Conservation Service (NRCS) soil survey database for New Mexico that includes over 1200 sample points (U.S. Department of Agriculture 2000). US EPA guidance (US EPA 2001a) provides additional methodologies for estimating site-specific air-filled soil porosities and water-filled soil porosities.

It should be noted that the basic principle of the VF model (i.e., Henry's Law) is applicable only if the soil contaminant concentration is at or below soil saturation, C_{sat}. Above the soil saturation limit, the model cannot predict an accurate VF-based SSL.

3.2 Soil Saturation Limit

C_{sat} describes a chemical-physical soil condition that integrates certain chemical-specific properties with physical attributes of the soil to estimate the contaminant concentration at which the soil pore water, pore air, and surface sorption sites are saturated with contaminants. Above this concentration, the contaminants may be present in free phase within the soil matrix – as non-aqueous phase liquids (NAPLs) for substances that are liquid at ambient soil temperatures, and pure solid phases for compounds that are solids at ambient soil temperatures (US EPA 1996a). Generic C_{sat} concentrations should not be interpreted as confirmation of a saturated soil condition, but as estimates of when this condition may occur. It should be noted that C_{sat} concentrations are not risk-based values. Instead, they correspond to a theoretical threshold above which free phase contaminant may exist. C_{sat} concentrations, therefore, serve to identify an upper limit to the applicability of generic risk-based soil criteria, because certain default assumptions and models used in the generic algorithms are not applicable when free phase contaminant is present in soil. The basic principle of the volatilization model is not applicable when free-phase contaminants are present. How these cases are handled depends on whether the contaminant is liquid or solid at ambient temperatures. Liquid contaminants that have VF-based screening levels that exceed the "sat" concentration are set equal to "C_{sat}" whereas for solids (e.g., PAHs), soil screening decisions are based on appropriate other pathways of concern at the site (e.g., ingestion and dermal contact). Equation 47, given below is used to calculate C_{sat} for each volatile contaminant considered within the SSLs.

Equation 47
Derivation of the Soil Saturation Limit

$$C_{sat} = \frac{S}{\rho_b}\left(K_d\rho_b + \theta_w + H'\theta_a\right)$$

Parameter	**Definition (units)**	**Default**
C_{sat}	Soil saturation concentration (mg/kg)	Chemical-specific
S	Solubility in water (mg/L-water)	Chemical-specific
ρ_b	Dry soil bulk density (kg/L)	1.5
K_d	Soil-water partition coefficient (L/kg; $K_{oc} \times f_{oc}$)	Chemical-specific
K_{oc}	Soil organic carbon/water partition coefficient (L/kg)	Chemical-specific
f_{oc}	Fraction organic carbon in soil (g/g)	0.0015
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.26
H′	Dimensionless Henry's Law constant	Chemical-specific
θ_a	Air-filled soil porosity (n- θ_w),(L_{air}/L_{soil})	0.17
n	Total soil porosity (1 – (ρ_b/ρ_s)), (L_{pore}/L_{soil})	0.43
ρ_s	Soil particle density (kg/L)	2.65

Chemical-specific parameters used in Equation 47 were obtained from physical-chemical information presented in several sources including: US EPA's *Soil Screening Guidance: Technical Background Document* (US EPA 1996a and US EPA 2002a), the US EPA Regional Screening Levels (US EPA 2014a), US EPA's *Basics of Pump and Treat Groundwater remediation Technology* (US EPA 1990), US EPA's *Dermal Exposure Assessment* (US EPA 1992a), *Superfund Public Health Evaluation Manual* (US EPA 1986), US EPA's *Additional Environmental Fate Constants* (US EPA 1995), Hazardous Substance Release/Health Effects Database (ATSDR 2003), the RAIS, CHEMFACTS, WATER9, and PHYSPROP databases, and EPISUITE.

3.3 Particulate Emission Factor

Inhalation of chemicals adsorbed to suspended respirable particles is assessed using a chemical-specific PEF, which relates the contaminant concentration in soil to the concentration of respirable particles in the air due to fugitive dust emissions from contaminated soils. This guidance addresses dust generated from open sources, which is termed "fugitive" because it is not discharged into the atmosphere in a confined flow stream. For further details on the methodology associated with the PEF model, the reader is referred to US EPA's *Soil Screening Guidance: Technical Background Document* (US EPA 1996a), *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (US EPA 2002a) and *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (US EPA 2005b).

It is important to note that the PEF for use in evaluating exposure of residential and commercial/industrial receptors addresses only windborne dust emissions and does not consider emissions from traffic or other forms of mechanical disturbance, which could lead to a greater level of exposure. The PEF for use in evaluating construction worker exposures considers windborne dust emissions and emissions from vehicle traffic associated with construction activities. Therefore, the fugitive dust pathway should be considered carefully when developing the CSM at sites where receptors may be exposed to fugitive dusts by other mechanisms. Equation 48 is used to calculate a New Mexico region-specific PEF value, used for both the residential and commercial/industrial exposure scenarios. A scenario-specific PEF value was calculated for a construction worker receptor (PEF_{cw}) using Equation 49.

Equation 48
Derivation of the Particulate Emission Factor
Residential and Commercial/Industrial Scenarios

$$PEF = Q/C_{wind} \times \frac{3{,}600\ \text{sec}/\text{hr}}{0.036 \times (1 - V) \times \left(\dfrac{U_m}{U_t}\right)^3 \times F(x)}$$

Parameter	Definition (units)	Default
PEF	Particulate emission factor (m^3/kg)	6.61E+09
Q/C_{wind}	Inverse of a mean concentration at center of a 0.5-acre-square source (g/m^2-s per kg/m^3)	81.85
V	Fraction of vegetative cover (unitless)	0.5
U_m	Mean annual windspeed (m/s)	4.02
U_t	Equivalent threshold value of windspeed at 7 m (m/s)	11.32
F(x)	Function dependent on U_m/U_t derived using Cowherd et al. (1985) (unitless)	0.0553

Equation 49
Derivation of the Particulate Emission Factor
Construction Worker Scenario

$$PEF_{CW} = Q/C_{CW} \times \frac{1}{F_D} \left[\frac{T \times A_R}{556 \times \left(\dfrac{W}{3}\right)^{0.4} \times \dfrac{(365\ \text{days/yr} - P)}{365\ \text{days/yr}} \times \sum VKT} \right]$$

Parameter	Definition (units)	Default
PEF_{CW}	Particulate emission factor for a construction worker (m^3/kg)	2.1E+06

Q/C_{CW}	Inverse of a mean concentration at center of a 0.5-acre-square source (g/m^2-s per kg/m^3)	23.02
F_D	Dispersion correction factor (unitless)	0.185
T	Total time over which construction occurs (s)	7.2E+06
A_R	Surface area of road segment (m^2)	274.2
W	Mean vehicle weight (tons)	8
P	Number of days with at least 0.01 inches of precipitation (days/yr)	60
ΣVKT	sum of fleet vehicle kilometers traveled during the exposure duration (km)	168.75

3.4 Physical-Chemical Parameters

Several chemical-specific parameters are required for calculating SSLs including the organic carbon normalized soil-organic carbon/water partition coefficients for organic compounds (K_{oc}), the soil-water partition coefficient for organic and inorganic constituents (K_d), the solubility of a compound in water (S), Henry's Law constant (H), air diffusivity (D_a), water diffusivity (D_w), molecular weight, the octanol-water partition coefficient (K_{ow}), and the dermal permeability coefficient in water (K_p). Prior to calculating site-specific SSLs, each relevant chemical specific parameter value presented in Appendix B should be checked against the most recent version of its source to determine if updated data are available. Tables B-1, B-2, and B-3 in Appendix B provide the chemical-specific parameters used in calculating the NMED SSLs. Chemical-specific parameters were selected from the following sources in the order listed:

- Organic carbon partition coefficient (K_{oc}; L/kg). US EPA (2012b) Estimation Program Interface (EPI) Suite software, v4.11.
- Soil-water partition coefficient (K_d; cm^3/g). For organics, $K_d = K_{oc}$ x fraction of organic carbon in soil, (f_{oc} NMED default value of 0.15%). For inorganics, 1) US EPA (2002a); 2) Baes (1984) Figure 2.31.
- Water solubility (S; mg/L at 25 °C). US EPA (2012b) EPI Suite software, v4.11.
- Henry's Law constant (H; atm-m^3/mole at 25 °C). 1) US EPA (2012b) EPI Suite software, v4.11: a) experimental values; b) estimated values via the bond method; c) estimated values via the group method; and 2) US EPA (2002a).
- Diffusivity in air (D_a; cm^2/s). 1) US EPA (2006) Water 9 v3.0; 2) US EPA (2002a).
- Diffusivity in water (D_w; cm^2/s). 1) US EPA (2006) Water 9 v3.0; 2) US EPA (2002a).
- Molecular weight (MW). US EPA (2012b) EPI Suite software, v4.11.
- Dermal permeability coefficient in water (Kp; cm/hr). US EPA (2012a) EPI Suite software, v.4.11.

3.4.1 *Solubility, K_{ow}, and Henry's Law Constant*

The solubility of a contaminant refers to the maximum amount that can be dissolved in a fixed volume of solvent, usually pure water, at a specific temperature and pH. A chemical with a high solubility readily dissolves in water, while a low solubility indicates an inability to dissolve. Water solubility is generally predicted based on correlations with the octanol-water partition coefficient (K_{ow}). Solubility is used to calculate soil saturation limits for the NMED SSLs.

The octanol-water partition coefficient (K_{ow}) of a chemical is the ratio of a chemical's solubility in octanol versus its solubility in water at equilibrium. Essentially, this chemical-specific property is used as an indication of a contaminant's propensity to migrate from soil to water. It is an important parameter and is used in the assessment of environmental fate and transport for organic chemicals.

The Henry's Law constant (H) is used when evaluating air exposure pathways. For all chemicals that are capable of exchanging across the air-water interface, there is a point at which the rate of volatilization into the air and dissolution to the water or soil will be equal. The ratio of gas- and liquid-phase concentrations of the chemical at this equilibrium point is represented by H, which is used to determine the rate at which a contaminant will volatilize from soil to air. Values for H may be calculated using the following equation and the values for S, vapor pressure (VP), and MW.

$$H = \frac{\text{VP x MW}}{\text{S}}$$

Equation 50

The dimensionless form of Henry's Law constant (H′) used in calculating soil saturation limits and volatilization factors for the NMED SSLs was calculated by multiplying H by a factor of 41 to convert the Henry's Law constant to a unitless value.

3.4.2 Soil Organic Carbon/Water Partition Coefficients (K_{oc})

The soil organic carbon-water partition coefficient (K_{oc}) is a measure of a chemical's tendency to adsorb to organic carbon present in soil. High K_{oc} values indicate a tendency for the chemical to adsorb to soil particles rather than remain dissolved in the soil solution. Strongly adsorbed molecules will not migrate unless the soil particle to which they are adsorbed moves (as in erosion). K_{oc} values of less than 500 indicate weak adsorption and a potential for leaching. K_{oc} is calculated using the following equation:

$$K_{oc} = \frac{\text{concentration adsorbed/concentration dissolved}}{\text{\% organic carbon in soil}}$$

Equation 51

K_{oc} can also be calculated by dividing the K_d value by the fraction of organic carbon (f_{oc}) present in the soil or sediment. It should be noted that a strong linear relationship exists between K_{oc} and K_{ow} and that this relationship can be used to predict K_{oc}.

3.4.3 Soil/Water Partition Coefficients (K_d)

The soil-water partition coefficient (K_d) for organic chemicals is the ratio of a contaminant's distribution between soil and water particles. The soil-water partitioning behavior of nonionizing and ionizing organic compounds differs because the partitioning of ionizing organics can be influenced by soil pH. K_d values were used in calculating soil saturation limits and VFs used in developing the NMED SSLs.

For organic compounds, K_d represents the tendency of a chemical to adsorb to the organic carbon fraction in soils, and is represented by:

$$K_d = K_{oc} \text{ x } f_{oc}$$ **Equation 52**

Where:

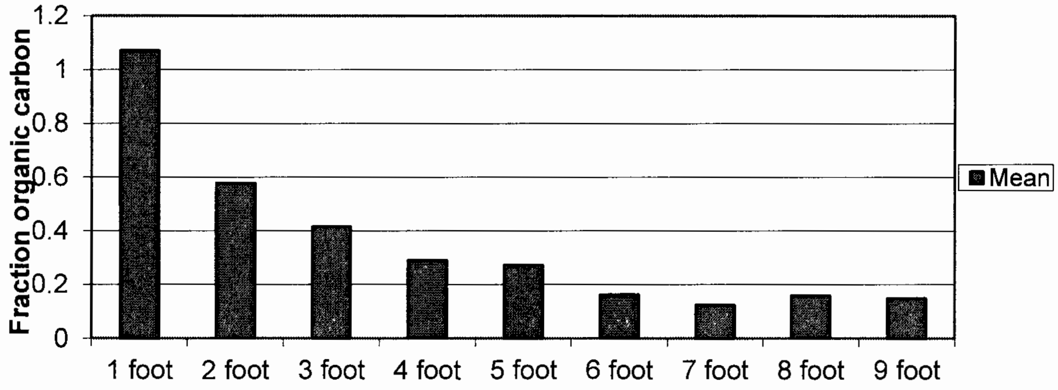
K_{oc} = organic carbon partition coefficient (L/kg or cm^3/g); and
f_{oc} = fraction of organic carbon in soil (mg/mg).

This relationship is generally valid for volatile halogenated hydrocarbons as long as the fraction of organic carbon in soil is above approximately 0.001 (0.1 percent) (Piwoni and Banaerjee, 1989 Schwarzenbach and Westall 1981). For low organic carbon soils ($f_{oc} < 0.001$), Piwoni and Banerjee (1989) developed the following empirical correlation for organic chemicals:

$$\log K_d = 1.01 \log K_{ow} - 0.36$$ **Equation 53**

The use of a fixed K_{oc} value in the soil-water partition equation for the migration to groundwater pathway is only valid for hydrophobic non-ionizing organic chemicals. For organic chemicals that ionize in the soil environment, existing in both neutral and ionized forms within the normal soil pH range, K_{oc} values must consider the relative proportions and differences in sorptive properties of these forms. For the equations and applications of developing K_{oc} values for ionizing organic acids as a function of pH, the reader is referred to US EPA 1996. The default value used for f_{oc} in development of NMED SSLs is 0.0015 (0.15%). This value represents the median value of 212 data points included in the NRCS soil survey database for New Mexico (U.S. Department of Agriculture 2000). Only samples collected from a depth of greater than 5 feet were included in the calculation of the mean f_{oc} value. Shallow soil samples tend to have higher f_{oc} values as shown in Figure 3-1. There is a steady decline in f_{oc} value with depth until approximately 5 feet bgs. Below 5 feet, there is little variability in the f_{oc} value. Because a lower f_{oc} value provides a more conservative calculation of SSL, a value representative of deeper soil conditions is used as the default value.

Figure 3-1 Mean Value - Fraction Organic Carbon (f_{oc})
All Counties in New Mexico



As with organic chemicals, development of the NMED SSLs for inorganic constituents (i.e., metals) requires a soil-water partition coefficient (K_d) for each contaminant. K_d values for metals are affected by a variety of soil conditions, most notably pH, oxidation-reduction conditions, iron oxide content, soil organic matter content, cation exchange capacity and major ion chemistry. US EPA developed default K_d values for metals using either an equilibrium geochemical speciation model (MINTEQ2) or from empirical pH-dependent adsorption relationships developed by USEPA's Office of Research and Development (EPA/ORD) (US EPA 1996a).

4.0 MIGRATION OF CONTAMINANTS TO GROUNDWATER

Generic SSLs were developed that address the potential for migration of contaminants from soil to groundwater. The methodology used to calculate generic SSLs addresses the potential leaching of contaminants from the vadose zone to groundwater. This method does not take into account any additional attenuation associated with contaminant transport in groundwater. The SSLs developed from this analysis are risk-based values incorporating NMED-specific tap water SSLs. This methodology is modeled after US EPA's *Soil Screening Guidance: Technical Background Document* (US EPA 1996a) and the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (US EPA 2002a).*

4.1 Overview of the SSL Model Approach

Two approaches to developing soil leachate-based SSLs are presented, the generic model and the site-specific model. Both models use the same set of equations to calculate SSLs and are based on leaching to groundwater scenarios that NMED believes are protective of groundwater. The generic model calculates SSLs using default parameter values generally representative of conditions in New Mexico. These values are presented in Tables B-1 and B-2 of Appendix B. The site-specific model provides the flexibility of using site-specific meteorological, soil and hydrological data to calculate SSLs, while retaining the simplicity and ease of use associated with the generic model.

The development of soil leachate SSLs is based upon a two step process. The first step is the development of a Dilution Attenuation Factor (DAF). The DAF accounts for leachate mixing in the aquifer. A leachate concentration that is protective of groundwater is back calculated by multiplying the groundwater standard for a given constituent by the DAF. That leachate concentration is then used to back calculate an SSL that is protective of groundwater using a simple linear equilibrium soil/water partition equation. For the generic SSL approach, default parameter values are used for all non-chemical specific parameters. At sites that are not adequately represented by the default values and where more site-specific data are available, it may be more appropriate to use the site-specific SSL model. The site-specific model uses the same spreadsheet equations to calculate SSLs as those in the generic look-up table; however, site-specific data are used in the site-specific model.

The following sections of this document provide a general description of the leaching to groundwater pathway SSL model (generic and site-specific) including the assumptions, equations, and input parameters. Justification for the default parameters used in the generic model is also provided. Additionally, a sensitivity analysis was performed on each of the input parameters to provide guidance on when use of the site-specific model may be warranted. Applicability and limitations of the generic and site-specific models are also presented.

4.2 Model Assumptions

Assumptions regarding the release and distribution of contaminants in the subsurface that are incorporated into the SSL methodology include the following:

- The source is infinite (a constant concentration is maintained for the duration of the exposure period).
- Contamination is uniformly distributed from the surface to the water table.
- Soil/water partitioning is instantaneous and follows a linear equilibrium isotherm.
- There is no attenuation of the contaminant in soil or the aquifer (i.e., no irreversible adsorption, chemical transformation or biological degradation).
- The potentially impacted aquifer is unconfined and unconsolidated with homogenous and isotropic hydrologic properties.
- The receptor well (point of exposure) is at the downgradient edge of the source and is screened within the potentially impacted aquifer.
- NAPLs are not present.

4.3 Soil Water Partition Equation

US EPA's *Supplemental Soil Screening Guidance: Technical Background Document* (US EPA 1996a) and *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (US EPA 2002a) developed an equation to estimate contaminant release in soil leachate based on the Freundlich adsorption isotherm. The Freundlich equation was modified to relate the sorbed concentration to the total concentration measured in a soil sample (which includes contaminants associated with solid soil, soil-water and soil-air components) (Feenstra 1991). Equation 54, given below, is used to calculate SSLs corresponding to target soil leachate concentrations (C_w).

Equation 54
Soil Screening Level For Leaching To Groundwater Pathway

$$SSL = C_w \text{ x} \left[K_d + \left(\frac{\theta_w + \theta_a H'}{\rho_b} \right) \right]$$

Parameter	Definition (units)	Default
SSL	Soil Screening Level for migration to groundwater pathway (mg/kg)	Chemical-Specific
C_w	Target soil leachate concentration (mg/L)	Chemical-Specific
K_d	Soil /water partition coefficient (L/kg)	Chemical-Specific
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.26
θ_a	Air-filled soil porosity (L_{air}/L_{soil}), n - θ_w	0.17
n	Total soil porosity (L_{pore}/L_{soil}), 1 - (ρ_b/ρ_s)	0.43
ρ_s	Soil particle density (kg/L)	2.65
ρ_b	Dry soil bulk density (kg/L)	1.5
H′	Dimensionless Henry's Law constant	Chemical-Specific

Target soil leachate concentrations (C_w) are equivalent to the NMED-specific tap water SSLs multiplied by a DAF.

$$C_w = \text{Tap Water SSL x DAF} \quad \textbf{Equation 55}$$

The derivation of the DAF is discussed in subsequent sections of this document.

4.4 Dilution Attenuation Factor

Contaminants transported as a leachate through soil to groundwater are affected by physical, chemical, and biological processes that can significantly reduce their concentration. These processes include adsorption, biological degradation, chemical transformation, and dilution from mixing of the leachate with groundwater. The total reduction in concentration between the source of the contaminant (vadose zone soil) and the point of groundwater withdrawal is defined as the ratio of contaminant concentration in soil leachate to the concentration in groundwater at the point of withdrawal. This ratio is termed a dilution/attenuation factor (DAF; US EPA 1996a and 1996b). The higher the DAF value the greater the degree of dilution and attenuation of contaminants along the migration flow path. A DAF of 1 implies no reduction in contaminant concentration occurs.

Development of New Mexico SSLs considers only the dilution of contaminant concentration through mixing with groundwater in the aquifer directly beneath the source. This is consistent with the conservative assumptions used in the SSL methodology including an infinite source, soil contamination extending from surface to groundwater and the point of exposure occurring at the downgradient edge of the source. The ratio of contaminant concentration in soil leachate to the concentration in groundwater at the point of withdrawal that considers only dilution processes is calculated using the simple water balance equation (Equation 56), described below.

Equation 56
Dilution/Attenuation Factor (DAF)

$$\mathrm{DAF} = 1 + \left(\frac{\mathrm{K} \times \mathrm{i} \times \mathrm{D}}{\mathrm{I} \times \mathrm{L}}\right)$$

Where:

$$\mathrm{D} = \left(0.0112 \times \mathrm{L}^2\right)^{0.5} + \mathrm{D}_a\left(1 - \exp\left[\frac{-\mathrm{L} \times \mathrm{I}}{\mathrm{K} \times \mathrm{i} \times \mathrm{D}_a}\right]\right)$$

Parameter	**Definition (units)**	**Default**
DAF	Dilution/attenuation factor (unitless)	Site-Specific
K	Aquifer hydraulic conductivity (m/yr)	Site-Specific
i	Hydraulic gradient (m/m)	Site-Specific
D	Mixing zone depth (m)	Site-Specific
I	Infiltration rate (m/yr)	Site-Specific
L	Source length parallel to groundwater flow (m)	Site-Specific
D_a	Aquifer thickness (m)	Site-Specific

Most of these parameters are available from routine environmental site investigations. The mixing zone depth incorporates one additional parameter, the aquifer thickness (D_a).

For the calculation of SSLs, the DAF is used to back calculate the target soil leachate concentration (C_W in Equation 55) from an appropriate groundwater concentration, such as the tap water SSL, a Water Quality Control Commission (WQCC) standard, or a Federal Maximum Contaminant Level (MCL). For example, if the WQCC standard for a constituent is 0.1 mg/L and the DAF is 20, the target soil leachate concentration would be 2 mg/L.

The US EPA conducted an extensive evaluation of the range and distribution of DAFs to select a default value to be used for developing generic SSLs that would be reasonably protective of groundwater quality (US EPA 1996a, 1996b, and 2002a). The evaluation included a probabilistic modeling exercise using US EPA's Composite Model for Leachate Migration with Transformation Products (CMTP). A cumulative frequency distribution of DAF values was developed from the model output. Results of the Monte Carlo modeling analysis indicate that for a 0.5 acre source area a DAF of approximately 170 is protective of groundwater at 90 percent of the sites. Groundwater is protected at 95 percent of the sites with a DAF of 7.

US EPA applied the simple SSL water balance dilution model (Equation 55) to 300 sites included in surveys of hydrogeologic investigations to further evaluate the range and distribution of DAF values. Results of this analysis indicated that a DAF of 10 was protective of groundwater for a 30-acre source and that a DAF of 20 was protective of groundwater for a 0.5 acre-source (US EPA 1996a, 1996b, and 2002a).

An assessment was performed of US EPA's methodology to determine whether a default DAF value of 20 for a 0.5 acre source, and a DAF of 10 for a 30 acre source, would be appropriate for use as default values for sites in New Mexico. Typical New Mexico conditions may be notably different than conditions represented by areas included in the US EPA analysis of DAFs. For example, infiltration rates across much of New Mexico are substantially less than the average range of 0.15 to 0.24 m/yr reported for many of the hydrogeologic regions used in the US EPA analysis. In addition, effective porosity was assumed to be 0.35, presumably because this value is representative of the most prevalent aquifer type in the databases used (US EPA 1996a). However, the regions included in the US EPA analysis also contain extensive glacial, regolith, lacustrine, swamp, and marsh deposits which have high percentages of fine-grained sediments and thus, are not representative of typical New Mexico sandy soils. Sandy soils typically have higher hydraulic conductivities than more fine-grained soils and subsequently higher Darcian velocities, under equal hydraulic gradient. According to the DAF equation (Equation 56), soils with relatively greater hydraulic conductivities will tend to result in a higher calculated DAF.

An assessment was made of input parameters to the DAF equation. In order to support a DAF that is protective of the most vulnerable groundwater environments in New Mexico (i.e. areas close to perennial streams or where groundwater is very shallow), environmental parameters typical of those areas in New Mexico were used to assess the DAF. This assessment indicated that the DAF is most sensitive to variations in hydraulic conductivity. This is because this parameter exhibits such large variations in the natural environment. If a hydraulic conductivity value representative of a fine-grained sand is used in the DAF equation, along with an infiltration rate representative of New Mexico's arid to semi-arid environments, then the result is a DAF of approximately 20. NMED believes that a DAF of 20 for a 0.5 acre source area is protective of groundwater in New Mexico. If the default DAF is not representative of conditions at a specific site, then it is appropriate to calculate a site-specific DAF based upon available site data.

4.5 Limitations on the Use of the Dilution Attenuation Factor

Because of assumptions used in SSL model approach, use of the DAF model may be inappropriate for certain conditions, including sites where:

- Adsorption or degradation processes are expected to significantly attenuate contaminant concentrations in the soil or aquifer media;
- Saturated thickness is significantly less than 12 meters thick;

- Fractured rock or karst aquifer types exist (violates the unconfined, unconsolidated, homogeneous, isotropic assumptions);
- Facilitated transport is significant (colloidal transport, transport via dissolved organic matter, or transport via solvents other than water); and/or
- NAPLs are present.

For sites that have these types of conditions, consideration should be given to application of a more detailed site-specific analysis than either the generic or site-specific models described herein.

4.6 Generic SSLs for Protection of Groundwater

The migration to groundwater pathway model, incorporating the assumptions previously stated, the soil-water partition equation, and the DAF, was used to develop NMED SSLs. Default values based on conditions predominant in New Mexico were used for the input parameters in the soil-water partition equation. The NMED SSLs are presented for both default DAF values of 1 and 20.

Target soil leachate concentrations (C_W) are equivalent to the appropriate groundwater standards multiplied by a DAF. To maintain an approach that is protective of groundwater quality in the development of generic SSLs, a DAF of 20 is selected as reasonably protective. However SSLs are provided for two DAFs in Appendix A. The use of the SSL listed for a DAF of 20 is advised unless site-specific data on hydrologic conditions are available, and these indicate that the generic DAF is not representative of site conditions. As will be demonstrated in the sensitivity analysis section of this document, calculation of an SSL using the migration to groundwater pathway model is most sensitive to the DAF. The inclusion of the SSL for a DAF of 1 is provided for convenience to the user. If data on hydrologic conditions are readily available, a site specific DAF can be calculated and multiplied by the generic SSL for a DAF of 1 to provide a site-specific SSL.

The generic approach may be inappropriate for use at sites where conditions are substantially different from the default values used to develop the generic soil leachate SSLs.

4.7 Development of Site Specific SSLs for Protection of Groundwater

New Mexico, as with any other state, offers a variety of geologic and hydrologic conditions that may not be readily represented by a single default parameter value.

Site specific conditions may differ considerably from the typical or average conditions represented by the default values used to calculate generic SSLs. The site-specific model can be used to address the variability inherent in environmental conditions across and within the state.

Application of the site-specific model to develop soil leachate SSLs is the same as the generic approach except that site-specific values are used. Use of the site-specific model approach may incorporate replacement of all default values used for the generic SSLs with site-specific values, or may only include substitution of a single key parameter, such as hydraulic conductivity. The decision to use the site-specific model approach instead of the generic approach should be based on consideration of the sensitivity of the calculated SSL to specific parameters and the availability of those parameters as site-specific data. Sufficient site-specific data may be available such that each of the default values used for developing generic SSLs can be readily substituted with a more representative site-derived value. Conversely, limited site-specific data may restrict the number of default values to be replaced.

The NMED SSLs are generally more sensitive to the DAF than to other parameters in the soil-water partition equation. Fortunately, information needed to derive the DAF is usually available for sites that have undergone even the most basic levels of environmental investigation. Apart from the DAF, SSLs are most sensitive to the soil-water partition coefficient (K_d) as the values for this parameter can range over several orders of magnitude, particularly for metals. Although the K_d term may be critical in developing protective SSLs, information required to evaluate this parameter is more difficult to obtain and less likely to be available. Porosity and bulk density are not particularly sensitive because of the relatively small range of values encountered in subsurface conditions.

Using benzene as a representative contaminant, a sensitivity analysis was performed to compare a generic soil leachate SSL to site-specific model results simulating a range of model input parameters that might be representative of different conditions in New Mexico. The generic soil leachate SSL calculated using the New Mexico default values and a DAF of 1 is 2.8 µg/kg. These results are summarized in Table 4-1. As shown, the resulting SSLs for benzene range from 1.3 to 6.1 µg/kg for the various sensitivity simulations compared to the generic SSL of 2.8 µg/kg. These results indicate that the calculation of SSLs using the site-specific approach is not overly sensitive to the reasonable range of porosity (air and water filled), bulk density and fraction of organic carbon (f_{oc}) expected for New Mexico or even for a range of values for chemical-specific properties. The generic SSL for benzene of 2.8 µg/kg is representative of values that could be calculated using a spectrum of input parameters, exclusive of the DAF term. Unless there are sufficient data to calculate a site-specific DAF, there is little benefit derived from using the site-specific model approach instead of the generic SSL.

Table 4-1. Input Parameters and Resulting SSLs for the Sensitivity Analysis of the Soil-Water Partition Equation - Migration to Groundwater Pathway Model

Input parameter (NMED default value)	Sensitivity Analysis Values	Resulting SSLs
Bulk density	Lower Limit = 1.20	3.4
(default value = 1.55 gm/cm)	Upper Limit = 1.90	2.5
Air filled porosity	Lower Limit = 0.04[a]	1.3
(default value = 0.18)	Upper Limit = 0.25[b]	3.5
Fraction organic carbon	Lower Limit = 0.0005	2.2
(default value = 0.0015)	Upper Limit = 0.007	6.1
Volume water content	Lower Limit = 0.05[c]	1.8
(default value = 0.26)	Upper Limit = 0.40[c]	3.5
K_{oc}	Lower Limit = 30	2.4
(default value = 58.9 ml/g)	Upper Limit = 120	3.7
Dimensionless Henry's Law constant	Lower Limit = 0.1	2.7
(default value = 0.228)	Upper Limit = 0.4	3.0

[a] total porosity was reduced from 0.44 to 0.10 for this simulation
[b] total porosity was increased from 0.44 to 0.6 for this simulation
[c] total porosity remained at 0.44 for this simulation.

As previously stated, calculation of SSLs is most sensitive to the DAF term. The input parameter values and resulting DAFs for the sensitivity analysis are included in Table 4-2. Effects on the DAFs are, from greatest to least, the Darcian velocity (hydraulic conductivity multiplied by the hydraulic gradient), infiltration rates, size of the contaminated area, and the aquifer thickness. Corresponding effects on DAFs for each of these parameters and discussion of the relevance of the use of default values versus site-specific conditions are summarized below.

Table 4-2. Input Parameters and Resulting DAFs for the Sensitivity Analysis of the Dilution Attenuation Factor-Migration to Groundwater Pathway Model

Parameter	Groundwater Velocity (m/yr)	Infiltration Rate (m/yr)	Source Length (m)	Aquifer thickness (m)	Mixing Zone Depth (m)	Dilution Attenuation Factor (DAF)
Groundwater Velocity	2.2	0.13	45	12	7.15	3.7
Groundwater Velocity	22	0.13	45	12	5.03	19.9
Groundwater Velocity	220	0.13	45	12	4.79	181.1
Infiltration Rate	22	0.065	45	12	4.89	37.8
Infiltration Rate	22	0.13	45	12	5.03	19.9
Infiltration Rate	22	0.26	45	12	5.28	10.9
Source Length	22	0.13	22.5	12	2.51	19.9
Source Length	22	0.13	45	12	5.03	19.9
Source Length	22	0.13	348.4	12	38.76*	6.8
Aquifer Thickness	22	0.13	45	3	5.02*	12.3
Aquifer Thickness	22	0.13	45	12	5.03	19.9
Aquifer Thickness	22	0.13	45	48	5.03	19.9

Note: If mixing zone depth calculation is greater than aquifer thickness, then aquifer thickness is used to calculate the DAF.

Higher Darcian velocity results in higher DAFs. Slower mixing of groundwater with soil leachate occurs at lower groundwater velocity. Thus, using a lower velocity constitutes a more conservative approach. Sandy soils typically have higher hydraulic conductivities than more fine-grained soils and subsequently higher Darcian velocity (under equal hydraulic gradient). Use of a sandy soil type will generally be less conservative (result in higher DAFs) with respect to protection of groundwater quality.

Lower infiltration rates result in higher DAFs. Therefore, using a higher infiltration rate is a more conservative approach (results in a lower DAF).

Larger source sizes result in lower DAFs. The default DAF used to develop SSLs for a 0.5 acre source may not be protective of groundwater at sites larger than 0.5 acre. However, the selection of a second source size is arbitrary. If generic SSLs are developed for a 30 acre source, then those values are considered overly conservative for a 12 acre source. Conversely, SSLs developed for a 30 acre source will be less protective of a 40 acre source. Rather than develop a separate set of generic SSLs for a second (or third or fourth) source size, the following two approaches are proposed.

- As the size of the source area increases, the assumptions underlying the generic model are less applicable. One of the conservative assumptions in the generic SSL approach is the uniform distribution of contaminants throughout the vadose zone. There are few sites that have relatively uniform soil contamination (both laterally and vertically) of a single constituent in an area of greater than 0.5 acres (22,000 ft^2). Soil contamination at large facilities (such as federal facilities) are usually concentrated in discrete portions of the site. Contamination at large sites is commonly the result of multiple sources. It is advisable to attempt to subdivide the facility by source and contaminant type and then apply generic SSLs to those smaller source areas.
- If this approach is impractical, calculation of site specific DAFs is recommended. Most of the parameters required for these calculations are available from routine environmental site investigations or can be reasonably estimated from general geologic and hydrologic studies.

Thin aquifers will result in lower DAFs. The nominal aquifer thickness used in the sensitivity analysis was 12 meters (m). Reducing the aquifer thickness to 3 m results in a 40 percent reduction in the DAF. Increasing the aquifer thickness beyond the nominal value has very little impact.

The significant effects of the DAF on the calculation of SSLs, coupled with the common availability of site-specific data used to calculate the DAF, suggest that use of the site specific modeling approach should at least incorporate recalculation of the DAF term. If data are available that indicate soil properties significantly different than the default values (such as high or low f_{oc} for organic contaminants, or highly acidic or basic conditions for metal contaminants) the K_d term should also be evaluated and recalculated.

4.8 Detailed Model Analysis for SSL Development

Sites that have complex or heterogeneous subsurface conditions may require more detailed evaluation for development of SSLs that are reasonably, but not overly, protective of groundwater and surface water resources. These types of sites may require more complex models that can address a wide range of variability in environmental site conditions including soil properties, contaminant mass concentration and distribution, contaminant degradation and transformation, recharge rates and recharge concentration, and depth to the water table. Model codes suitable for these types of more detailed analyses range from simple one-dimensional analytical models to complex three-dimensional numerical models. Note that resource requirements (data, time and cost) increase for the more complex codes. The selection of an appropriate code needs to balance the required accuracy of the output with the level of effort necessary to develop the model.

4.9 Summary of the Migration to Groundwater Pathway SSLs

SSLs for New Mexico have been developed for the migration to groundwater pathway, and are provided in Table A-1 of Appendix A. The NMED SSLs were developed using default parameter values representative of environmental conditions in New Mexico and utilize a DAF of 20. This approach maintains the conservative approach of the SSL methodology and is protective of groundwater quality under a wide range of site conditions. Soil contaminant concentrations can be compared directly to the generic SSLs to determine if additional investigation is necessary to evaluate potential leaching and migration of contaminants from the vadose zone to groundwater in excess of NMED-specific tap water SSLs.

Site-specific SSLs can be developed by substituting site-related data for the default values in the leaching to groundwater pathway model. SSLs developed from this model are most sensitive to the DAF. SSLs are also provided in the lookup table for a DAF of 1. If data on hydrologic conditions are readily available, a site specific DAF can be calculated.

5.0 USE OF THE SSLS

For screening sites with multiple contaminants, the following procedure should be followed: take the site-specific concentration (first step screening assessments should use the maximum reported concentration) and divide by the SSL concentration for each analyte. For multiple contaminants, simply add the ratio for each chemical. For carcinogens, multiply the sum by the NMED target risk level of 1E-05 as shown in Equation 57. Equation 58 shows the sum of the ratios is multiplied by the NMED target hazard of 1.0 for non-carcinogens.

$$\text{Site Risk} = \left(\frac{\text{conc}_x}{\text{SSL}_x} + \frac{\text{conc}_y}{\text{SSL}_y} + \frac{\text{conc}_z}{\text{SSL}_z} + \ldots + \frac{\text{conc}_i}{\text{SSL}_i} \right) \times 10^{-5} \qquad \textbf{Equation 57}$$

$$\text{Site Hazard Index (HI)} = \left(\frac{\text{conc}_x}{\text{SSL}_x} + \frac{\text{conc}_y}{\text{SSL}_y} + \frac{\text{conc}_z}{\text{SSL}_z} + \ldots + \frac{\text{conc}_i}{\text{SSL}_i} \right) \times 1 \qquad \textbf{Equation 58}$$

Site risks and hazard indices for any additional completed exposure pathways not included in the SSLs (e.g., vapor intrusion or ingestion of potentially contaminated produce/meat/dairy) should be added to the results of Equations 57 and 58. For noncarcinogenic effects, constituents can be grouped according to the same toxic endpoint and/or mechanism of action. The sources provided in Section 2.1 should be consulted to determine the endpoint and/or target organ system.

It is important to remember that site concentrations should be developed for each receptor and corresponding soil horizons, or exposure intervals. As discussed in Section 2.7.5 and summarized in Table 2-6, it is assumed that residential and construction worker receptors are exposed to soil from 0-10 ft bgs, while commercial/industrial receptors are exposed to soil 0-1 ft bgs. An exposure interval of 0-5 ft bgs should be assumed for non-burrowing ecological receptors and shallow rooted plants, and an exposure interval of 0-10 ft bgs should be assumed for burrowing receptors and deep rooted plants. For the vapor intrusion and soil-to-groundwater migration pathways, maximum concentrations regardless of sampling depth should be considered for all receptors.

Site risks less than the NMED target level of 1E-05 and hazard indices less than the NMED target level of one (1) indicate that concentrations at the site are unlikely to result in adverse health impacts. If the total cancer risk is greater than the target risk level of 1E-5 or if the hazard index is greater than one, concentrations at the site warrant further, site-specific evaluation. Further site-specific evaluation may include refinement of receptor-specific exposure point concentrations via calculation of UCLs (Section 2.5). The calculated UCLs may then be used as the input concentrations for Equations 57 and 58. As stated in Section 1.2, further evaluation may also include additional sampling to better characterize the nature and extent of contamination, consideration of background levels, reevaluation of COPCs or associated risk and hazard using site-specific parameters, and/or a reassessment of the assumptions associated with the generic NMED SSLs.

As with any risk-based tool, the potential exists for misapplication. In most cases the root cause will be a lack of understanding of the intended use of NMED SSLs. In order to prevent misuse of SSLs, the following should be avoided:

- Applying SSLs to a site without adequately developing a CSM that identifies relevant exposure pathways and exposure scenarios,
- Failing to consider additional exposure pathways not included in the SSLs,
- Using the SSLs as cleanup levels without verifying numbers with a toxicologist or risk assessor, and
- Failing to consider the effects of additivity when screening multiple chemicals.

When generic NMED SSLs are used for screening level evaluations at a facility, site-specific conditions must be evaluated for each receptor to determine if the exposure assumptions associated with the generic NMED SSLs are appropriate for comparison with the available site data. The exposure assumptions for each receptor on which the generic NMED SSLs are based are shown in Table A-2. Therefore, Table A-2 should be consulted when the generic NMED SSLs are being applied at a facility. If the exposure assumptions presented in Table A-2 are not protective of the exposure and types of receptors found at a facility, NMED should be consulted to determine if refinement of the generic SSLs based on site-specific exposure paramters is appropriate.

5.1 Use of Chromium Screening Levels

Elemental chromium (Cr) is naturally present and considered stable in the ambient environment in one of two valence states: chromium (III) and chromium (VI). Chromium (III) occurs in chromite compounds or minerals and concentrations in soil/groundwater result from the weathering of minerals. Chromium (III) is the most stable state of environmental chromium; chromium (VI) in the environment is man-made, present in chromate and dichromate compounds, and is the more toxic of the oxidation states. (http://rais.ornl.gov/tox/profiles/chromium.html#t21).

The oxidation state of Cr has a significant effect on its transport and fate in the environment. The equilibrium distribution of the Cr between the two oxidation states is controlled by the redox environment. Oxidation depends on a variety of factors and is a function of pH and the rate of electron exchange, or standard reduction potential (Eh). Chromium (VI) is converted to the less toxic and much less mobile form of chromium (III) by reduction reactions. The corresponding oxidation of chromium (III) to chromium (VI) can also occur under oxidizing conditions.

The degree to which chromium (III) can interact with other soil constituents is limited by the fact that most chromium (III) is present in the form of insoluble chromium oxide precipitates rendering chromium (III) relatively stable in most soils. Oxidation of chromium (III) to chromium (VI) can occur under specific environmental conditions with influencing factors including the soil pH, chromium (III) concentration, presence of competing metal ions, availability of manganese oxides, presence of chelating agents (i.e., low molecular weight organic compounds), and soil water activity. Chromium (III) oxidation is favored under acidic conditions, where the increased solubility of chromium (III) at lower pH enables increased contact with oxidizing agents. Aside from decreasing soil pH, chromium (III) solubility is enhanced by chelation to low molecular weight compounds such as citric or fulvic acids. Conversely, factors influencing the reduction of chromium (VI) to chromium (III) in soil include soil pH, the presence of electron donors such as organic matter or ferrous ions, and soil oxygen levels (CEQG, 1999). Chromium reducing action of organic matter increases with decreasing pH.

Figure 5-1 (TCEQ, 2002) shows a generalized Eh-pH diagram for the chromium-water system. Chromium (III) exists over a wide range of Eh and pH conditions (e.g., Cr^{3+}, $Cr(OH)_3$, and CrO_2^-) while chromium (VI) exists only in strongly oxidizing conditions (e.g., $HCrO^{-}_{4}$ and CrO^{2}_{4}).

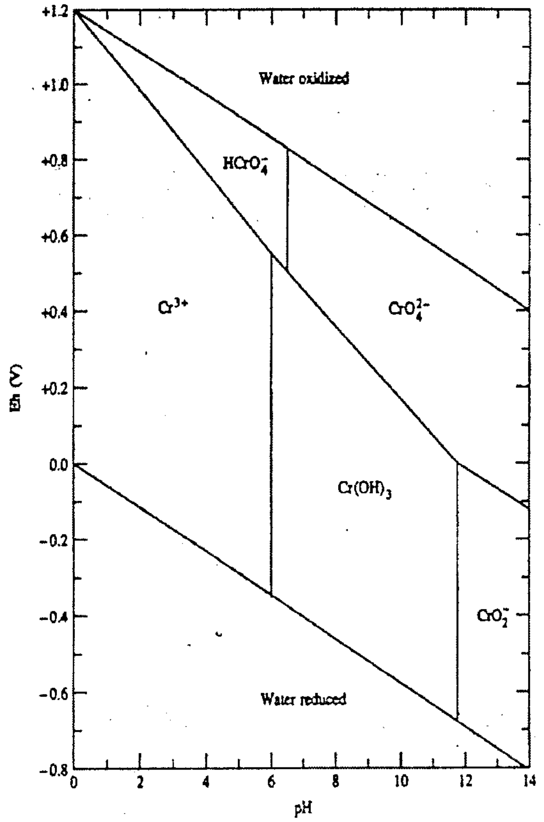


Figure 5-1. Eh-pH Diagram for Chromium

Generally, groundwater containing high concentrations of chromium is more likely to be comprised of chromium (VI) than chromium (III) because chromium (III) is more likely to have precipitated as Cr_2O_3 x H_2O and, to a lesser extent, adsorbed. Chromium (VI) is highly mobile in groundwaters with neutral to basic pH. In acidic groundwaters chromium (VI) can be moderately adsorbed by pH-dependent minerals such as iron and aluminum oxides. Under favorable conditions, chromium (VI) reduces to chromium (III) rapidly via ferrous iron, organic matter, and microbes. The oxidation of chromium (III) to chromium (VI) by dissolved oxygen and monoxides is kinetically slower (TCEQ, 2002). Redox conditions and pH dominate Cr speciation and thus are important parameters required for assessment of groundwater data.

The RSL tables no longer contain risk-based screening levels for total chromium (with the exception of air). The US EPA deleted the total chromium values due to uncertainty associated with the previously applied ratio of trivalent to hexavalent chromium. The concern was that an assumed ratio (1:6) had the potential to both under- and over-estimate risk.

For sites where chromium is to be included for analysis, a tiered process should be applied. If there is site history sufficient to identify chromium (VI) as a potential site contaminant, such as the site previously housed a plating operation or soil/water chemistry may allow for speciation, analyses of media (soil and/or groundwater) should include hexavalent and total chromium in the analytical suite along with determination of pH (water samples) and Eh to assess chemical state.

Comparison of the species-specific data can be compared to representative background concentrations.

If site history does not indicate a known source for chromium (VI), the data (soil and/or groundwater) should be analyzed for total chromium. If the site levels of total chromium are within background, no additional analyses would be required (chromium would drop from the risk assessment as a constituent of concern). However, if the total chromium concentrations are statistically different (using a 95% confidence level) from background for soil or if chromium appears to be a site contaminant in groundwater, a two tiered approach should be applied:

1. A more detailed review of the site history should be conducted to see if there were any potential sources for chromium (VI) or any processes that could have resulted in an alteration of speciation (such as introduction of acids). If there is no potential source, or it does not appear that any other chemicals or contaminants are present that may have altered the speciation of Cr, and this can be documented, no additional analyses will be required and the data may be evaluated as total chromium. Table A-1 includes derived screening levels for total chromium, using the methodology outlined in this document and assuming a ratio of chromium (VI) to chromium (III) of 1:6.

2. If there is a potential source for chromium (VI) or the data are statistically different (using a 95% confidence level) from background, additional sampling should be conducted to determine speciation. The species-specific data will then be compared to the trivalent and hexavalent chromium NMED screening levels presented in Table A-1.

5.2 Essential Nutrients

Essential nutrients are naturally occurring inorganic constituents that are essential for human health in trace amounts, but may be toxic in high doses. Inorganics classified as essential nutrients that do not have published toxicity data (from the US EPA [2003] recommended hierarchy of sources) may be eliminated from further consideration in the risk assessments if they are detected in soil at concentrations that would not cause adverse effects to human health or the environment. Inorganics classified as essential nutrients that could be naturally occurring and do not have published toxicity data include: calcium, chloride, magnesium, phosphorous, potassium, and sodium.

Soil screening levels were calculated based upon dietary guidelines. The Institute of Medicine of the National Academy of Sciences has developed dietary guidelines for essential nutrients which include tolerable upper intake levels (ULs), recommended daily allowances (RDAs), and adequate intakes (AIs) (NAP, 2011 and 2006). A UL is the highest average daily intake level likely to pose no risk of adverse health effects to most individuals within the general population. As intake increases above the UL, the potential risk of adverse effects may increase. RDAs and AIs are the daily dietary intake levels of a nutrient considered to be sufficient within an age group. Screening levels for essential nutrients were calculated for three different types of receptors (industrial worker, resident, and construction worker). The UL/RDA/AI was selected for industrial and construction workers based on an adult age group; for residents, levels were selected for a child age group.

The SSLs were derived using ULs and if an UL was not available, the more conservative of the available RDAs or AIs was utilized. Screening levels were calculated using the exposure assumptions in Equation 59 for ingestion of soil only and are presented in Table 5-1.

Table 5-1. Soil Screening Levels for Essential Nutrients

Essential Nutrient and Receptor	Upper Level (UL) or Adequate Intake (AI) (mg/day)		Soil Screening Level (mg/kg)
Calcium			
Industrial Worker	2000	UL	3.24E+07
Resident	2500	UL	1.30E+07
Construction worker	2000	UL	8.85E+06
Chloride			
Industrial Worker	3400	UL	5.52E+07
Resident	2300	UL	1.20E+07
Construction worker	3400	UL	1.50E+07
Magnesium			
Industrial Worker	350	UL	5.68E+06
Resident	65	UL	3.39E+05
Construction worker	350	UL	1.55E+06
Phosphorous			
Industrial Worker	3000	UL	4.87E+07
Resident	3000	UL	1.56E+07
Construction worker	3000	UL	1.33E+07
Potassium			
Industrial Worker	4500	AI	7.30E+07
Resident	3000	AI	1.56E+07
Construction worker	4500	AI	1.99E+07
Sodium			
Industrial Worker	2200	UL	3.57E+07
Resident	1500	UL	7.82E+06
Construction worker	2200	UL	9.73E+06

ULs and AIs taken from The National Academies Press (2011 and 2006)

Equation 59
Calculation of SSLs for Essential Nutrients

$$SSL_{en} = \frac{DI \times AT}{IR \times CF \times EF \times ED}$$

Parameter	**Definition (units)**	**Default**
SSL_{en}	Soil screening level for essential nutrients (mg/kg)	Chemical-specific
DI	Daily intake (UL, RDA or AI) (mg/day)	Chemical-specific
AT	Averaging time (365 day/yr x ED)	Receptor-specific
IR	Ingestion rate (mg/day)	
	Industrial worker	100
	Resident (child)	200
	Construction worker	330
CF	Conversion factor (1E-06 kg/mg)	1E-06
EF	Exposure frequency (day/yr)	
	Industrial worker	225
	Resident (child)	350
	Construction worker	250
ED	Exposure duration (yr)	
	Industrial worker	25
	Resident (child)	6
	Construction worker	1

If the maximum detected concentration of an essential nutrient at a site is below the soil SSLs, then exposure is not likely to cause adverse effects to receptors, and the inorganic constituent may be eliminated from further evaluation in the risk assessments.

6.0 TOTAL PETROLEUM HYDROCABONS (TPH)

In some instances, it may be practical to assess areas of soil contamination that are the result of releases of petroleum products using total petroleum hydrocarbon (TPH) analyses. TPH results may be used to delineate the extent of petroleum-related contamination at these sites and ascertain if the residual level of petroleum products in soil represents an unacceptable risk to future users of the site. Petroleum hydrocarbons consist of complex mixtures of compounds, some of which are regulated constituents while others are not. In addition, the amount and types of the constituent compounds in a petroleum hydrocarbon release differ widely depending on what type of product was spilled and how the spill has weathered. This variability makes it difficult to determine the toxicity of weathered petroleum products in soil solely from TPH results; however, these results can be used to approximate risk in some cases, depending upon the nature of the petroleum product, the release scenario, how well the site has been characterized, and the anticipated potential future land uses.

Site cleanup decisions cannot be based solely on the results of TPH sampling. Rather, the soil screening levels for TPH in Table 6-2 must be used in conjunction with the screening levels for individual petroleum-related contaminants listed in Table A-1 for soil exposure, threat to ground water, and vapor intrusion. The TPH screening levels are not designed to be protective of exposure to these individual contaminants. Sites with petroleum product releases must be tested for VOCs, SVOCs, and if warranted, metals and PCBs, to determine if other potentially toxic constituents are present. Sites with unknown oil or waste oil releases must be tested for VOCs, SVOCs, metals, and PCBs.

The toxicity of petroleum hydrocarbons depends on their classification as aliphatic or aromatic and on their carbon number/molecular weight. Because TPH is essentially a summation of the three fractions, C11-C22 Aromatics, C9-C18 Aliphatics and C19-C36 Aliphatics, NMED derived TPH soil-screening values based on reasonable assumptions about the composition of petroleum products commonly found at contaminated sites, as shown in Table 6-1.

Table 6-1. TPH Compositional Assumptions[a] Used in Deriving Screening Levels

Petroleum Product	C11-C22 Aromatics	C9-C18 Aliphatics	C19-C36 Aliphatics
Diesel #2/ new crankcase oil	60%	40%	0%
#3 and #6 Fuel Oil	70%	30%	0%
Kerosene and jet fuel	30%	70%	0%
Mineral oil dielectric fluid	20%	40%	40%
Unknown oil	100%	0%	0%
Waste Oil[b]	0%	0%	100%

[a] From MADEP, 2002

[b] Compositional assumption for waste oil developed by NMED is based on review of chromatographs of several types of waste oil.

TPH soil screening levels were calculated based on the noncarcinogenic toxicity of the hydrocarbon fractions as applicable to the ingestion and dermal exposure pathways, weighted according to the assumed composition of the petroleum product. Ceiling values that account for exposure pathways and factors that were not considered in the toxicity calculations, including public welfare concerns related to odors, were used where more conservative. (MADEP 2014.)

Table 6-2. TPH Soil Screening Levels

Petroleum Product	Residential Exposure (mg/kg)	Industrial/Occupational Exposure (mg/kg)
Diesel #2/crankcase oil	1000	3000
#3 and #6 Fuel Oil	1000	3000
Kerosene and jet fuel	1000	3000

Mineral oil dielectric fluid	1800	3800
Unknown oil	1000	3800
Waste Oil	3000	5000
Gasoline	Not applicable	Not applicable

Mineral oil based hydraulic fluids can be evaluated for petroleum fraction toxicity using the screening guidelines from Table 6-2 specified for waste oil, because this type of hydraulic fluid is composed of approximately the same range of carbon fractions as waste oil. However, these hydraulic fluids often contain proprietary additives that may be significantly more toxic than the oil itself; these additives must be considered on a site- and product-specific basis (see ATSDR, 1997). Use of alternate screening levels requires prior written approval from the NMED.

The TPH soil screening levels are based solely on human health considerations related to direct soil exposure, not ecological risk considerations, protection of surface or ground water, or potential indoor air impacts from soil vapor. Potential soil vapor impacts shall be evaluated for individual petroleum-related contaminants listed in Table A-1 and following the methodology in Section 2.5 of this guidance.

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APPENDIX A

NMED SOIL SCREENING LEVELS (SSLs)

Appendix A

State of New Mexico Soil Screening Levels

Table A-1 provides State of New Mexico Soil Screening Levels (SSLs), as developed by the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) and the Ground Water Quality Bureau Voluntary Remediation Program for chemicals most commonly associated with environmental releases within the state. These NMED SSLs are derived using default exposure parameter values (refer to Equations in Volume I) and chemical- and State of New Mexico-specific physical parameters (as presented in Tables B-1, B-2, and B-3 of Appendix B). These default values are assumed to be appropriately conservative in the face of uncertainty and are likely to be protective for the majority of site conditions relevant to soil exposures within New Mexico. Note that SSLs are derived using the appropriate equations provided in Volume I for noncarcinogens, carcinogens, mutagens, and for vinyl chloride and trichloroethylene.

However, the NMED SSLs are not necessarily protective of all known human exposure pathways, reasonable land uses or ecological threats. Thus, before applying NMED SSLs at a site, it is extremely important to compare the conceptual site model (CSM) with the assumptions upon which the NMED SSLs are predicated to ensure that the site conditions and exposure pathways match those used to develop the NMED SSLs. Table A-2 lists the exposure assumptions that were applied in the calculations of the NMED SSLs. If this comparison indicates that the site at issue is more complex than the corresponding SSL scenarios, or that there are significant exposure pathways not accounted for by the NMED SSLs, then the NMED SSLs are insufficient for use in a defensible assessment of the site. A more detailed site-specific approach will be necessary to evaluate the additional pathways or site conditions.

Table A-1

Column 1:	The first column in Table A-1 presents the names of the chemicals for which NMED has developed SSLs.
Column 2:	The second column presents NMED SSLs predicated on residential soil exposures.
Column 3, 5, 7, and 9:	These columns present indicator categories for the NMED SSL residential, industrial, construction, and tap water basis, whether predicated on carcinogenic (c) and noncarcinogenic (n) effects. In some cases, the risk-based SSL is greater than the soil saturation limit, and in these cases, the SSL is denoted as either "cs" or "ns" depending on carcinogenicity or non-carcinogenicity, respectively. In the case where a noncarcinogenic SSL is greater than the ceiling limit (1E+05), the SSL is denoted as "nl" and in a few cases, "nls" is used to indicate the SSL is both above the saturation level and the ceiling limit. NMED SSLs predicated on a carcinogenic endpoint reflect age-adjusted child-to-adult exposures. NMED SSLs predicated on a noncarcinogenic endpoint reflect child-only exposures. Detected concentrations above a saturation value ("cs", "ns", or "nsl") may indicate the presence of nonaqueous phase liquid (NAPL).

Columns 4 and 6:	The fourth and sixth columns present NMED SSLs analogous to Column 1, with the exception that these values correspond to Industrial/Occupational and Construction worker (adult-only) exposures, respectively.
Column 8:	Presents the tap water SL for the residential scenario.
Columns 10 and 11:	The tenth column presents NMED SSLs for the migration to groundwater pathway developed using a default dilution attenuation factor (DAF) of 1, which assume no effective dilution or attenuation. These values can be considered at sites where little or no dilution or attenuation of soil leachate concentrations is expected (e.g., shallow water tables, karst topography). Column 11 presents NMED SSLs for the migration to groundwater pathway developed using a DAF of 20 to account for natural processes that reduce contaminant concentrations in the subsurface. The SSLs based on a DAF of 20 are default SSLs that should be applicable at most sites.

As noted above, separate NMED SSLs are presented for use in evaluating three discrete potential receptor populations: Residential, Industrial/Occupational, and Construction. Each NMED SSL considers incidental ingestion of soil, inhalation of volatiles from soil (limited to those chemicals noted as volatile organic compounds [VOCs] within Table B-2) and/or particulate emissions from impacted soil, and dermal contact with soil.

Generally, if a contaminant is detected at a level in soil exceeding the most relevant NMED SSL, and the site-specific CSM is in general agreement with the underlying assumptions upon which the NMED SSLs are predicated, this result indicates the potential for adverse human health effects to occur. Conversely, if no contaminants are detected above the most relevant NMED SSL, this tends to indicate to the user that environmental conditions may not necessitate remedial action of the surface soil or the vadose zone.

A detection above a NMED SSL does not indicate that unacceptable exposures are, in fact, occurring. The NMED SSLs are predicated on relatively conservative exposure assumptions and an exceedance only tends to indicate the potential for adverse effects. The NMED SSLs do not account for additive exposures, whether for carcinogenic or noncarcinogenic endpoints. Section 5 of Volume I addresses a methodology by which an environmental manager may determine whether further site-evaluation is warranted, however, this methodology does not replace the need for defensible risk assessment where indicated. The SSLs also do not account for ingestion of homegrown produce/animals or the vapor intrusion pathway. If these or other exposure pathways are complete, additional analyses may be warranted.

The NMED SSLs address a basic subset of exposures fundamental to the widest array of environmentally-impacted sites within the State of New Mexico. The NMED SSLs cannot address all relevant exposure pathways associated with all sites. The utility of the NMED SSLs depends heavily upon the understanding of site conditions as accurately reflected in the CSM and nature and extent of contamination determinations. Consideration of the NMED SSLs does not preclude the need for site-specific risk assessment in all instances.

Table A-3 provides State of New Mexico vapor intrusion screening levels (VISLs) for chemicals most commonly associated with environmental releases within the state and that are determined to be sufficiently volatile and toxic. A chemical is considered to be sufficiently volatile if its Henry's law constant is approximately 1×10^{-5} atm-m^3/mole or greater and its molecular weight is approximately 200 g/mole or less. A chemical is considered to be sufficiently toxic if the vapor concentration of the pure component poses an incremental life time cancer risk greater than 1E-05 or the noncancer hazard index is greater than 1.0. The NMED VISLs calculated for chemicals in Table A-3 are sufficiently volatile and toxic to be considered for the vapor intrusion pathway. The list of chemicals included in Table A-3 is <u>not</u> comprehensive of all potential volatile and toxic compounds that may be present in site media. If volatile and toxic constituents are detected in site media and are not listed in Table A-3, VISLs should be calculated following the methodologies herein and risks addressed. The NMED VISLs are derived using default exposure parameter values (refer to Equations in Volume I) and chemical-specific physical parameters (as presented in Tables B-1 and B-2 of Appendix B). These default values are assumed to be appropriately conservative in the face of uncertainty and are likely to be protective for the majority of site conditions relevant to vapor intrusion exposures within New Mexico.

<u>Table A-3</u>

Column 1:	The first column in Table A-3 presents the names of the chemicals for which NMED has developed VISLs.
Columns 2 and 6:	These columns present NMED indoor air screening levels predicated on residential and commercial/industrial exposures, respectively. These indoor air screening levels were used to derive VISLs for soil-gas and groundwater.
Columns 3 and 7	These columns present indicator categories for the NMED indoor air residential and commercial/industrial screening levels, whether predicated on carcinogenic (c) or noncarcinogenic (n) effects.
Columns 4 and 8:	The fourth and eighth columns present NMED VISLs for volatiles detected in soil-gas for the residential and commercial/industrial exposures, respectively.
Columns 5 and 9:	The fifth and ninth columns present NMED VISLs for volatiles detected in groundwater for the residential and commercial/industrial exposures, respectively.

Table A-1: NMED Soil Screening Levels

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	Tap Water (ug/L)	End-point	Risk-based SSL for a DAF of 1 (mg/kg)	Risk-based SSL for a DAF of 20 (mg/kg)
Acenaphthene	3.48E+03	n	5.05E+04	n	1.51E+04	n	5.35E+02	n	4.12E+00	8.25E+01
Acetaldehyde	2.49E+02	n	1.17E+03	n	2.17E+02	n	1.88E+01	n	3.29E-03	6.58E-02
Acetone	6.63E+04	n	9.60E+05	nls	2.42E+05	nls	1.41E+04	n	2.49E+00	4.98E+01
Acrylonitrile	4.93E+00	c	2.46E+01	c	3.52E+01	n	5.23E-01	c	9.77E-05	1.95E-03
Acetophenone	7.82E+03	ns	1.30E+05	nls	3.54E+04	ns	1.92E+03	n	4.82E-01	9.64E+00
Acrolein	4.54E-01	n	2.16E+00	n	4.01E-01	n	4.15E-02	n	7.29E-06	1.46E-04
Aldrin	3.11E-01	c	1.50E+00	c	8.07E+00	n	4.54E-02	c	5.60E-03	1.12E-01
Aluminum	7.80E+04	n	1.29E+06	nl	4.14E+04	n	1.99E+04	n	2.99E+04	5.97E+05
Anthracene	1.74E+04	n	2.53E+05	nl	7.53E+04	n	1.72E+03	n	4.25E+01	8.51E+02
Antimony	3.13E+01	n	5.19E+02	n	1.42E+02	n	7.26E+00	n	3.28E-01	6.56E+00
Arsenic	4.25E+00	c	2.15E+01	c	5.74E+01	n	5.13E-01	c	1.50E-02	2.99E-01
Barium	1.56E+04	n	2.55E+05	nl	4.39E+03	n	3.28E+03	n	1.35E+02	2.70E+03
Benzene	1.78E+01	c	8.72E+01	c	1.42E+02	n	4.54E+00	c	1.90E-03	3.80E-02
Benzidine	5.18E-03	c	1.12E-01	c	8.12E-01	c	1.07E-03	c	2.09E-06	4.17E-05
Benzo(a)anthracene	1.53E+00	c	3.23E+01	c	2.40E+02	c	3.43E-01	c	9.11E-02	1.82E+00
Benzo(a)pyrene	1.53E-01	c	3.23E+00	c	2.40E+01	c	3.43E-02	c	3.02E-02	6.05E-01
Benzo(b)fluoranthene	1.53E+00	c	3.23E+01	c	2.40E+02	c	3.43E-01	c	3.09E-01	6.17E+00
Benzo(k)fluoranthene	1.53E+01	c	3.23E+02	c	2.31E+03	c	3.43E+00	c	3.02E+00	6.05E+01
Beryllium	1.56E+02	n	2.58E+03	n	1.48E+02	n	1.24E+01	n	9.79E+00	1.96E+02
a-BHC (a-Hexachlorocyclohexane, a-HCH)	8.45E-01	c	4.07E+00	c	2.97E+01	c	6.80E-02	c	2.98E-04	5.96E-03
b-BHC (b-Hexachlorocyclohexane, b-HCH)	2.96E+00	c	1.43E+01	c	1.04E+02	c	2.38E-01	c	1.04E-03	2.09E-02
g-BHC (Lindane)	5.63E+00	c	2.83E+01	c	9.43E+01	n	4.08E-01	c	1.79E-03	3.58E-02
1,1-Biphenyl	6.32E+01	n	2.98E+02	n	5.46E+01	n	8.34E-01	n	6.56E-03	1.31E-01
Bis(2-chloroethyl) ether	3.11E+00	c	1.57E+01	c	1.95E+00	c	1.36E-01	c	3.03E-05	6.05E-04
Bis(2-chloroisopropyl) ether	9.93E+01	c	5.19E+02	cs	3.54E+03	cs	9.76E+00	c	2.37E-03	4.73E-02
Bis(2-ethylhexyl) phthalate	3.80E+02	c	1.83E+03	c	5.38E+03	n	5.56E+01	c	9.99E+00	2.00E+02
Bis(chloromethyl) ether	2.08E-03	c	1.02E-02	c	4.81E-02	c	7.20E-04	c	1.50E-07	3.00E-06
Boron	1.56E+04	n	2.59E+05	nl	5.14E+04	n	3.95E+03	n	1.25E+01	2.51E+02
Bromodichloromethane	6.19E+00	c	3.02E+01	c	1.43E+02	c	1.34E+00	c	3.10E-04	6.21E-03
Bromomethane	1.77E+01	n	9.45E+01	n	1.79E+01	n	7.54E+00	n	1.71E-03	3.43E-02
1,3-Butadiene	6.86E-01	c	3.41E+00	c	2.02E+00	n	1.80E-01	c	1.04E-04	2.07E-03

Chemical	**Residential Soil (mg/kg)**	**End-point**	**Industrial/ Occupational Soil (mg/kg)**	**End-point**	**Construction Worker Soil (mg/kg)**	**End-point**	**Tap Water (ug/L)**	**End-point**	**Risk-based SSL for a DAF of 1 (mg/kg)**	**Risk-based SSL for a DAF of 20 (mg/kg)**
2-Butanone (Methyl ethyl ketone, MEK)	3.74E+04	n	4.11E+05	nls	9.17E+04	ns	5.56E+03	n	1.00E+00	2.01E+01
tert-Butyl methyl ether (MTBE)	9.75E+02	c	4.82E+03	c	2.42E+04	cs	1.43E+02	c	2.77E-02	5.53E-01
Cadmium	7.05E+01	n	1.11E+03	n	7.21E+01	n	6.24E+00	n	4.69E-01	9.39E+00
Carbon disulfide	1.55E+03	ns	8.54E+03	ns	1.62E+03	ns	8.10E+02	n	2.21E-01	4.42E+00
Carbon tetrachloride	1.07E+01	c	5.25E+01	c	2.02E+02	n	4.53E+00	c	1.66E-03	3.33E-02
Chlordane	1.77E+01	c	8.90E+01	c	1.53E+02	n	2.23E+00	c	1.13E-01	2.26E+00
2-Chloroacetophenone	1.72E+05	nl	8.12E+05	nl	2.81E+02	n				
2-Chloro-1,3-butadiene	1.75E-01	c	8.48E-01	c	3.95E+00	c	1.87E-01	c	9.83E-05	1.97E-03
1-Chloro-1,1-difluoroethane	1.09E+05	nls	5.15E+05	nls	9.58E+04	ns	1.04E+05	n	5.34E+01	1.07E+03
Chlorobenzene	3.78E+02	ns	2.16E+03	ns	4.12E+02	ns	7.76E+01	n	4.18E-02	8.36E-01
1-Chlorobutane	3.13E+03	ns	5.19E+04	ns	1.42E+04	ns	6.31E+02	n	2.27E-01	4.53E+00
Chlorodifluoromethane	1.02E+05	nls	4.83E+05	nls	8.98E+04	ns	1.04E+05	n	4.27E+01	8.55E+02
Chloroform	5.90E+00	c	2.87E+01	c	1.34E+02	c	2.29E+00	c	5.46E-04	1.09E-02
Chloromethane	4.11E+01	c	2.01E+02	c	2.35E+02	n	2.03E+01	c	4.76E-03	9.51E-02
b-Chloronaphthalene	6.26E+03	n	1.04E+05	nl	2.83E+04	ns	7.33E+02	n	2.85E+00	5.70E+01
o-Chloronitrobenzene	1.78E+01	c	8.55E+01	c	8.39E+01	n	2.35E+00	c	1.71E-03	3.42E-02
p-Chloronitrobenzene	6.16E+01	n	9.16E+02	n	2.57E+02	n	1.79E+01	n	1.28E-02	2.57E-01
2-Chlorophenol	3.91E+02	n	6.49E+03	n	1.77E+03	n	9.10E+01	n	5.76E-02	1.15E+00
2-Chloropropane	2.86E+02	n	1.35E+03	ns	2.51E+02	ns	2.09E+02	n	6.31E-02	1.26E+00
o-Chlorotoluene	1.56E+03	ns	2.60E+04	ns	7.08E+03	ns	2.33E+02	n	1.78E-01	3.56E+00
Chromium III	1.17E+05	nl	1.95E+06	nl	5.31E+05	nl	1.36E+04	n	2.46E+07	4.91E+08
Chromium VI	3.05E+00	c	7.21E+01	c	6.69E+01	c	2.52E-01	c	4.84E-03	9.68E-02
Chromium (Total)	9.66E+01	c	5.05E+02	c	1.34E+02	n	5.59E+00	c	1.01E+04	2.01E+05
Chrysene	1.53E+02	c	3.23E+03	c	2.31E+04	c	3.43E+01	c	9.30E+00	1.86E+02
Copper	3.13E+03	n	5.19E+04	n	1.42E+04	n	7.90E+02	n	2.78E+01	5.56E+02
Crotonaldehyde	3.66E+00	c	1.91E+01	c	1.30E+02	c	4.04E-01	c	7.11E-05	1.42E-03
Cumene (isopropylbenzene)	2.36E+03	ns	1.42E+04	ns	2.74E+03	ns	4.47E+02	n	5.69E-01	1.14E+01
Cyanide	1.12E+01	n	6.33E+01	n	1.21E+01	n	1.46E+00	n	2.61E-04	5.22E-03
Cyanogen	7.82E+01	n	1.30E+03	n	3.54E+02	n	1.99E+01	n	4.01E-03	8.01E-02
Cyanogen bromide	7.04E+03	n	1.17E+05	nl	3.19E+04	n	1.80E+03	n	5.29E-01	1.06E+01
Cyanogen chloride	3.91E+03	n	6.49E+04	n	1.77E+04	n	9.99E+02	n	2.94E-01	5.88E+00
DDD	2.22E+01	c	1.07E+02	c	7.78E+02	c	3.06E-01	c	5.39E-02	1.08E+00
DDE	1.57E+01	c	7.55E+01	c	5.49E+02	c	2.29E+00	c	4.04E-01	8.08E+00

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	Tap Water (ug/L)	End-point	Risk-based SSL for a DAF of 1 (mg/kg)	Risk-based SSL for a DAF of 20 (mg/kg)
DDT	1.87E+01	c	9.50E+01	c	1.62E+02	n	2.29E+00	c	5.80E-01	1.16E+01
Dibenz(a,h)anthracene	1.53E-01	c	3.23E+00	c	2.40E+01	c	1.06E-01	c	3.05E-01	6.11E+00
1,2-Dibromo-3-chloropropane	8.58E-02	c	1.18E+00	c	5.53E+00	c	3.36E-03	c	1.17E-06	2.34E-05
Dibromochloromethane	1.39E+01	c	6.74E+01	c	3.40E+02	c	1.68E+00	c	3.77E-04	7.54E-03
1,2-Dibromoethane	6.72E-01	c	3.31E+00	c	1.63E+01	c	7.46E-02	c	1.76E-05	3.52E-04
1,4-Dichloro-2-butene	1.15E-01	c	5.58E-01	c	2.59E+00	c	1.34E-02	c	5.00E-06	9.99E-05
1,2-Dichlorobenzene	2.15E+03	ns	1.30E+04	ns	2.50E+03	ns	3.02E+02	n	2.29E-01	4.58E+00
1,4-Dichlorobenzene	3.28E+01	c	1.59E+02	c	7.46E+02	c	4.81E+00	c	3.60E-03	7.20E-02
3,3-Dichlorobenzidine	1.18E+01	c	5.70E+01	c	4.10E+02	c	1.24E+00	c	6.14E-03	1.23E-01
Dichlorodifluoromethane	1.82E+02	n	8.65E+02	ns	1.61E+02	n	1.97E+02	n	3.61E-01	7.23E+00
1,1-Dichloroethane	7.86E+01	c	3.83E+02	c	1.82E+03	cs	2.75E+01	c	6.79E-03	1.36E-01
1,2-Dichloroethane	8.32E+00	c	4.07E+01	c	5.38E+01	n	1.71E+00	c	4.07E-04	8.14E-03
cis-1,2-Dichloroethene	1.56E+02	n	2.60E+03	ns	7.08E+02	n	3.65E+01	n	9.18E-03	1.84E-01
trans-1,2-Dichloroethene	2.95E+02	n	1.61E+03	ns	3.05E+02	n	9.32E+01	n	2.35E-02	4.69E-01
1,1-Dichloroethene	4.40E+02	n	2.26E+03	ns	4.24E+02	n	2.84E+02	n	9.74E-02	1.95E+00
2,4-Dichlorophenol	1.85E+02	n	2.75E+03	n	8.07E+02	n	4.53E+01	n	4.13E-02	8.25E-01
1,2-Dichloropropane	1.78E+01	c	8.68E+01	c	2.54E+01	n	4.37E+00	c	1.21E-03	2.43E-02
1,3-Dichloropropene	2.93E+01	c	1.46E+02	c	1.30E+02	n	4.70E+00	c	1.40E-03	2.80E-02
Dicyclopentadiene	1.73E+00	n	8.14E+00	n	1.51E+00	n	6.25E-01	n	1.71E-03	3.42E-02
Dieldrin	3.33E-01	c	1.60E+00	c	1.17E+01	c	1.71E-02	c	5.18E-04	1.04E-02
Diethyl phthalate	4.93E+04	n	7.33E+05	nl	2.15E+05	nl	1.48E+04	n	4.89E+00	9.79E+01
Di-n-butyl phthalate (Dibutyl phthalate)	6.16E+03	n	9.16E+04	n	2.69E+04	n	8.85E+02	n	1.69E+00	3.38E+01
2,4-Dimethylphenol	1.23E+03	n	1.83E+04	n	5.38E+03	n	3.54E+02	n	3.22E-01	6.45E+00
4,6-Dinitro-o-cresol	4.93E+00	n	7.33E+01	n	2.15E+01	n	1.51E+00	n	1.97E-03	3.94E-02
2,4-Dinitrophenol	1.23E+02	n	1.83E+03	n	5.38E+02	n	3.88E+01	n	3.35E-02	6.71E-01
2,4-Dinitrotoluene	1.71E+01	c	8.23E+01	c	5.36E+02	n	2.37E+00	c	2.46E-03	4.91E-02
2,6-Dintitrotoluene	3.56E+00	c	1.72E+01	c	8.09E+01	n	4.84E-01	c	5.10E-04	1.02E-02
2,4/2,6-Dintrotoluene Mixture	7.83E+00	c	3.77E+01	c	2.77E+02	c	1.06E+00	c	1.12E-03	2.23E-02
1,4-Dioxane	5.33E+01	c	2.57E+02	c	1.88E+03	c	7.76E+00	c	1.38E-03	2.75E-02
1,2-Diphenylhydrazine	6.66E+00	c	3.21E+01	c	2.34E+02	c	7.73E-01	c	1.88E-03	3.76E-02
Endosulfan	3.70E+02	n	5.50E+03	n	1.61E+03	n	9.87E+01	n	1.02E+00	2.04E+01
Endrin	1.85E+01	n	2.75E+02	n	8.07E+01	n	2.23E+00	n	6.77E-02	1.35E+00
Epichlorohydrin	4.27E+01	n	2.15E+02	n	4.02E+01	n	2.05E+00	n	3.86E-04	7.72E-03

Chemical	**Residential Soil (mg/kg)**	**End-point**	**Industrial/ Occupational Soil (mg/kg)**	**End-point**	**Construction Worker Soil (mg/kg)**	**End-point**	**Tap Water (ug/L)**	**End-point**	**Risk-based SSL for a DAF of 1 (mg/kg)**	**Risk-based SSL for a DAF of 20 (mg/kg)**
Ethyl acetate	1.82E+03	n	8.75E+03	n	1.63E+03	n	1.45E+02	n	2.64E-02	5.28E-01
Ethyl acrylate	1.45E+02	c	7.57E+02	c	5.16E+03	cs	1.56E+01	c	2.99E-03	5.97E-02
Ethyl chloride	1.90E+04	ns	8.95E+04	ns	1.66E+04	ns	2.09E+04	n	5.37E+00	1.07E+02
Ethyl ether	1.56E+04	ns	2.60E+05	nls	7.08E+04	ns	3.93E+03	n	7.60E-01	1.52E+01
Ethyl methacrylate	2.73E+03	ns	1.78E+04	ns	3.48E+03	ns	4.55E+02	n	9.15E-02	1.83E+00
Ethylbenzene	7.51E+01	c	3.68E+02	cs	1.77E+03	cs	1.49E+01	c	1.31E-02	2.62E-01
Ethylene oxide	5.02E+00	c	2.48E+01	c	1.23E+02	c	5.08E-01	c	9.09E-05	1.82E-03
Fluoranthene	2.32E+03	n	3.37E+04	n	1.00E+04	n	8.02E+02	n	6.69E+01	1.34E+03
Fluorene	2.32E+03	n	3.37E+04	n	1.00E+04	n	2.88E+02	n	4.00E+00	8.00E+01
Fluoride	4.69E+03	n	7.78E+04	n	1.81E+04	n	1.18E+03	n	1.78E+02	3.56E+03
Furan	7.24E+01	n	1.15E+03	n	3.54E+02	n	1.92E+01	n	6.12E-03	1.22E-01
Heptachlor	1.18E+00	c	5.70E+00	c	4.15E+01	c	4.39E-02	c	2.73E-03	5.45E-02
Hexachlorobenzene	3.33E+00	c	1.60E+01	c	1.17E+02	c	4.87E-01	c	4.61E-03	9.22E-02
Hexachloro-1,3-butadiene	6.16E+01	n	3.29E+02	c	2.69E+02	n	2.95E+00	c	4.39E-03	8.79E-02
Hexachlorocyclopentadiene	3.70E+02	n	5.49E+03	n	8.67E+02	n	2.78E+01	n	6.68E-02	1.34E+00
Hexachloroethane	4.31E+01	n	6.41E+02	c	1.88E+02	n	6.80E+00	n	3.31E-03	6.62E-02
n-Hexane	6.15E+02	ns	3.20E+03	ns	6.03E+02	ns	3.19E+02	n	2.78E+00	5.57E+01
HMX	3.85E+03	n	6.33E+04	n	1.74E+04	n	1.00E+03	n	9.72E-01	1.94E+01
Hydrazine anhydride	1.78E+00	c	8.55E+00	c	5.99E+01	c	2.60E-01	c	4.50E-05	9.00E-04
Hydrogen cyanide	1.02E+01	n	5.72E+01	n	1.09E+01	n	1.46E+00	n	2.61E-04	5.22E-03
Indeno(1,2,3-c,d)pyrene	1.53E+00	c	3.23E+01	c	2.40E+02	c	3.43E-01	c	1.00E+00	2.01E+01
Iron	5.48E+04	n	9.08E+05	nl	2.48E+05	nl	1.38E+04	n	3.48E+02	6.96E+03
Isobutanol (Isobutyl alcohol)	1.85E+04	n	2.75E+05	nl	8.07E+04	n	5.91E+03	n	1.05E+00	2.10E+01
Isophorone	5.61E+03	c	2.70E+04	c	5.37E+04	n	7.79E+02	c	2.11E-01	4.22E+00
Lead	4.00E+02	IEUBK	8.00E+02	IEUBK	8.00E+02	IEUBK				
Lead (tetraethyl-)	6.16E-03	n	9.16E-02	n	3.54E-02	n	1.24E-03	n	4.70E-06	9.41E-05
Maleic hydrazide	3.08E+04	n	4.58E+05	nl	1.35E+05	nl	1.00E+04	n	1.79E+00	3.57E+01
Manganese	1.05E+04	n	1.60E+05	nl	4.64E+02	n	2.02E+03	n	1.31E+02	2.63E+03
Mercury (elemental)	2.38E+01	ns	1.12E+02	ns	2.07E+01	ns	6.26E-01	n	3.27E-02	6.54E-01
Mercury (methyl)	7.82E+00	n	1.30E+02	n	3.54E+01	n	1.96E+00	n	4.45E-04	8.89E-03
Mercury (salts)	2.35E+01	n	3.89E+02	ns	7.71E+01	n	4.92E+00	n	2.56E-01	5.13E+00
Methacrylonitrile	7.70E+00	n	1.23E+02	n	3.28E+01	n	1.91E+00	n	3.71E-04	7.43E-03
Methomyl	1.54E+03	n	2.29E+04	n	6.73E+03	n	4.98E+02	n	9.37E-02	1.87E+00

Chemical	**Residential Soil (mg/kg)**	**End-point**	**Industrial/ Occupational Soil (mg/kg)**	**End-point**	**Construction Worker Soil (mg/kg)**	**End-point**	**Tap Water (ug/L)**	**End-point**	**Risk-based SSL for a DAF of 1 (mg/kg)**	**Risk-based SSL for a DAF of 20 (mg/kg)**
Methyl acetate	7.82E+04	ns	1.30E+06	nls	3.54E+05	nls	1.99E+04	n	3.55E+00	7.11E+01
Methyl acrylate	3.50E+02	n	1.85E+03	n	3.48E+02	n	3.90E+01	n	7.13E-03	1.43E-01
Methyl isobutyl ketone	5.81E+03	ns	8.16E+04	ns	2.02E+04	ns	1.24E+03	n	2.40E-01	4.80E+00
Methyl methacrylate	1.11E+04	ns	5.65E+04	ns	1.06E+04	ns	1.39E+03	n	2.61E-01	5.22E+00
Methyl styrene (alpha)	5.48E+03	ns	9.08E+04	ns	2.48E+04	ns	7.65E+02	n	9.43E-01	1.89E+01
Methyl styrene (mixture)	2.73E+02	ns	2.20E+03	ns	4.49E+02	ns	3.73E+01	n	4.70E-02	9.40E-01
Methylcyclohexane	5.50E+03	ns	2.59E+04	ns	4.82E+03	ns	6.26E+03	n	1.58E+01	3.16E+02
Methylene bromide (Dibromomethane)	5.79E+01	n	2.88E+02	n	5.39E+01	n	8.00E+00	n	1.68E-03	3.35E-02
Methylene chloride	4.09E+02	n	5.13E+03	ns	1.21E+03	n	1.06E+02	n	2.35E-02	4.71E-01
Molybdenum	3.91E+02	n	6.49E+03	n	1.77E+03	n	9.87E+01	n	1.99E+00	3.98E+01
Naphthalene	4.97E+01	c	2.41E+02	c	1.59E+02	n	1.65E+00	c	4.11E-03	8.23E-02
Nickel	1.56E+03	n	2.57E+04	n	7.53E+02	n	3.72E+02	n	2.42E+01	4.85E+02
Nitrate	1.25E+05	nl	2.08E+06	nl	5.66E+05	nl	3.16E+04	n	2.13E+01	4.25E+02
Nitrite	7.82E+03	n	1.30E+05	nl	3.54E+04	n	1.97E+03	n	1.33E+00	2.66E+01
Nitrobenzene	6.04E+01	c	2.93E+02	c	3.53E+02	n	1.40E+00	c	7.20E-04	1.44E-02
Nitroglycerin	6.16E+00	n	9.16E+01	n	2.69E+01	n	1.96E+00	n	6.80E-04	1.36E-02
N-Nitrosodiethylamine	7.94E-03	c	1.71E-01	c	1.25E+00	c	1.65E-03	c	4.92E-07	9.84E-06
N-Nitrosodimethylamine	2.34E-02	c	5.03E-01	c	2.14E+00	n	4.90E-03	c	1.02E-06	2.03E-05
N-Nitrosodi-n-butylamine	7.81E-01	c	3.77E+00	c	2.46E+01	c	2.72E-02	c	4.21E-05	8.41E-04
N-Nitrosodiphenylamine	1.09E+03	c	5.24E+03	c	3.79E+04	c	1.21E+02	c	4.98E-01	9.95E+00
N-Nitrosopyrrolidine	2.54E+00	c	1.22E+01	c	8.89E+01	c	3.70E-01	c	1.15E-04	2.30E-03
m-Nitrotoluene	6.16E+00	n	9.16E+01	n	2.69E+01	n	1.74E+00	n	1.25E-03	2.50E-02
o-Nitrotoluene	3.16E+01	c	1.65E+02	c	3.19E+02	n	3.13E+00	c	2.28E-03	4.56E-02
p-Nitrotoluene	2.47E+02	n	1.60E+03	c	1.08E+03	n	4.24E+01	c	3.05E-02	6.09E-01
Pentachlorobenzene	4.93E+01	n	7.33E+02	n	2.15E+02	n	3.07E+00	n	1.76E-02	3.52E-01
Pentachlorophenol	9.85E+00	c	4.45E+01	c	3.46E+02	c	4.00E-01	c	3.04E-03	6.08E-02
Perchlorate	5.48E+01	n	9.08E+02	ns	2.48E+02	n	1.38E+01	n	5.85E-03	1.17E-01
Phenanthrene	1.74E+03	n	2.53E+04	n	7.53E+03	n	1.70E+02	n	4.30E+00	8.59E+01
Phenol	1.85E+04	n	2.75E+05	nl	7.74E+04	n	5.76E+03	n	2.62E+00	5.23E+01
Polychlorinatedbiphenyls (PCBs)										
Aroclor 1016	3.98E+00	n	5.74E+01	n	1.72E+01	n	1.40E+00	n	1.01E-01	2.01E+00
Aroclor 1221	1.81E+00	c	8.57E+00	c	5.53E+01	cs	5.54E-02	c	7.08E-04	1.42E-02
Aroclor 1232	1.86E+00	c	8.82E+00	c	5.76E+01	cs	5.54E-02	c	7.08E-04	1.42E-02

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	Tap Water (ug/L)	End-point	Risk-based SSL for a DAF of 1 (mg/kg)	Risk-based SSL for a DAF of 20 (mg/kg)
Aroclor 1242	2.43E+00	c	1.15E+01	c	8.53E+01	c	3.89E-01	c	4.57E-02	9.14E-01
Aroclor 1248	2.43E+00	c	1.15E+01	c	8.53E+01	c	3.89E-01	c	4.48E-02	8.96E-01
Aroclor 1254	1.14E+00	n	1.15E+01	c	4.91E+00	n	3.89E-01	c	7.63E-02	1.53E+00
Aroclor 1260	2.43E+00	c	1.15E+01	c	8.53E+01	c	3.89E-01	c	2.04E-01	4.09E+00
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)	3.75E-01	c	1.77E+00	c	1.72E+00	n	5.99E-02	c	3.21E-02	6.42E-01
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)	3.75E+00	c	1.77E+01	c	1.72E+01	n	5.99E-01	c	3.14E-01	6.29E+00
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)	1.25E+00	c	5.89E+00	c	5.73E+00	n	2.00E-01	c	1.05E-01	2.10E+00
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)	1.25E+00	c	5.89E+00	c	5.73E+00	n	2.00E-01	c	6.27E-02	1.25E+00
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)	1.25E+00	c	5.89E+00	c	5.73E+00	n	2.00E-01	c	6.40E-02	1.28E+00
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)	1.25E+00	c	5.89E+00	c	5.73E+00	n	2.00E-01	c	6.40E-02	1.28E+00
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)	1.25E-03	c	5.89E-03	c	5.73E-03	n	2.00E-04	c	6.27E-05	1.25E-03
2',3,4,4',5-Pentachlorobiphenyl (PCB 123)	1.25E+00	c	5.89E+00	c	5.73E+00	n	2.00E-01	c	3.91E-02	7.83E-01
2',3',4,4',5-Pentachlorobiphenyl (PCB 118)	1.25E+00	c	5.89E+00	c	5.73E+00	n	2.00E-01	c	3.84E-02	7.67E-01
2',3,3',4,4'-Pentachlorobiphenyl (PCB 105)	1.25E+00	c	5.89E+00	c	5.73E+00	n	2.00E-01	c	3.91E-02	7.83E-01
2,3,4,4',5-Pentachlorobiphenyl (PCB 114)	1.25E+00	c	5.89E+00	c	5.73E+00	n	2.00E-01	c	3.91E-02	7.83E-01
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)	3.75E-04	c	1.77E-03	c	1.72E-03	n	5.99E-05	c	1.15E-05	2.30E-04
3,3',4,4'-Tetrachlorobiphenyl (PCB 77)	3.75E-01	c	1.77E+00	c	1.72E+00	n	5.99E-02	c	7.03E-03	1.41E-01
3,4,4',5-Tetrachlorobiphenyl (PCB 81)	1.25E-01	c	5.89E-01	c	5.73E-01	n	2.00E-02	c	2.34E-03	4.69E-02
Propylene oxide	2.56E+01	c	1.33E+02	c	7.99E+02	n	2.66E+00	c	4.82E-04	9.65E-03
Pyrene	1.74E+03	n	2.53E+04	n	7.53E+03	n	1.17E+02	n	9.59E+00	1.92E+02
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine	6.04E+01	c	3.11E+02	c	1.01E+03	n	7.02E+00	c	2.16E-03	4.31E-02
Selenium	3.91E+02	n	6.49E+03	n	1.75E+03	n	9.87E+01	n	5.11E-01	1.02E+01
Silver	3.91E+02	n	6.49E+03	n	1.77E+03	n	8.12E+01	n	6.88E-01	1.38E+01
Strontium	4.69E+04	n	7.79E+05	nl	2.12E+05	nl	1.18E+04	n	4.17E+02	8.33E+03
Styrene	7.26E+03	ns	5.13E+04	ns	1.02E+04	ns	1.21E+03	n	1.03E+00	2.06E+01
Sulfolane	6.16E+01	n	9.16E+02	n	2.65E+02	n	2.00E+01	n	3.75E-03	7.49E-02
2,3,7,8-TCDD	4.90E-05	c	2.48E-04	c	2.26E-04	n	5.99E-06	c	2.24E-06	4.48E-05
2,3,7,8-TCDF	4.90E-04	c	2.48E-03	c	1.72E-02	c	2.01E-06	c	4.22E-07	8.44E-06
1,2,4,5-Tetrachlorobenzene	1.85E+01	n	2.75E+02	n	8.07E+01	n	1.66E+00	n	5.83E-03	1.17E-01
1,1,1,2-Tetrachloroethane	2.81E+01	c	1.37E+02	c	6.59E+02	cs	5.72E+00	c	1.80E-03	3.59E-02
1,1,2,2-Tetrachloroethane	7.98E+00	c	3.94E+01	c	1.97E+02	c	7.57E-01	c	2.40E-04	4.80E-03
Tetrachloroethene	1.11E+02	ns	6.29E+02	ns	1.20E+02	ns	4.03E+01	n	1.60E-02	3.21E-01
Tetryl (Trinitrophenylmethylnitramine)	1.56E+02	n	2.59E+03	n	7.06E+02	n	3.94E+01	n	2.79E-01	5.59E+00

Chemical	**Residential Soil (mg/kg)**	**End-point**	**Industrial/ Occupational Soil (mg/kg)**	**End-point**	**Construction Worker Soil (mg/kg)**	**End-point**	**Tap Water (ug/L)**	**End-point**	**Risk-based SSL for a DAF of 1 (mg/kg)**	**Risk-based SSL for a DAF of 20 (mg/kg)**
Thallium	7.82E-01	n	1.30E+01	n	3.54E+00	n	1.97E-01	n	1.41E-02	2.81E-01
Toluene	5.23E+03	ns	6.13E+04	ns	1.40E+04	ns	1.09E+03	n	6.07E-01	1.21E+01
Toxaphene	4.84E+00	c	2.33E+01	c	1.70E+02	c	1.53E-01	c	1.77E-02	3.54E-01
Tribromomethane (Bromoform)	6.74E+02	c	3.25E+03	c	5.38E+03	n	9.19E+01	c	2.05E-02	4.11E-01
1,1,2-Trichloro-1,2,2-trifluoroethane	5.08E+04	ns	2.43E+05	nls	4.53E+04	ns	5.50E+04	n	1.60E+02	3.20E+03
1,2,4-Trichlorobenzene	8.29E+01	n	4.23E+02	ns	7.91E+01	n	3.98E+00	n	8.82E-03	1.76E-01
1,1,1-Trichloroethane	1.44E+04	ns	7.25E+04	ns	1.36E+04	ns	8.00E+03	n	2.55E+00	5.11E+01
1,1,2-Trichloroethane	2.61E+00	n	1.24E+01	n	2.30E+00	n	4.15E-01	n	1.11E-04	2.23E-03
Trichloroethylene	6.77E+00	n	3.65E+01	n	6.90E+00	n	2.82E+00	n	8.75E-04	1.75E-02
Trichlorofluoromethane	1.23E+03	ns	6.03E+03	ns	1.13E+03	ns	1.14E+03	n	7.84E-01	1.57E+01
2,4,5-Trichlorophenol	6.16E+03	n	9.16E+04	n	2.69E+04	n	1.17E+03	n	3.31E+00	6.62E+01
2,4,6-Trichlorophenol	6.16E+01	n	9.16E+02	n	2.69E+02	n	1.19E+01	n	3.37E-02	6.74E-01
1,1,2-Trichloropropane	3.91E+02	n	6.49E+03	ns	1.77E+03	ns	8.81E+01	n	2.79E-02	5.59E-01
1,2,3-Trichloropropane	5.10E-02	c	1.21E+00	c	6.31E+00	n	7.47E-03	c	2.60E-06	5.21E-05
Triethylamine	1.93E+02	n	9.09E+02	n	1.69E+02	n	1.46E+01	n	3.65E-03	7.31E-02
2,4,6-Trinitrotoluene	3.60E+01	n	5.73E+02	n	1.61E+02	n	9.80E+00	n	4.30E-02	8.61E-01
Uranium (soluable salts)	2.34E+02	n	3.88E+03	ns	2.77E+02	ns	5.92E+01	n	2.67E+01	5.33E+02
Vanadium	3.94E+02	n	6.53E+03	n	6.14E+02	n	6.31E+01	n	6.31E+01	1.26E+03
Vinyl acetate	2.56E+03	n	1.24E+04	ns	2.30E+03	ns	4.09E+02	n	7.52E-02	1.50E+00
Vinyl bromide	2.71E+00	c	1.31E+01	c	8.46E+00	n	1.75E+00	c	4.62E-04	9.23E-03
Vinyl chloride	7.42E-01	c	2.84E+01	c	1.61E+02	c	2.01E-01	c	6.75E-05	1.35E-03
m-Xylene	7.64E+02	ns	3.73E+03	ns	6.96E+02	ns	1.93E+02	n	1.48E-01	2.97E+00
o-Xylene	8.05E+02	ns	3.94E+03	ns	7.36E+02	ns	1.93E+02	n	1.49E-01	2.98E+00
Xylenes	8.71E+02	ns	4.28E+03	ns	7.98E+02	ns	1.93E+02	n	1.49E-01	2.98E+00
Zinc	2.35E+04	n	3.89E+05	nl	1.06E+05	nl	5.96E+03	n	3.71E+02	7.41E+03

c – carcinogen
cs - carcinogenic, SSL may exceed saturation
DAF – Dilution Attenuation Factor
mg/kg – milligrams per kilogram
n – noncarcinogenic
nl - noncarcinogen, SSL may exceed ceiling limit
ns - noncarcinogen, SSL may exceed saturation
nls - noncarcinogen, SSL may exceed both saturation and ceiling limit
SSL – Soil Screening Level
µg/L – micrograms per liter

Table A-2 **Default Exposure Factors**			
Symbol	**Definition (units)**	**Default**	**Reference**
CSF_o	Cancer slope factor oral $(mg/kg\text{-}day)^{-1}$	Chem.-spec.	See Appendix C
IUR	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Chem.-spec.	See Appendix C
RfD_o	Reference dose oral (mg/kg-day)	Chem.-spec.	See Appendix C
RfC	Inhalation Reference Concentration (mg/m^3)	Chem.-spec.	See Appendix C
TR	Target cancer risk	1E-05	NMED-specified value
THQ	Target hazard quotient	1	NMED-specified value
BW	Body weight (kg)		
	-- adult	80	US EPA, 2014
	-- child	15	US EPA, 2014
AT	Averaging time (days)		
	-- carcinogens	25550	US EPA, 2014
	-- noncarcinogens	ED*365	
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chem.-spec.	See Appendix C
SA	Exposed surface area for soil/dust (cm^2/day)		
	– adult resident	6,032	US EPA, 2014
	– adult worker	3,470	US EPA, 2014
	-- child	2,690	US EPA, 2014
SA	Exposed surface area for water exposure (cm^2)		
	– adult resident	20,900	US EPA, 2014
	– child resident	6,378	US EPA, 2014
AF	Adherence factor, soils (mg/cm^2)		
	– adult resident	0.07	US EPA, 2014
	– adult worker	0.12	US EPA, 2014
	-- child resident	0.2	US EPA, 2014

	– construction worker	0.3	US EPA, 2014
ABS	Skin absorption defaults (unitless):		
	– semi-volatile organics	Chem.-spec.	See Appendix C
	– volatile organics	Chem.-spec.	See Appendix C
	– inorganics	Chem.-spec.	See Appendix C
IRW	Drinking water ingestion rate (L/day)		
	-- adult	2.5	US EPA, 2014
	-- child	0.78	US EPA, 2014
IRS	Soil ingestion (mg/day)		
	-- adult resident	100	US EPA, 2014
	-- child resident	200	US EPA, 2014
	-- commercial/industrial worker	100	US EPA, 2002
	construction worker	330	US EPA, 2002
EF	Exposure frequency (days/yr)		
	-- residential	350	US EPA, 2014
	-- commercial/industrial	225	US EPA, 2002
	– construction worker	250	US EPA, 2002
ED	Exposure duration (years)		
	-- residential	20[a]	US EPA, 2014
	-- child	6	US EPA, 1991
	-- commercial/industrial	25	US EPA, 2014
	– construction worker	1	US EPA, 2002
ET	Exposure time (unitless)		
	--residential	1	24 hours/day
	--commercial/industrial	0.33	8 hours/day
	--construction worker	0.33	8 hours/day
t_{event_a}	Dermal exposure time per event, water, adult resident (hours/event)	0.71	US EPA, 2014
t_{event_c}	Dermal exposure time per event, water, child resident (hours/event)	0.54	US EPA, 2014
PEF	Particulate emission factor (m^3/kg)	Chem.-spec.	US EPA, 2002

VFs	Volatilization factor for soil (m^3/kg)	Chem.-spec.	US EPA, 2002
K	Andelman volatilization factor for water (L/m^3)	0.5	US EPA, 1991
C_{sat}	Soil saturation concentration (mg/kg)	Chem.-spec.	US EPA, 2002

[a] Exposure duration for lifetime residents is assumed to be 26 years total. For carcinogens, exposures are combined for children (6 years) and adults (20 years).
Chem.-spec.- Chemical-specific value

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Table A-3. NMED Vapor Intrusion Screening Levels (VISLs)

Chemical	Residential Indoor Air (μg/m³)	Endpoint	Residential Soil-gas (μg/m³)	Residential Groundwater (μg/L)	Industrial/ Occupational Indoor Air (μg/m³)	Endpoint	Industrial/ OccupationalSoil -gas (μg/m³)	Industrial/ Occupational Groundwater (μg/L)
Acetaldehyde	9.39E+00	n	9.39E+01	3.43E+03	4.42E+01	n	4.42E+02	1.62E+04
Acetone	3.23E+04	n	3.23E+05	2.25E+07	1.52E+05	n	1.52E+06	1.06E+08
Acrylonitrile	4.13E-01	c	4.13E+00	7.30E+01	2.02E+00	c	2.02E+01	3.58E+02
Acrolein	2.09E-02	n	2.09E-01	4.17E+00	9.83E-02	n	9.83E-01	1.97E+01
Benzene	3.60E+00	c	3.60E+01	1.58E+01	1.76E+01	c	1.76E+02	7.76E+01
1,1-Biphenyl	4.17E-01	n	4.17E+00	3.30E+01	1.97E+00	n	1.97E+01	1.56E+02
Bis(2-chloroethyl) ether	8.51E-02	c	8.51E-01	1.22E+02	4.17E-01	c	4.17E+00	5.98E+02
Bis(chloromethyl) ether	4.53E-04	c	4.53E-03	2.53E-03	2.22E-03	c	2.22E-02	1.24E-02
Bromodichloromethane	7.59E-01	c	7.59E+00	8.73E+00	3.72E+00	c	3.72E+01	4.28E+01
Bromomethane	5.21E+00	n	5.21E+01	1.73E+01	2.46E+01	n	2.46E+02	8.17E+01
1,3-Butadiene	9.36E-01	c	9.36E+00	3.10E-01	4.59E+00	c	4.59E+01	1.52E+00
2-Butanone (Methyl ethyl ketone, MEK)	5.21E+03	n	5.21E+04	2.24E+06	2.46E+04	n	2.46E+05	1.05E+07
tert-Butyl methyl ether (MTBE)	1.08E+02	c	1.08E+03	4.49E+03	5.29E+02	c	5.29E+03	2.20E+04
Carbon disulfide	7.30E+02	n	7.30E+03	1.24E+03	3.44E+03	n	3.44E+04	5.83E+03
Carbon tetrachloride	4.68E+00	c	4.68E+01	4.14E+00	2.29E+01	c	2.29E+02	2.03E+01
2-Chloro-1,3-butadiene	9.36E-02	c	9.36E-01	4.07E-02	4.59E-01	c	4.59E+00	1.99E-01
1-Chloro-1,1-difluoroethane	5.21E+04	n	5.21E+05	2.16E+04	2.46E+05	n	2.46E+06	1.02E+05
Chlorobenzene	5.21E+01	n	5.21E+02	4.09E+02	2.46E+02	n	2.46E+03	1.93E+03
Chlorodifluoromethane	5.21E+04	n	5.21E+05	3.13E+04	2.46E+05	n	2.46E+06	1.48E+05
Chloroform	1.22E+00	c	1.22E+01	8.11E+00	5.98E+00	c	5.98E+01	3.98E+01
Chloromethane	1.56E+01	c	1.56E+02	4.31E+01	7.65E+01	c	7.65E+02	2.11E+02

Chemical	**Residential Indoor Air (µg/m³)**	**Endpoint**	**Residential Soil-gas (µg/m³)**	**Residential Groundwater (µg/L)**	**Industrial/ Occupational Indoor Air (µg/m³)**	**Endpoint**	**Industrial/ OccupationalSoil -gas (µg/m³)**	**Industrial/ Occupational Groundwater (µg/L)**
2-Chloropropane	1.04E+02	n	1.04E+03	1.45E+02	4.92E+02	n	4.92E+03	6.85E+02
Cumene (isopropylbenzene)	4.17E+02	n	4.17E+03	8.85E+02	1.97E+03	n	1.97E+04	4.17E+03
Cyanide	8.34E-01	n	8.34E+00	1.53E+02	3.93E+00	n	3.93E+01	7.21E+02
1,2-Dibromo-3-chloropropane	1.69E-03	c	1.69E-02	2.80E-01	2.29E-02	c	2.29E-01	3.81E+00
Dibromochloromethane	1.04E+00	c	1.04E+01	3.24E+01	5.10E+00	c	5.10E+01	1.59E+02
1,2-Dibromoethane	4.68E-02	c	4.68E-01	1.76E+00	2.29E-01	c	2.29E+00	8.61E+00
1,4-Dichloro-2-butene	6.68E-03	c	6.68E-02	2.46E-01	3.28E-02	c	3.28E-01	1.20E+00
1,2-Dichlorobenzene	2.09E+02	n	2.09E+03	2.65E+03	9.83E+02	n	9.83E+03	1.25E+04
1,4-Dichlorobenzene	2.55E+00	c	2.55E+01	2.58E+01	1.25E+01	c	1.25E+02	1.27E+02
Dichlorodifluoromethane	1.04E+02	n	1.04E+03	7.42E+00	4.92E+02	n	4.92E+03	3.50E+01
1,1-Dichloroethane	1.75E+01	c	1.75E+02	7.62E+01	8.60E+01	c	8.60E+02	3.73E+02
1,2-Dichloroethane	1.08E+00	c	1.08E+01	2.23E+01	5.29E+00	c	5.29E+01	1.09E+02
trans-1,2-Dichloroethene	6.26E+01	n	6.26E+02	3.74E+02	2.95E+02	n	2.95E+03	1.76E+03
1,1-Dichloroethene	2.09E+02	n	2.09E+03	1.95E+02	9.83E+02	n	9.83E+03	9.19E+02
1,2-Dichloropropane	2.81E+00	c	2.81E+01	2.43E+01	1.38E+01	c	1.38E+02	1.19E+02
1,3-Dichloropropene	7.02E+00	c	7.02E+01	4.82E+01	3.44E+01	c	3.44E+02	2.36E+02
Dicyclopentadiene	3.13E-01	n	3.13E+00	1.22E-01	1.47E+00	n	1.47E+01	5.76E-01
Epichlorohydrin	1.04E+00	n	1.04E+01	8.37E+02	4.92E+00	n	4.92E+01	3.94E+03
Ethyl acetate	7.30E+01	n	7.30E+02	1.33E+04	3.44E+02	n	3.44E+03	6.26E+04
Ethyl chloride	1.04E+04	n	1.04E+05	2.29E+04	4.92E+04	n	4.92E+05	1.08E+05
Ethyl methacrylate	3.13E+02	n	3.13E+03	1.33E+04	1.47E+03	n	1.47E+04	6.28E+04
Ethylbenzene	1.12E+01	c	1.12E+02	3.48E+01	5.51E+01	c	5.51E+02	1.70E+02
Ethylene oxide	3.19E-01	c	3.19E+00	5.26E+01	1.56E+00	c	1.56E+01	2.58E+02
n-Hexane	7.30E+02	n	7.30E+03	9.89E+00	3.44E+03	n	3.44E+04	4.66E+01
Hydrogen cyanide	8.34E-01	n	8.34E+00	1.53E+02	3.93E+00	n	3.93E+01	7.21E+02

Chemical	**Residential Indoor Air (µg/m^3)**	**Endpoint**	**Residential Soil-gas (µg/m^3)**	**Residential Groundwater (µg/L)**	**Industrial/ Occupational Indoor Air (µg/m^3)**	**Endpoint**	**Industrial/ OccupationalSoil -gas (µg/m^3)**	**Industrial/ Occupational Groundwater (µg/L)**
Mercury (elemental)	3.13E-01	n	3.13E+00	6.69E-01	1.47E+00	n	1.47E+01	3.16E+00
Methacrylonitrile	3.13E+01	n	3.13E+02	3.09E+03	1.47E+02	n	1.47E+03	1.46E+04
Methyl acrylate	2.09E+01	n	2.09E+02	2.56E+03	9.83E+01	n	9.83E+02	1.21E+04
Methyl isobutyl ketone	3.13E+03	n	3.13E+04	5.53E+05	1.47E+04	n	1.47E+05	2.61E+06
Methyl methacrylate	7.30E+02	n	7.30E+03	5.58E+04	3.44E+03	n	3.44E+04	2.63E+05
Methyl styrene (mixture)	4.17E+01	n	4.17E+02	3.34E+02	1.97E+02	n	1.97E+03	1.57E+03
Methylcyclohexane	3.13E+03	n	3.13E+04	1.77E+02	1.47E+04	n	1.47E+05	8.36E+02
Methylene bromide (Dibromomethane)	4.17E+00	n	4.17E+01	1.24E+02	1.97E+01	n	1.97E+02	5.83E+02
Methylene chloride	6.26E+02	n	6.26E+03	4.70E+03	2.95E+03	n	2.95E+04	2.21E+04
Naphthalene	8.26E-01	c	8.26E+00	4.58E+01	4.05E+00	c	4.05E+01	2.24E+02
Nitrobenzene	7.02E-01	c	7.02E+00	7.13E+02	3.44E+00	c	3.44E+01	3.50E+03
N-Nitrosodi-n-butylamine	1.75E-02	c	1.75E-01	3.24E+01	8.60E-02	c	8.60E-01	1.59E+02
Aroclor 1221	4.93E-02	c	4.93E-01	1.63E+00	2.41E-01	c	2.41E+00	8.00E+00
Aroclor 1232	4.93E-02	c	4.93E-01	1.63E+00	2.41E-01	c	2.41E+00	8.00E+00
Propylene oxide	7.59E+00	c	7.59E+01	2.66E+03	3.72E+01	c	3.72E+02	1.30E+04
Styrene	1.04E+03	n	1.04E+04	9.25E+03	4.92E+03	n	4.92E+04	4.36E+04
1,1,1,2-Tetrachloroethane	3.79E+00	c	3.79E+01	3.70E+01	1.86E+01	c	1.86E+02	1.81E+02
1,1,2,2-Tetrachloroethane	4.84E-01	c	4.84E+00	3.22E+01	2.37E+00	c	2.37E+01	1.58E+02
Tetrachloroethene	4.17E+01	n	4.17E+02	5.75E+01	1.97E+02	n	1.97E+03	2.71E+02
Toluene	5.21E+03	n	5.21E+04	1.92E+04	2.46E+04	n	2.46E+05	9.03E+04
1,1,2-Trichloro-1,2,2-trifluoroethane	3.13E+04	n	3.13E+05	1.45E+03	1.47E+05	n	1.47E+06	6.84E+03
1,2,4-Trichlorobenzene	2.09E+00	n	2.09E+01	3.58E+01	9.83E+00	n	9.83E+01	1.69E+02
1,1,1-Trichloroethane	5.21E+03	n	5.21E+04	7.39E+03	2.46E+04	n	2.46E+05	3.49E+04
1,1,2-Trichloroethane	2.09E-01	n	2.09E+00	6.17E+00	9.83E-01	n	9.83E+00	2.91E+01
Trichloroethylene	2.09E+00	n	2.09E+01	5.16E+00	9.83E+00	n	9.83E+01	2.43E+01

Chemical	**Residential Indoor Air (µg/m³)**	**Endpoint**	**Residential Soil-gas (µg/m³)**	**Residential Groundwater (µg/L)**	**Industrial/ Occupational Indoor Air (µg/m³)**	**Endpoint**	**Industrial/ OccupationalSoil -gas (µg/m³)**	**Industrial/ Occupational Groundwater (µg/L)**
Trichlorofluoromethane	7.30E+02	n	7.30E+03	1.84E+02	3.44E+03	n	3.44E+04	8.65E+02
1,2,3-Trichloropropane	3.13E-01	n	3.13E+00	2.22E+01	1.47E+00	n	1.47E+01	1.05E+02
Triethylamine	7.30E+00	n	7.30E+01	1.19E+03	3.44E+01	n	3.44E+02	5.63E+03
Vinyl acetate	2.09E+02	n	2.09E+03	9.96E+03	9.83E+02	n	9.83E+03	4.69E+04
Vinyl bromide	8.77E-01	c	8.77E+00	1.74E+00	4.30E+00	c	4.30E+01	8.53E+00
Vinyl chloride	1.68E+00	c	1.68E+01	1.47E+00	3.13E+01	c	3.13E+02	2.74E+01
m-Xylene	1.04E+02	n	1.04E+03	3.54E+02	4.92E+02	n	4.92E+03	1.67E+03
o-Xylene	1.04E+02	n	1.04E+03	4.91E+02	4.92E+02	n	4.92E+03	2.31E+03
Xylenes	1.04E+02	n	1.04E+03	4.91E+02	4.92E+02	n	4.92E+03	2.31E+03

APPENDIX B

CHEMICAL AND PHYSICAL PROPERTIES

Table B-1: Chemical CAS and Molecular Weight

Chemical	**Chemical Abstracts Service (CAS) Registry Number**	**Molecular Weight (MW) (g/mole)**	**Ref.**
Acenaphthene	83-32-9	154.21	EPI
Acetaldehyde	75-07-0	44.05	EPI
Acetone	67-64-1	58.08	EPI
Acrylonitrile	107-13-1	53.06	EPI
Acetophenone	98-86-2	120.15	EPI
Acrolein	107-02-8	56.06	EPI
Aldrin	309-00-2	364.92	EPI
Aluminum	7429-90-5	26.98	P
Anthracene	120-12-7	178.24	EPI
Antimony	7440-36-0	121.76	P
Arsenic	7440-38-2	74.92	P
Barium	7440-39-3	137.33	P
Benzene	71-43-2	78.11	EPI
Benzidine	92-87-5	184.24	EPI
Benzo(a)anthracene	56-55-3	228.3	EPI
Benzo(a)pyrene	50-32-8	252.32	EPI
Benzo(b)fluoranthene	205-99-2	252.32	EPI
Benzo(k)fluoranthene	207-08-9	252.32	EPI
Beryllium	7440-41-7	9.01	P
a-BHC (HCH)	319-84-6	290.83	EPI
b-BHC (HCH)	319-85-7	290.83	EPI
g-BHC	58-89-9	290.83	EPI
1,1-Biphenyl	92-52-4	154.21	EPI
Bis(2-chloroethyl) ether	111-44-4	143.01	EPI
Bis(2-chloroisopropyl) ether	108-60-1	171.07	EPI
Bis(2-ethylhexyl) phthalate	117-81-7	390.57	EPI
Bis(chloromethyl) ether	542-88-1	114.96	EPI
Boron	7440-42-8	10.81	P
Bromodichloromethane	75-27-4	163.83	EPI
Bromomethane	74-83-9	94.94	EPI
1,3-Butadiene	106-99-0	54.09	EPI
2-Butanone (Methyl ethyl ketone, MEK)	78-93-3	72.11	EPI
tert-Butyl methyl ether (MTBE)	1634-04-4	88.15	EPI

Chemical	**Chemical Abstracts Service (CAS) Registry Number**	**Molecular Weight (MW) (g/mole)**	**Ref.**
Cadmium	7440-43-9	112.41	P
Carbon disulfide	75-15-0	76.13	EPI
Carbon tetrachloride	56-23-5	153.82	EPI
Chlordane	12789-03-6	409.78	EPI
2-Chloroacetophenone	532-27-4	154.6	EPI
2-Chloro-1,3-butadiene	126-99-8	88.54	EPI
1-Chloro-1,1-difluoroethane	75-68-3	100.5	EPI
Chlorobenzene	108-90-7	112.56	EPI
1-Chlorobutane	109-69-3	92.57	EPI
Chlorodifluoromethane	75-45-6	86.47	EPI
Chloroform	67-66-3	119.38	EPI
Chloromethane	74-87-3	50.49	EPI
b-Chloronaphthalene	91-58-7	162.62	EPI
o-Chloronitrobenzene	88-73-3	157.56	EPI
p-Chloronitrobenzene	100-00-5	157.56	EPI
2-Chlorophenol	95-57-8	128.56	EPI
2-Chloropropane	75-29-6	78.54	EPI
o-Chlorotoluene	95-49-8	126.59	EPI
Chromium III	16065-83-1	52	P
Chromium VI	18540-29-9	52	P
Chromium (Total)		52	P
Chrysene	218-01-9	228.3	EPI
Copper	7440-50-8	63.55	P
Crotonaldehyde	123-73-9	70.09	EPI
Cumene (isopropylbenzene)	98-82-8	120.2	EPI
Cyanide	57-12-5	27.03	EPI
Cyanogen	460-19-5	52.04	EPI
Cyanogen bromide	506-68-3	105.92	EPI
Cyanogen chloride	506-77-4	61.47	EPI
DDD	72-54-8	320.05	EPI
DDE	72-55-9	318.03	EPI
DDT	50-29-3	354.49	EPI
Dibenz(a,h)anthracene	53-70-3	278.36	EPI
1,2-Dibromo-3-chloropropane	96-12-8	236.33	EPI
Dibromochloromethane	124-48-1	208.28	EPI

Chemical	**Chemical Abstracts Service (CAS) Registry Number**	**Molecular Weight (MW) (g/mole)**	**Ref.**
1,2-Dibromoethane	106-93-4	187.86	EPI
1,4-Dichloro-2-butene	764-41-0	125	EPI
1,2-Dichlorobenzene	95-50-1	147	EPI
1,4-Dichlorobenzene	106-46-7	147	EPI
3,3-Dichlorobenzidine	91-94-1	253.13	EPI
Dichlorodifluoromethane	75-71-8	120.91	EPI
1,1-Dichloroethane	75-34-3	98.96	EPI
1,2-Dichloroethane	107-06-2	98.96	EPI
cis-1,2-Dichloroethene	156-59-2	96.94	EPI
trans-1,2-Dichloroethene	156-60-5	96.94	EPI
1,1-Dichloroethene	75-35-4	96.94	EPI
2,4-Dichlorophenol	120-83-2	163	EPI
1,2-Dichloropropane	78-87-5	112.99	EPI
1,3-Dichloropropene	542-75-6	110.97	EPI
Dicyclopentadiene	77-73-6	132.21	EPI
Dieldrin	60-57-1	380.91	EPI
Diethyl phthalate	84-66-2	222.24	EPI
Di-n-butyl phthalate (Dibutyl phthalate)	84-74-2	278.35	EPI
2,4-Dimethylphenol	105-67-9	122.17	EPI
4,6-Dinitro-o-cresol	534-52-1	198.14	EPI
2,4-Dinitrophenol	51-28-5	184.11	EPI
2,4-Dinitrotoluene	121-14-2	182.14	EPI
2,6-Dintitrotoluene	606-20-2	182.14	EPI
2,4/2,6-Dintrotoluene Mixture	25321-14-6	182.14	EPI
1,4-Dioxane	123-91-1	88.11	EPI
1,2-Diphenylhydrazine	122-66-7	184.24	EPI
Endosulfan	115-29-7	406.92	EPI
Endrin	72-20-8	380.91	EPI
Epichlorohydrin	106-89-8	92.53	EPI
Ethyl acetate	141-78-6	88.11	EPI
Ethyl acrylate	140-88-5	100.12	EPI
Ethyl chloride	75-00-3	64.52	EPI
Ethyl ether	60-29-7	74.12	EPI
Ethyl methacrylate	97-63-2	114.15	EPI
Ethylbenzene	100-41-4	106.17	EPI

Chemical	**Chemical Abstracts Service (CAS) Registry Number**	**Molecular Weight (MW) (g/mole)**	**Ref.**
Ethylene oxide	75-21-8	44.05	EPI
Fluoranthene	206-44-0	202.26	EPI
Fluorene	86-73-7	166.22	EPI
Fluoride	7782-41-4	19	P
Furan	110-00-9	68.08	EPI
Heptachlor	76-44-8	373.32	EPI
Hexachlorobenzene	118-74-1	284.78	EPI
Hexachloro-1,3-butadiene	87-68-3	260.76	EPI
Hexachlorocyclopentadiene	77-47-4	272.77	EPI
Hexachloroethane	67-72-1	236.74	EPI
n-Hexane	110-54-3	86.18	EPI
HMX	2691-41-0	296.16	EPI
Hydrazine anhydride	302-01-2	32.05	EPI
Hydrogen cyanide	74-90-8	27.03	EPI
Indeno(1,2,3-c,d)pyrene	193-39-5	276.34	EPI
Iron	7439-89-6	55.85	P
Isobutanol (Isobutyl alcohol)	78-83-1	74.12	EPI
Isophorone	78-59-1	138.21	EPI
Lead	7439-92-1	207.2	P
Lead (tetraethyl-)	78-00-2	323.45	EPI
Maleic hydrazide	123-33-1	112.09	EPI
Manganese	7439-96-5	54.94	P
Mercury (elemental)	7439-97-6	200.59	EPI
Mercury (methyl)	22967-92-6	215.63	EPI
Mercury Chloride (Mercury Salts)	7487-94-7	271.5	EPI
Methacrylonitrile	126-98-7	67.09	EPI
Methomyl	16752-77-5	162.21	EPI
Methyl acetate	79-20-9	74.08	EPI
Methyl acrylate	96-33-3	86.09	EPI
Methyl isobutyl ketone	108-10-1	100.16	EPI
Methyl methacrylate	80-62-6	100.12	EPI
Methyl styrene (alpha)	98-83-9	118.18	EPI
Methyl styrene (mixture)	25013-15-4	118.18	EPI
Methylcyclohexane	108-87-2	98.19	EPI
Methylene bromide (Dibromomethane)	74-95-3	173.84	EPI

Chemical	**Chemical Abstracts Service (CAS) Registry Number**	**Molecular Weight (MW) (g/mole)**	**Ref.**
Methylene chloride	75-09-2	84.93	EPI
Molybdenum	7439-98-7	95.96	P
Naphthalene	91-20-3	128.18	EPI
Nickel	7440-02-0	58.69	EPI
Nitrate	14797-55-8	62	EPI
Nitrite	14797-65-0	47.01	EPI
Nitrobenzene	98-95-3	123.11	EPI
Nitroglycerin	55-63-0	227.09	EPI
N-Nitrosodiethylamine	55-18-5	102.14	EPI
N-Nitrosodimethylamine	62-75-9	74.08	EPI
N-Nitrosodi-*n*-butylamine	924-16-3	158.25	EPI
N-Nitrosodiphenylamine	86-30-6	198.23	EPI
N-Nitrosopyrrolidine	930-55-2	100.12	EPI
m-Nitrotoluene	99-08-1	137.14	EPI
o-Nitrotoluene	88-72-2	137.14	EPI
p-Nitrotoluene	99-99-0	137.14	EPI
Pentachlorobenzene	608-93-5	250.34	EPI
Pentachlorophenol	87-86-5	266.34	EPI
Perchlorate	14797-73-0	99.45	ToxNet
Phenanthrene	85-01-8	178.24	EPI
Phenol	108-95-2	94.11	EPI
Polychlorinatedbiphenyls (PCBs)			
Aroclor 1016	12674-11-2	257.55	EPI
Aroclor 1221	11104-28-2	188.66	EPI
Aroclor 1232	11141-16-5	188.66	EPI
Aroclor 1242	53469-21-9	291.99	EPI
Aroclor 1248	12672-29-6	291.99	EPI
Aroclor 1254	11097-69-1	326.44	EPI
Aroclor 1260	11096-82-5	395.33	EPI
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)	35065-30-6	395.33	EPI
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)	35065-29-3	395.33	EPI
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)	39635-31-9	395.33	EPI
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)	52663-72-6	360.88	EPI
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)	69782-90-7	360.88	EPI
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)	38380-08-4	360.88	EPI

Chemical	**Chemical Abstracts Service (CAS) Registry Number**	**Molecular Weight (MW) (g/mole)**	**Ref.**
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)	32774-16-6	360.88	EPI
2',3,4,4',5-Pentachlorobiphenyl (PCB 123)	65510-44-3	326.44	EPI
2',3',4,4',5-Pentachlorobiphenyl (PCB 118)	31508-00-6	326.44	EPI
2',3,3',4,4'-Pentachlorobiphenyl (PCB 105)	32598-14-4	326.44	EPI
2,3,4,4',5-Pentachlorobiphenyl (PCB 114)	74472-37-0	326.44	EPI
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)	57465-28-8	326.44	EPI
3,3',4,4'-Tetrachlorobiphenyl (PCB 77)	32598-13-3	291.99	EPI
3,4,4',5-Tetrachlorobiphenyl (PCB 81)	70362-50-4	291.99	EPI
Propylene oxide	75-56-9	58.08	EPI
Pyrene	129-00-0	202.26	EPI
RDX	121-82-4	222.12	EPI
Selenium	7782-49-2	78.96	P
Silver	7440-22-4	107.87	P
Strontium	7440-24-6	87.62	P
Styrene	100-42-5	104.15	EPI
Sulfolane	126-33-0	120.17	EPI
2,3,7,8-TCDD	1746-01-6	321.98	EPI
2,3,7,8-TCDF	51207-31-9	305.98	EPI
1,2,4,5-Tetrachlorobenzene	95-94-3	215.89	EPI
1,1,1,2-Tetrachloroethane	630-20-6	167.85	EPI
1,1,2,2-Tetrachloroethane	79-34-5	167.85	EPI
Tetrachloroethene	127-18-4	165.83	EPI
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	287.15	EPI
Thallium	7440-28-0	204.38	P
Toluene	108-88-3	92.14	EPI
Toxaphene	8001-35-2	413.82	EPI
Tribromomethane (Bromoform)	75-25-2	252.73	EPI
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.38	EPI
1,2,4-Trichlorobenzene	120-82-1	181.45	EPI
1,1,1-Trichloroethane	71-55-6	133.41	EPI
1,1,2-Trichloroethane	79-00-5	133.41	EPI
Trichloroethylene	79-01-6	131.39	EPI
Trichlorofluoromethane	75-69-4	137.37	EPI
2,4,5-Trichlorophenol	95-95-4	197.45	EPI
2,4,6-Trichlorophenol	88-06-2	197.45	EPI

Chemical	**Chemical Abstracts Service (CAS) Registry Number**	**Molecular Weight (MW) (g/mole)**	**Ref.**
1,1,2-Trichloropropane	598-77-6	147.43	EPI
1,2,3-Trichloropropane	96-18-4	147.43	EPI
Triethylamine	121-44-8	101.19	EPI
2,4,6-Trinitrotoluene	118-96-7	227.13	EPI
Uranium (soluable salts)		238.03	P
Vanadium	7440-62-2	50.94	EPI
Vinyl acetate	108-05-4	86.09	P
Vinyl bromide	593-60-2	106.95	EPI
Vinyl chloride	75-01-4	62.5	EPI
m-Xylene	108-38-3	106.17	EPI
o-Xylene	95-47-6	106.17	EPI
Xylenes	1330-20-7	106.17	EPI
Zinc	7440-66-6	65.38	P

EPI= US EPA. 2012. Estimation Programs Interface (EPI) Suite™ for Microsoft® Windows, v 4.11. Washington, DC, USA.
g/mole – grams per mole
P = periodic table of the elements
Ref – reference
ToxNet – Toxicological Data Network, US National Library of Medicine, http://chem.sis.nlm.nih.gov/chemidplus/rn/14797-73-0

Table B-2: Physical and Chemical Properties

Chemical	H (atm-m^3/mole)	Ref.	H' (unitless)	D_a (cm^2/s)	Ref.	D_w (cm^2/s)	Ref.	K_{oc} (cm^3/g)	Ref.	K_d (cm^3/g)	Ref.	S (mg/L-water)	Ref.	D_A (cm^2/s)	Res/Ind. VF (m^3/kg)	Comm/ VF (m^3/kg)	Soil SAT (mg/kg)	VOC
Acenaphthene	1.84E-04	EPI	7.54E-03	4.76E-02	W9	7.69E-06	W9	5.03E+03	EPI	7.54E+00	CALC	3.90E+00	EPI	4.91E-07	1.77E+05	3.66E+04		1
Acetaldehyde	6.67E-05	EPI	2.73E-03	1.24E-01	W9	1.41E-05	W9	1.00E+00	EPI	1.50E-03	CALC	1.00E+06	EPI	2.20E-05	2.65E+04	5.47E+03	1.75E+05	1
Acetone	3.50E-05	EPI	1.44E-03	1.24E-01	W9	1.14E-05	W9	2.36E+00	EPI	3.55E-03	CALC	1.00E+06	EPI	1.23E-05	3.54E+04	7.31E+03	1.77E+05	1
Acrylonitrile	1.38E-04	EPI	5.66E-03	1.28E-01	W9	1.66E-05	W9	8.51E+00	EPI	1.28E-02	CALC	7.45E+04	EPI	4.11E-05	1.94E+04	4.00E+03	1.39E+04	1
Acetophenone	1.04E-05	EPI	4.26E-04	6.00E-02	W9	8.73E-06	W9	5.19E+01	EPI	7.78E-02	CALC	6.13E+03	EPI	2.37E-06	8.07E+04	1.67E+04	1.54E+03	1
Acrolein	1.22E-04	EPI	5.00E-03	1.05E-01	W9	1.22E-05	W9	1.00E+00	EPI	1.50E-03	CALC	2.12E+05	EPI	3.18E-05	2.20E+04	4.55E+03	3.72E+04	1
Aldrin	4.40E-05	EPI	1.80E-03	1.96E-02	W9	4.86E-06	W9	8.20E+04	EPI	1.23E+02	CALC	1.70E-02	EPI	4.35E-09				
Aluminum										1.50E+03	Baes							
Anthracene	5.56E-05	EPI	2.28E-03	3.85E-02	W9	7.74E-06	W9	1.64E+04	EPI	2.45E+01	CALC	4.34E-02	EPI	4.69E-08	5.73E+05	1.18E+05		1
Antimony										4.50E+01	SSG							
Arsenic										2.90E+01	SSG							
Barium										4.10E+01	SSG							
Benzene	5.55E-03	EPI	2.28E-01	8.80E-02	W9	1.02E-05	W9	1.46E+02	EPI	2.19E-01	CALC	1.79E+03	EPI	4.65E-04	5.75E+03	1.19E+03	7.48E+02	1
Benzidine	5.17E-11	EPI	2.12E-09	3.26E-02	W9	1.50E-05	W9	1.19E+03	EPI	1.79E+00	CALC	3.22E+02	EPI	3.04E-07				
Benzo(a)anthracene	1.20E-05	EPI	4.92E-04	5.10E-02	W9	9.00E-06	W9	1.77E+05	EPI	2.65E+02	CALC	9.40E-03	EPI	2.26E-09				
Benzo(a)pyrene	4.57E-07	EPI	1.87E-05	4.30E-02	W9	9.00E-06	W9	5.87E+05	EPI	8.81E+02	CALC	1.62E-03	EPI	4.15E-10				
Benzo(b)fluoranthene	6.57E-07	EPI	2.69E-05	2.23E-02	W9	5.56E-06	W9	5.99E+05	EPI	8.99E+02	CALC	1.50E-03	EPI	2.52E-10				
Benzo(k)fluoranthene	5.84E-07	EPI	2.39E-05	2.23E-02	W9	5.56E-06	W9	5.87E+05	EPI	8.81E+02	CALC	8.00E-04	EPI	2.56E-10				
Beryllium										7.90E+02	SSG							
a-BHC (HCH)	5.14E-06	EPI	2.11E-04	2.21E-02	W9	5.57E-06	W9	2.81E+03	EPI	4.21E+00	CALC	8.00E+00	EPI	6.08E-08				
b-BHC (HCH)	5.14E-06	EPI	2.11E-04	2.21E-02	W9	5.57E-06	W9	2.81E+03	EPI	4.21E+00	CALC	8.00E+00	EPI	6.08E-08				
g-BHC	5.10E-06	EPI	2.09E-04	2.75E-02	W9	7.34E-06	W9	2.81E+03	EPI	4.21E+00	CALC	8.00E+00	EPI	7.92E-08				
1,1-Biphenyl	3.08E-04	EPI	1.26E-02	4.04E-02	W9	8.15E-06	W9	5.13E+03	EPI	7.69E+00	CALC	6.94E+00	EPI	6.70E-07	1.52E+05	3.13E+04		1
Bis(2-chloroethyl) ether	1.70E-05	EPI	6.97E-04	4.13E-02	W9	9.49E-06	W9	3.22E+01	EPI	4.83E-02	CALC	1.72E+04	EPI	2.96E-06	7.22E+04	1.49E+04	3.81E+03	1
Bis(2-chloroisopropyl) ether	7.42E-05	EPI	3.04E-03	6.02E-02	W9	6.41E-06	W9	4.58E+01	EPI	6.87E-02	CALC	1.70E+03	EPI	8.37E-06	4.29E+04	8.86E+03	4.12E+02	1
Bis(2-ethylhexyl) phthalate	2.70E-07	EPI	1.11E-05	3.51E-02	W9	3.66E-06	W9	1.20E+05	EPI	1.79E+02	CALC	2.70E-01	EPI	8.31E-10				
Bis(chloromethyl) ether	4.36E-03	EPI	1.79E-01	7.62E-02	W9	9.38E-06	W9	9.70E+00	EPI	1.45E-02	CALC	2.20E+04	EPI	6.36E-04	4.92E+03	1.02E+03	4.58E+03	1
Boron										3.00E+00	Baes							
Bromodichloromethane	2.12E-03	EPI	8.69E-02	5.61E-02	W9	1.06E-05	W9	3.18E+01	EPI	4.77E-02	CALC	3.03E+03	EPI	2.06E-04	8.64E+03	1.78E+03	7.00E+02	1
Bromomethane	7.34E-03	EPI	3.01E-01	7.28E-02	W9	1.21E-05	W9	1.32E+01	EPI	1.98E-02	CALC	1.52E+04	EPI	9.36E-04	4.06E+03	8.38E+02	3.45E+03	1
1,3-Butadiene	7.36E-02	EPI	3.02E+00	2.49E-01	W9	1.08E-05	W9	3.96E+01	EPI	5.94E-02	CALC	7.35E+02	EPI	1.27E-02	1.10E+03	2.28E+02	4.22E+02	1
2-Butanone (Methyl ethyl ketone, MEK)	5.69E-05	EPI	2.33E-03	8.08E-02	W9	9.80E-06	W9	4.51E+00	EPI	6.77E-03	CALC	2.23E+05	EPI	1.23E-05	3.54E+04	7.31E+03	4.02E+04	1
tert-Butyl methyl ether (MTBE)	5.87E-04	EPI	2.41E-02	8.59E-02	W9	1.01E-05	W9	1.16E+01	EPI	1.73E-02	CALC	5.10E+04	EPI	1.06E-04	1.21E+04	2.49E+03	9.86E+03	1
Cadmium										7.50E+01	SSG							

Chemical	**H (atm-m^3/mole)**	**Ref.**	**H' (unitless)**	**D_a (cm^2/s)**	**Ref.**	**D_w (cm^2/s)**	**Ref.**	**K_{oc} (cm^3/g)**	**Ref.**	**K_d (cm^3/g)**	**Ref.**	**S (mg/L-water)**	**Ref.**	**D_A (cm^2/s)**	**Res/Ind. VF (m^3/kg)**	**Comm/ VF (m^3/kg)**	**Soil SAT (mg/kg)**	**VOC**
Carbon disulfide	1.44E-02	EPI	5.90E-01	1.04E-01	W9	1.00E-05	W9	2.17E+01	EPI	3.26E-02	CALC	2.16E+03	EPI	2.18E-03	2.66E+03	5.49E+02	5.89E+02	1
Carbon tetrachloride	2.76E-02	EPI	1.13E+00	7.80E-02	W9	8.80E-06	W9	4.39E+01	EPI	6.58E-02	CALC	7.93E+02	EPI	2.33E-03	2.57E+03	5.31E+02	2.91E+02	1
Chlordane	4.86E-05	EPI	1.99E-03	1.79E-02	W9	4.37E-06	W9	3.38E+04	EPI	5.07E+01	CALC	5.60E-02	EPI	1.02E-08				
2-Chloroacetophenone	3.46E-06	EPI	1.42E-04	3.83E-02	W9	8.71E-06	W9	9.89E+01	EPI	1.48E-01	CALC	1.64E+03	EPI	1.24E-06				
2-Chloro-1,3-butadiene	5.61E-02	EPI	2.30E+00	1.04E-01	W9	1.00E-05	W9	6.07E+01	EPI	9.11E-02	CALC	8.75E+02	EPI	4.42E-03	1.87E+03	3.86E+02	4.59E+02	1
1-Chloro-1,1-difluoroethane	5.88E-02	EPI	2.41E+00	7.69E-02	W9	9.54E-06	W9	4.39E+01	EPI	6.58E-02	CALC	1.40E+03	EPI	3.51E-03	2.10E+03	4.33E+02	7.17E+02	1
Chlorobenzene	3.11E-03	EPI	1.28E-01	7.30E-02	W9	8.70E-06	W9	2.34E+02	EPI	3.51E-01	CALC	4.98E+02	EPI	1.68E-04	9.57E+03	1.98E+03	2.68E+02	1
1-Chlorobutane	1.67E-02	EPI	6.85E-01	7.72E-02	W9	9.57E-06	W9	7.22E+01	EPI	1.08E-01	CALC	1.10E+03	EPI	1.43E-03	3.29E+03	6.79E+02	3.95E+02	1
Chlorodifluoromethane	4.06E-02	EPI	1.66E+00	1.01E-01	W9	1.28E-05	W9	3.18E+01	EPI	4.77E-02	CALC	2.77E+03	EPI	3.99E-03	1.97E+03	4.06E+02	1.13E+03	1
Chloroform	3.67E-03	EPI	1.50E-01	1.04E-01	W9	1.00E-05	W9	3.18E+01	EPI	4.77E-02	CALC	7.95E+03	EPI	6.39E-04	4.91E+03	1.01E+03	1.89E+03	1
Chloromethane	8.82E-03	EPI	3.62E-01	1.26E-01	W9	6.50E-06	W9	1.32E+01	EPI	1.98E-02	CALC	5.32E+03	EPI	1.89E-03	2.86E+03	5.90E+02	1.25E+03	1
b-Chloronaphthalene	3.20E-04	EPI	1.31E-02	4.92E-02	W9	8.79E-06	W9	2.48E+03	EPI	3.72E+00	CALC	1.17E+01	EPI	1.70E-06	9.53E+04	1.97E+04		1
o-Chloronitrobenzene	9.30E-06	EPI	3.81E-04	5.37E-02	W9	9.37E-06	W9	3.71E+02	EPI	5.56E-01	CALC	4.41E+02	EPI	7.83E-07				
p-Chloronitrobenzene	4.89E-06	EPI	2.00E-04	5.01E-02	W9	8.52E-06	W9	3.63E+02	EPI	5.45E-01	CALC	2.25E+02	EPI	6.07E-07				
2-Chlorophenol	1.12E-05	EPI	4.59E-04	6.60E-02	W9	9.46E-06	W9	3.07E+02	EPI	4.60E-01	CALC	2.85E+04	EPI	1.06E-06	1.21E+05	2.49E+04	1.80E+04	1
2-Chloropropane	1.75E-02	EPI	7.18E-01	8.88E-02	W9	1.01E-05	W9	3.18E+01	EPI	4.77E-02	CALC	3.10E+03	EPI	2.04E-03	2.75E+03	5.67E+02	9.37E+02	1
o-Chlorotoluene	3.57E-03	EPI	1.46E-01	6.28E-02	W9	8.70E-06	W9	3.83E+02	EPI	5.74E-01	CALC	3.74E+02	EPI	1.17E-04	1.15E+04	2.37E+03	2.86E+02	1
Chromium III										1.80E+06	SSG							
Chromium VI										1.90E+01	SSG							
Chromium (Total)										1.80E+06	SSG							
Chrysene	5.23E-06	EPI	2.14E-04	2.44E-02	W9	6.21E-06	W9	1.81E+05	EPI	2.71E+02	CALC	2.00E-03	EPI	1.10E-09				
Copper										3.50E+01	Baes							
Crotonaldehyde	1.94E-05	EPI	7.95E-04	1.02E-01	W9	1.18E-05	W9	1.79E+00	EPI	2.69E-03	CALC	1.81E+05	EPI	7.14E-06	4.64E+04	9.59E+03	3.19E+04	1
Cumene (isopropylbenzene)	1.15E-02	EPI	4.72E-01	6.50E-02	W9	7.10E-06	W9	6.98E+02	EPI	1.05E+00	CALC	6.13E+01	EPI	2.33E-04	8.12E+03	1.68E+03	7.81E+01	1
Cyanide	1.33E-04	EPI	5.45E-03	1.56E-01	W9	1.77E-05	W9	2.84E+00	EPI	4.26E-03	CALC	1.00E+06	EPI	5.01E-05	1.75E+04	3.62E+03	1.78E+05	1
Cyanogen	5.40E-03	EPI	2.21E-01	1.23E-01	W9	1.37E-05	W9	1.83E+00	EPI	2.74E-03	CALC	1.19E+08	EPI	1.32E-03	3.42E+03	7.07E+02		1
Cyanogen bromide	2.45E-02	EPI	1.00E+00	7.32E-02	W9	9.25E-06	W9	4.67E+00	EPI	7.01E-03	CALC	1.08E+05	EPI	2.42E-03	2.52E+03	5.21E+02		1
Cyanogen chloride	2.45E-02	EPI	1.00E+00	1.29E-01	W9	1.57E-05	W9	4.67E+00	EPI	7.01E-03	CALC	1.58E+05	EPI	4.28E-03	1.90E+03	3.92E+02		1
DDD	6.60E-06	EPI	2.71E-04	2.27E-02	W9	5.79E-06	W9	1.18E+05	EPI	1.76E+02	CALC	9.00E-02	EPI	1.64E-09				
DDE	4.16E-05	EPI	1.71E-03	2.38E-02	W9	5.87E-06	W9	1.18E+05	EPI	1.76E+02	CALC	4.00E-02	EPI	3.55E-09				
DDT	8.32E-06	EPI	3.41E-04	1.99E-02	W9	4.95E-06	W9	1.69E+05	EPI	2.53E+02	CALC	5.50E-03	EPI	1.04E-09				
Dibenz(a,h)anthracene	1.41E-07	EPI	5.78E-06	2.11E-02	W9	5.24E-06	W9	1.91E+06	EPI	2.87E+03	CALC	1.03E-03	EPI	7.30E-11				
1,2-Dibromo-3-chloropropane	1.47E-04	EPI	6.03E-03	2.68E-02	W9	7.02E-06	W9	1.16E+02	EPI	1.74E-01	CALC	1.23E+03	EPI	5.30E-06	5.39E+04	1.11E+04	4.28E+02	1
Dibromochloromethane	7.83E-04	EPI	3.21E-02	3.66E-02	W9	1.05E-05	W9	3.18E+01	EPI	4.77E-02	CALC	2.70E+03	EPI	5.25E-05	1.71E+04	3.54E+03	6.07E+02	1
1,2-Dibromoethane	6.50E-04	EPI	2.67E-02	4.30E-02	W9	8.44E-06	W9	3.96E+01	EPI	5.94E-02	CALC	3.91E+03	EPI	4.85E-05	1.78E+04	3.68E+03	9.22E+02	1
1,4-Dichloro-2-butene	6.64E-04	EPI	2.72E-02	7.25E-02	W9	8.12E-06	W9	1.32E+02	EPI	1.97E-01	CALC	5.80E+02	EPI	5.21E-05	1.72E+04	3.55E+03	2.17E+02	1

Chemical	**H (atm-m^3/mole)**	**Ref.**	**H' (unitless)**	**D_a (cm^2/s)**	**Ref.**	**D_w (cm^2/s)**	**Ref.**	**K_{oc} (cm^3/g)**	**Ref.**	**K_d (cm^3/g)**	**Ref.**	**S (mg/L-water)**	**Ref.**	**D_A (cm^2/s)**	**Res/Ind. VF (m^3/kg)**	**Comm/ VF (m^3/kg)**	**Soil SAT (mg/kg)**	**VOC**
1,2-Dichlorobenzene	1.92E-03	EPI	7.87E-02	6.90E-02	W9	7.90E-06	W9	3.83E+02	EPI	5.74E-01	CALC	8.00E+01	EPI	7.00E-05	1.48E+04	3.06E+03	6.05E+01	1
1,4-Dichlorobenzene	2.41E-03	EPI	9.88E-02	6.90E-02	W9	7.90E-06	W9	3.75E+02	EPI	5.63E-01	CALC	8.13E+01	EPI	8.88E-05	1.32E+04	2.72E+03		1
3,3-Dichlorobenzidine	2.84E-11	EPI	1.16E-09	2.59E-02	W9	6.74E-06	W9	3.19E+03	EPI	4.79E+00	CALC	3.10E+00	EPI	5.40E-08				
Dichlorodifluoromethane	3.43E-01	EPI	1.41E+01	6.65E-02	W9	9.92E-06	W9	4.39E+01	EPI	6.58E-02	CALC	2.80E+02	EPI	4.94E-03	1.77E+03	3.65E+02	5.13E+02	1
1,1-Dichloroethane	5.62E-03	EPI	2.30E-01	7.42E-02	W9	1.05E-05	W9	3.18E+01	EPI	4.77E-02	CALC	5.04E+03	EPI	6.72E-04	4.79E+03	9.89E+02	1.25E+03	1
1,2-Dichloroethane	1.18E-03	EPI	4.84E-02	1.04E-01	W9	9.90E-06	W9	3.96E+01	EPI	5.94E-02	CALC	5.10E+03	EPI	2.06E-04	8.64E+03	1.78E+03	1.21E+03	1
cis-1,2-Dichloroethene	4.08E-03	EPI	1.67E-01	8.86E-02	W9	1.13E-05	W9	3.96E+01	EPI	5.94E-02	CALC	3.50E+03	EPI	5.72E-04	5.19E+03	1.07E+03	8.81E+02	1
trans-1,2-Dichloroethene	4.08E-03	EPI	1.67E-01	7.03E-02	W9	1.19E-05	W9	3.96E+01	EPI	5.94E-02	CALC	3.50E+03	EPI	4.55E-04	5.82E+03	1.20E+03	8.81E+02	1
1,1-Dichloroethene	2.61E-02	EPI	1.07E+00	9.00E-02	W9	1.04E-05	W9	3.18E+01	EPI	4.77E-02	CALC	2.42E+03	EPI	2.73E-03	2.38E+03	4.91E+02	8.28E+02	1
2,4-Dichlorophenol	4.29E-06	EPI	1.76E-04	4.89E-02	W9	8.77E-06	W9	4.92E+02	EPI	7.38E-01	CALC	4.50E+03	EPI	4.74E-07				
1,2-Dichloropropane	2.82E-03	EPI	1.16E-01	7.82E-02	W9	8.73E-06	W9	6.07E+01	EPI	9.11E-02	CALC	2.80E+03	EPI	3.17E-04	6.97E+03	1.44E+03	7.77E+02	1
1,3-Dichloropropene	3.55E-03	EPI	1.46E-01	6.26E-02	W9	1.00E-05	W9	7.22E+01	EPI	1.08E-01	CALC	2.80E+03	EPI	2.98E-04	7.20E+03	1.49E+03	8.35E+02	1
Dicyclopentadiene	6.25E-02	EPI	2.56E+00	5.57E-02	W9	7.75E-06	W9	1.51E+03	EPI	2.27E+00	CALC	5.19E+01	EPI	5.06E-04	5.52E+03	1.14E+03		1
Dieldrin	1.00E-05	EPI	4.10E-04	1.92E-02	W9	4.74E-06	W9	2.01E+04	EPI	3.01E+01	CALC	2.50E-01	EPI	8.73E-09				
Diethyl phthalate	6.10E-07	EPI	2.50E-05	2.49E-02	W9	6.35E-06	W9	1.05E+02	EPI	1.57E-01	CALC	1.08E+03	EPI	7.81E-07				
Di-n-butyl phthalate (Dibutyl phthalate)	1.81E-06	EPI	7.42E-05	4.38E-02	W9	7.86E-06	W9	1.16E+03	EPI	1.74E+00	CALC	1.12E+01	EPI	1.80E-07				
2,4-Dimethylphenol	9.51E-07	EPI	3.90E-05	6.43E-02	W9	8.69E-06	W9	4.92E+02	EPI	7.38E-01	CALC	7.87E+03	EPI	4.06E-07				
4,6-Dinitro-o-cresol	1.40E-06	EPI	5.74E-05	2.76E-02	W9	6.91E-06	W9	7.54E+02	EPI	1.13E+00	CALC	1.98E+02	EPI	2.22E-07				
2,4-Dinitrophenol	8.60E-08	EPI	3.53E-06	2.73E-02	W9	9.06E-06	W9	4.61E+02	EPI	6.91E-01	CALC	2.79E+03	EPI	4.17E-07				
2,4-Dinitrotoluene	5.40E-08	EPI	2.21E-06	2.03E-01	W9	7.06E-06	W9	5.76E+02	EPI	8.63E-01	CALC	2.00E+02	EPI	2.75E-07				
2,6-Dintitrotoluene	7.47E-07	EPI	3.06E-05	3.70E-02	W9	7.76E-06	W9	5.87E+02	EPI	8.81E-01	CALC	3.52E+02	EPI	3.03E-07				
2,4/2,6-Dintrotoluene Mixture	9.26E-08	EPI	3.80E-06	3.75E-02	W9	7.89E-06	W9	5.87E+02	EPI	8.81E-01	CALC	2.70E+02	EPI	2.99E-07				
1,4-Dioxane	4.80E-06	EPI	1.97E-04	2.29E-01	W9	1.02E-05	W9	2.63E+00	EPI	3.95E-03	CALC	1.00E+06	EPI	4.75E-06				
1,2-Diphenylhydrazine	4.78E-07	EPI	1.96E-05	3.47E-02	W9	7.36E-06	W9	1.51E+03	EPI	2.26E+00	CALC	2.21E+02	EPI	1.23E-07				
Endosulfan	6.50E-05	EPI	2.67E-03	1.85E-02	W9	4.55E-06	W9	6.76E+03	EPI	1.01E+01	CALC	4.50E-01	EPI	6.38E-08				
Endrin	1.00E-05	EPI	4.10E-04	1.92E-02	W9	4.74E-06	W9	2.01E+04	EPI	3.01E+01	CALC	2.50E-01	EPI	8.73E-09				
Epichlorohydrin	3.04E-05	EPI	1.25E-03	8.60E-02	W9	9.80E-06	W9	9.91E+00	EPI	1.49E-02	CALC	6.59E+04	EPI	7.58E-06	4.51E+04	9.31E+03	1.24E+04	1
Ethyl acetate	1.34E-04	EPI	5.49E-03	7.32E-02	W9	9.70E-06	W9	5.58E+00	EPI	8.37E-03	CALC	8.00E+04	EPI	2.35E-05	2.56E+04	5.29E+03	1.46E+04	1
Ethyl acrylate	3.39E-04	EPI	1.39E-02	7.70E-02	W9	8.60E-06	W9	1.07E+01	EPI	1.60E-02	CALC	1.50E+04	EPI	5.61E-05	1.66E+04	3.42E+03	2.86E+03	1
Ethyl chloride	1.11E-02	EPI	4.55E-01	2.71E-01	W9	1.15E-05	W9	2.17E+01	EPI	3.26E-02	CALC	6.71E+03	EPI	4.64E-03	1.82E+03	3.76E+02	1.73E+03	1
Ethyl ether	1.23E-03	EPI	5.04E-02	7.82E-02	W9	8.61E-06	W9	9.70E+00	EPI	1.45E-02	CALC	6.04E+04	EPI	1.99E-04	8.79E+03	1.82E+03	1.17E+04	1
Ethyl methacrylate	5.73E-04	EPI	2.35E-02	6.53E-02	W9	8.37E-06	W9	1.67E+01	EPI	2.50E-02	CALC	5.40E+03	EPI	7.56E-05	1.43E+04	2.95E+03	1.09E+03	1
Ethylbenzene	7.88E-03	EPI	3.23E-01	7.50E-02	W9	7.80E-06	W9	4.46E+02	EPI	6.69E-01	CALC	1.69E+02	EPI	2.67E-04	7.59E+03	1.57E+03	1.49E+02	1
Ethylene oxide	1.48E-04	EPI	6.07E-03	1.04E-01	W9	1.45E-05	W9	3.24E+00	EPI	4.86E-03	CALC	1.00E+06	EPI	3.74E-05	2.03E+04	4.19E+03	1.79E+05	1
Fluoranthene	8.86E-06	EPI	3.63E-04	2.51E-02	W9	6.35E-06	W9	5.55E+04	EPI	8.32E+01	CALC	2.60E-01	EPI	4.09E-09				
Fluorene	9.62E-05	EPI	3.94E-03	4.40E-02	W9	7.88E-06	W9	9.16E+03	EPI	1.37E+01	CALC	1.69E+00	EPI	1.43E-07	3.28E+05	6.77E+04		1

Chemical	H (atm-m^3/mole)	Ref.	H' (unitless)	D_a (cm^2/s)	Ref.	D_w (cm^2/s)	Ref.	K_{oc} (cm^3/g)	Ref.	K_d (cm^3/g)	Ref.	S (mg/L-water)	Ref.	D_A (cm^2/s)	Res/Ind. VF (m^3/kg)	Comm/ VF (m^3/kg)	Soil SAT (mg/kg)	VOC
Fluoride										1.50E+02	Baes							
Furan	5.40E-03	EPI	2.21E-01	1.04E-01	W9	1.22E-05	W9	8.00E+01	EPI	1.20E-01	CALC	1.00E+04	EPI	7.02E-04	4.68E+03	9.68E+02	3.18E+03	1
Heptachlor	2.94E-04	EPI	1.21E-02	2.23E-02	W9	5.69E-06	W9	4.13E+04	EPI	6.19E+01	CALC	1.80E-01	EPI	4.56E-08				
Hexachlorobenzene	1.70E-03	EPI	6.97E-02	5.42E-02	W9	5.91E-06	W9	6.20E+03	EPI	9.29E+00	CALC	6.20E-03	EPI	3.89E-06				
Hexachloro-1,3-butadiene	1.03E-02	EPI	4.22E-01	5.61E-02	W9	6.16E-06	W9	8.45E+02	EPI	1.27E+00	CALC	3.20E+00	EPI	1.54E-04				
Hexachlorocyclopentadiene	2.70E-02	EPI	1.11E+00	2.79E-02	W9	7.21E-06	W9	1.40E+03	EPI	2.11E+00	CALC	1.80E+00	EPI	1.25E-04				
Hexachloroethane	3.89E-03	EPI	1.59E-01	2.50E-03	W9	6.80E-06	W9	1.97E+02	EPI	2.95E-01	CALC	5.00E+01	EPI	8.50E-06				
n-Hexane	1.80E+00	EPI	7.38E+01	2.00E-01	W9	7.77E-06	W9	1.32E+02	EPI	1.97E-01	CALC	9.50E+00	EPI	1.64E-02	9.70E+02	2.00E+02	8.30E+01	1
HMX	8.67E-10	EPI	3.55E-08	2.69E-02	W9	7.15E-06	W9	5.32E+02	EPI	7.97E-01	CALC	9.44E+03	EPI	2.93E-07				
Hydrazine anhydride								1.60E-02	EPI	2.39E-05	CALC							
Hydrogen cyanide	1.33E-04	EPI	5.45E-03	1.97E-01	W9	1.82E-05	W9	2.84E+00	EPI	4.26E-03	CALC	1.00E+06	EPI	6.25E-05	1.57E+04	3.24E+03	1.78E+05	1
Indeno(1,2,3-c,d)pyrene	3.48E-07	EPI	1.43E-05	2.25E-02	W9	5.66E-06	W9	1.95E+06	EPI	2.93E+03	CALC	1.90E-04	EPI	7.79E-11				
Iron										2.50E+01	Baes							
Isobutanol (Isobutyl alcohol)	9.78E-06	EPI	4.01E-04	8.60E-02	W9	9.30E-06	W9	2.92E+00	EPI	4.38E-03	CALC	8.50E+04	EPI	3.96E-06	6.24E+04	1.29E+04		1
Isophorone	6.64E-06	EPI	2.72E-04	6.23E-02	W9	6.76E-06	W9	6.52E+01	EPI	9.77E-02	CALC	1.20E+04	EPI	1.60E-06				
Lead										9.00E+02	Baes							
Lead (tetraethyl-)	5.68E-01	EPI	2.33E+01	2.46E-02	W9	6.40E-06	W9	6.48E+02	EPI	9.72E-01	CALC	2.90E-01	EPI	1.47E-03				
Maleic hydrazide	2.65E-11	EPI	1.09E-09	5.81E-02	W9	8.14E-06	W9	3.30E+00	EPI	4.95E-03	CALC	4.51E+03	EPI	1.81E-06				
Manganese										6.50E+01	Baes							
Mercury (elemental)	1.14E-02	SSG	4.67E-01	3.07E-02	SSG	6.30E-06	SSG			5.20E+01	SSG	6.00E-02	EPI	2.67E-06	7.60E+04	1.57E+04	3.13E+00	1
Mercury (methyl)	7.22E-03	EPI	2.96E-01	2.40E-02	W9	6.04E-06	W9	1.32E+01	EPI	1.98E-02	CALC	3.13E+04	EPI					
Mercury Chloride (Mercury Salts)										5.20E+01	Baes							
Methacrylonitrile	2.47E-04	EPI	1.01E-02	1.12E-01	W9	1.32E-05	W9	1.31E+01	EPI	1.96E-02	CALC	2.54E+04	EPI	5.95E-05	1.61E+04	3.32E+03	4.93E+03	1
Methomyl	1.97E-11	EPI	8.08E-10	2.84E-02	W9	6.47E-06	W9	1.00E+01	EPI	1.50E-02	CALC	5.80E+04	EPI	1.36E-06				
Methyl acetate	1.15E-04	EPI	4.72E-03	9.57E-02	W9	1.10E-05	W9	3.06E+00	EPI	4.60E-03	CALC	2.43E+05	EPI	2.70E-05	2.39E+04	4.94E+03	4.34E+04	1
Methyl acrylate	1.99E-04	EPI	8.16E-03	8.66E-02	W9	1.02E-05	W9	5.84E+00	EPI	8.77E-03	CALC	4.94E+04	EPI	3.96E-05	1.97E+04	4.07E+03	9.04E+03	1
Methyl isobutyl ketone	1.38E-04	EPI	5.66E-03	7.50E-02	W9	7.80E-06	W9	1.26E+01	EPI	1.89E-02	CALC	1.90E+04	EPI	2.29E-05	2.59E+04	5.35E+03	3.66E+03	1
Methyl methacrylate	3.19E-04	EPI	1.31E-02	7.70E-02	W9	8.60E-06	W9	9.14E+00	EPI	1.37E-02	CALC	1.50E+04	EPI	5.36E-05	1.70E+04	3.50E+03	2.83E+03	1
Methyl styrene (alpha)	2.55E-03	EPI	1.05E-01	2.64E-01	W9	1.14E-05	W9	6.98E+02	EPI	1.05E+00	CALC	8.90E+01	EPI	2.18E-04	8.42E+03	1.74E+03	1.10E+02	1
Methyl styrene (mixture)	3.05E-03	EPI	1.25E-01	6.55E-02	W9	8.66E-06	W9	7.16E+02	EPI	1.07E+00	CALC	8.90E+01	EPI	6.32E-05	1.56E+04	3.22E+03	1.12E+02	1
Methylcyclohexane	4.30E-01	EPI	1.76E+01	7.35E-02	W9	8.52E-06	W9	2.34E+02	EPI	3.51E-01	CALC	1.40E+01	EPI	4.98E-03	1.76E+03	3.63E+02	3.53E+01	1
Methylene bromide (Dibromomethane)	8.22E-04	EPI	3.37E-02	4.30E-02	W9	8.44E-06	W9	2.17E+01	EPI	3.26E-02	CALC	1.19E+04	EPI	6.86E-05	1.50E+04	3.10E+03	2.50E+03	1
Methylene chloride	3.25E-03	EPI	1.33E-01	1.01E-01	W9	1.17E-05	W9	2.17E+01	EPI	3.26E-02	CALC	1.30E+04	EPI	5.92E-04	5.10E+03	1.05E+03	2.87E+03	1
Molybdenum										2.00E+01	Baes							
Naphthalene	4.40E-04	EPI	1.80E-02	5.90E-02	W9	7.50E-06	W9	1.54E+03	EPI	2.32E+00	CALC	3.10E+01	EPI	4.26E-06	6.01E+04	1.24E+04		1
Nickel										6.50E+01	SSG							

Chemical	**H (atm-m^3/mole)**	**Ref.**	**H' (unitless)**	**D_a (cm^2/s)**	**Ref.**	**D_w (cm^2/s)**	**Ref.**	**K_{oc} (cm^3/g)**	**Ref.**	**K_d (cm^3/g)**	**Ref.**	**S (mg/L-water)**	**Ref.**	**D_A (cm^2/s)**	**Res/Ind. VF (m^3/kg)**	**Comm/ VF (m^3/kg)**	**Soil SAT (mg/kg)**	**VOC**
Nitrate										5.00E-01	Baes							
Nitrite										5.00E-01	Baes							
Nitrobenzene	2.40E-05	EPI	9.84E-04	7.60E-02	W9	8.60E-06	W9	2.26E+02	EPI	3.40E-01	CALC	2.09E+03	EPI	2.08E-06	8.61E+04	1.78E+04	1.07E+03	1
Nitroglycerin	8.66E-08	EPI	3.55E-06	2.90E-02	W9	7.76E-06	W9	1.16E+02	EPI	1.74E-01	CALC	1.38E+03	EPI	8.91E-07				
N-Nitrosodiethylamine	3.63E-06	EPI	1.49E-04	7.65E-02	W9	9.51E-06	W9	8.29E+01	EPI	1.24E-01	CALC	1.06E+05	EPI	1.64E-06				
N-Nitrosodimethylamine	1.82E-06	EPI	7.46E-05	1.04E-01	W9	1.00E-05	W9	2.28E+01	EPI	3.42E-02	CALC	1.00E+06	EPI	2.28E-06				
N-Nitrosodi-*n*-butylamine	1.32E-05	EPI	5.41E-04	4.42E-02	W9	7.27E-06	W9	9.15E+02	EPI	1.37E+00	CALC	1.27E+03	EPI	3.37E-07	2.14E+05	4.42E+04		1
N-Nitrosodiphenylamine	1.21E-06	EPI	4.96E-05	2.83E-02	W9	7.19E-06	W9	2.63E+03	EPI	3.95E+00	CALC	3.50E+01	EPI	7.26E-08				
N-Nitrosopyrrolidine	4.89E-08	EPI	2.00E-06	8.20E-02	W9	1.04E-05	W9	9.19E+01	EPI	1.38E-01	CALC	1.00E+06	EPI	1.33E-06				
m-Nitrotoluene	9.30E-06	EPI	3.81E-04	5.86E-02	W9	8.64E-06	W9	3.63E+02	EPI	5.45E-01	CALC	5.00E+02	EPI	7.79E-07				
o-Nitrotoluene	1.25E-05	EPI	5.13E-04	5.87E-02	W9	8.67E-06	W9	3.71E+02	EPI	5.56E-01	CALC	6.50E+02	EPI	8.72E-07	1.33E+05	2.75E+04	4.74E+02	1
p-Nitrotoluene	5.63E-06	EPI	2.31E-04	5.85E-02	W9	8.61E-06	W9	3.63E+02	EPI	5.45E-01	CALC	4.42E+02	EPI	6.59E-07				
Pentachlorobenzene	7.03E-04	EPI	2.88E-02	5.70E-02	W9	6.30E-06	W9	3.71E+03	EPI	5.56E+00	CALC	8.31E-01	EPI	2.82E-06				
Pentachlorophenol	2.45E-08	EPI	1.00E-06	5.60E-02	W9	6.10E-06	W9	4.96E+03	EPI	7.44E+00	CALC	1.40E+01	EPI	3.19E-08				
Perchlorate										2.50E-01	Baes							
Phenanthrene	4.23E-05	EPI	1.73E-03	3.75E-02	W9	7.47E-06	W9	1.67E+04	EPI	2.50E+01	CALC	1.15E+00	EPI	3.68E-08	6.47E+05	1.34E+05		1
Phenol	3.33E-07	EPI	1.37E-05	8.20E-02	W9	9.10E-06	W9	1.87E+02	EPI	2.81E-01	CALC	8.28E+04	EPI	8.20E-07				
Polychlorinatedbiphenyls																		
Aroclor 1016	2.00E-04	EPI	8.20E-03	3.25E-02	W9	7.26E-06	W9	4.77E+04	EPI	7.16E+01	CALC	4.20E-01	EPI	4.00E-08				
Aroclor 1221	7.36E-04	EPI	3.02E-02	3.25E-02	W9	7.26E-06	W9	8.40E+03	EPI	1.26E+01	CALC	1.45E+00	EPI	7.67E-07	1.42E+05	2.93E+04	1.85E+01	1
Aroclor 1232	7.36E-04	EPI	3.02E-02	2.56E-02	W9	6.56E-06	W9	8.40E+03	EPI	1.26E+01	CALC	1.45E+00	EPI	6.07E-07	1.59E+05	3.29E+04	1.85E+01	1
Aroclor 1242	1.90E-04	EPI	7.79E-03	2.37E-02	W9	6.02E-06	W9	7.81E+04	EPI	1.17E+02	CALC	2.77E-01	EPI	1.73E-08				
Aroclor 1248	4.40E-04	EPI	1.80E-02	2.16E-02	W9	5.50E-06	W9	7.65E+04	EPI	1.15E+02	CALC	1.00E-01	EPI	3.48E-08				
Aroclor 1254	2.83E-04	EPI	1.16E-02	2.02E-02	W9	5.00E-06	W9	1.31E+05	EPI	1.96E+02	CALC	3.40E-03	EPI	1.26E-08				
Aroclor 1260	3.36E-04	EPI	1.38E-02	2.28E-02	W9	5.83E-06	W9	3.50E+05	EPI	5.25E+02	CALC	1.14E-02	EPI	6.24E-09				
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)	9.00E-06	EPI	3.69E-04	1.78E-02	W9	4.19E-06	W9	3.57E+05	EPI	5.35E+02	CALC	3.47E-03	EPI	4.30E-10				
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)	1.00E-05	EPI	4.10E-04	1.78E-02	W9	4.19E-06	W9	3.50E+05	EPI	5.25E+02	CALC	3.85E-03	EPI	4.52E-10				
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)	5.07E-05	EPI	2.08E-03	1.78E-02	W9	4.19E-06	W9	3.50E+05	EPI	5.25E+02	CALC	7.53E-04	EPI	9.99E-10				
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)	6.85E-05	EPI	2.81E-03	1.82E-02	W9	4.43E-06	W9	2.09E+05	EPI	3.14E+02	CALC	2.23E-03	EPI	2.14E-09				
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)	6.85E-05	EPI	2.81E-03	1.82E-02	W9	4.43E-06	W9	2.14E+05	EPI	3.20E+02	CALC	1.72E-03	EPI	2.09E-09				
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)	1.43E-04	EPI	5.86E-03	1.82E-02	W9	4.43E-06	W9	2.14E+05	EPI	3.20E+02	CALC	5.33E-03	EPI	3.78E-09				
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)	6.85E-05	EPI	2.81E-03	1.82E-02	W9	4.43E-06	W9	2.09E+05	EPI	3.14E+02	CALC	5.10E-04	EPI	2.14E-09				
2',3,4,4',5-Pentachlorobiphenyl (PCB 123)	9.24E-05	EPI	3.79E-03	1.92E-02	W9	4.70E-06	W9	1.31E+05	EPI	1.96E+02	CALC	1.60E-02	EPI	4.55E-09				
2',3',4,4',5-Pentachlorobiphenyl (PCB 118)	2.88E-04	EPI	1.18E-02	1.92E-02	W9	4.70E-06	W9	1.28E+05	EPI	1.92E+02	CALC	1.34E-02	EPI	1.24E-08				

Chemical	H (atm-m^3/mole)	Ref.	H' (unitless)	D_a (cm^2/s)	Ref.	D_w (cm^2/s)	Ref.	K_{oc} (cm^3/g)	Ref.	K_d (cm^3/g)	Ref.	S (mg/L-water)	Ref.	D_A (cm^2/s)	Res/Ind. VF (m^3/kg)	Comm/ VF (m^3/kg)	Soil SAT (mg/kg)	VOC
2',3,3',4,4'-Pentachlorobiphenyl (PCB 105)	2.83E-04	EPI	1.16E-02	1.92E-02	W9	4.70E-06	W9	1.31E+05	EPI	1.96E+02	CALC	3.40E-03	EPI	1.20E-08				
2,3,4,4',5-Pentachlorobiphenyl (PCB 114)	9.24E-05	EPI	3.79E-03	1.92E-02	W9	4.70E-06	W9	1.31E+05	EPI	1.96E+02	CALC	1.60E-02	EPI	4.55E-09				
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)	9.24E-05	EPI	3.79E-03	1.92E-02	W9	4.70E-06	W9	1.28E+05	EPI	1.92E+02	CALC	9.39E-03	EPI	4.64E-09				
3,3',4,4'-Tetrachlorobiphenyl (PCB 77)	9.40E-06	EPI	3.85E-04	2.04E-02	W9	5.03E-06	W9	7.81E+04	EPI	1.17E+02	CALC	5.69E-04	EPI	2.35E-09				
3,4,4',5-Tetrachlorobiphenyl (PCB 81)	1.25E-04	EPI	5.13E-03	2.04E-02	W9	5.03E-06	W9	7.81E+04	EPI	1.17E+02	CALC	5.32E-02	EPI	1.03E-08				
Propylene oxide	6.96E-05	EPI	2.85E-03	1.04E-01	W9	1.00E-05	W9	5.19E+00	EPI	7.79E-03	CALC	5.90E+05	EPI	1.80E-05	2.92E+04	6.04E+03	1.07E+05	1
Pyrene	1.19E-05	EPI	4.88E-04	2.77E-02	W9	7.24E-06	W9	5.43E+04	EPI	8.15E+01	CALC	1.35E-01	EPI	5.12E-09	1.73E+06	3.58E+05		1
RDX	2.00E-11	EPI	8.20E-10	3.11E-02	W9	8.49E-06	W9	8.91E+01	EPI	1.34E-01	CALC	5.97E+01	EPI	1.10E-06				
Selenium										5.00E+00	SSG							
Silver										8.30E+00	SSG							
Strontium										3.50E+01	Baes							
Styrene	2.75E-03	EPI	1.13E-01	7.10E-02	W9	8.00E-06	W9	4.46E+02	EPI	6.69E-01	CALC	3.10E+02	EPI	9.11E-05	1.30E+04	2.69E+03	2.65E+02	1
Sulfolane	4.85E-06	EPI	1.99E-04	7.13E-02	W9	9.85E-06	W9	9.08E+00	EPI	1.36E-02	CALC	2.93E+05	EPI	2.83E-06				
2,3,7,8-TCDD	5.00E-05	EPI	2.05E-03	1.04E-01	W9	5.60E-06	W9	2.49E+05	EPI	3.74E+02	CALC	2.00E-04	EPI	6.12E-09				
2,3,7,8-TCDF	1.67E-05	EPI	6.85E-04	2.35E-02	W9	6.10E-06	W9	1.40E+05	EPI	2.09E+02	CALC	6.92E-04	EPI	1.90E-09				
1,2,4,5-Tetrachlorobenzene	1.00E-03	EPI	4.10E-02	3.19E-02	W9	8.75E-06	W9	2.22E+03	EPI	3.33E+00	CALC	5.95E-01	EPI	3.71E-06				
1,1,1,2-Tetrachloroethane	2.50E-03	EPI	1.03E-01	7.10E-02	W9	7.90E-06	W9	8.60E+01	EPI	1.29E-01	CALC	1.07E+03	EPI	2.26E-04	8.26E+03	1.71E+03	3.36E+02	1
1,1,2,2-Tetrachloroethane	3.67E-04	EPI	1.50E-02	7.10E-02	W9	7.90E-06	W9	9.49E+01	EPI	1.42E-01	CALC	2.83E+03	EPI	3.36E-05	2.14E+04	4.42E+03	8.98E+02	1
Tetrachloroethene	1.77E-02	EPI	7.26E-01	7.20E-02	W9	8.20E-06	W9	9.49E+01	EPI	1.42E-01	CALC	2.06E+02	EPI	1.27E-03	3.48E+03	7.19E+02	8.20E+01	1
Tetryl (Trinitrophenylmethylnitramine)	2.71E-09	EPI	1.11E-07	2.06E-02	W9	5.08E-06	W9	4.61E+03	EPI	6.91E+00	CALC	7.40E+01	EPI	2.85E-08				
Thallium										7.10E+01	SSG							
Toluene	6.64E-03	EPI	2.72E-01	8.70E-02	W9	8.60E-06	W9	2.34E+02	EPI	3.51E-01	CALC	5.26E+02	EPI	4.14E-04	6.10E+03	1.26E+03	2.92E+02	1
Toxaphene	6.00E-06	EPI	2.46E-04	2.16E-02	W9	5.51E-06	W9	7.72E+04	EPI	1.16E+02	CALC	2.91E-02	EPI	2.33E-09				
Tribromomethane (Bromoform)	5.35E-04	EPI	2.19E-02	1.49E-02	W9	1.03E-05	W9	3.18E+01	EPI	4.77E-02	CALC	3.10E+03	EPI	1.60E-05				
1,1,2-Trichloro-1,2,2-trifluoroethane	5.26E-01	EPI	2.16E+01	7.80E-02	W9	8.20E-06	W9	1.97E+02	EPI	2.95E-01	CALC	1.70E+02	EPI	5.60E-03	1.66E+03	3.43E+02	4.95E+02	1
1,2,4-Trichlorobenzene	1.42E-03	EPI	5.82E-02	3.00E-02	W9	8.23E-06	W9	1.36E+03	EPI	2.03E+00	CALC	4.90E+01	EPI	7.79E-06	4.45E+04	9.18E+03	1.08E+02	1
1,1,1-Trichloroethane	1.72E-02	EPI	7.05E-01	7.80E-02	W9	8.80E-06	W9	4.39E+01	EPI	6.58E-02	CALC	1.29E+03	EPI	1.67E-03	3.04E+03	6.27E+02	4.12E+02	1
1,1,2-Trichloroethane	8.24E-04	EPI	3.38E-02	7.80E-02	W9	8.80E-06	W9	6.07E+01	EPI	9.11E-02	CALC	1.10E+03	EPI	9.65E-05	1.26E+04	2.61E+03	2.95E+02	1
Trichloroethylene	9.85E-03	EPI	4.04E-01	7.90E-02	W9	9.10E-06	W9	6.07E+01	EPI	9.11E-02	CALC	1.28E+03	EPI	9.98E-04	3.93E+03	8.12E+02	3.97E+02	1
Trichlorofluoromethane	9.70E-02	EPI	3.98E+00	8.70E-02	W9	9.70E-06	W9	4.39E+01	EPI	6.58E-02	CALC	1.10E+03	EPI	4.86E-03	1.78E+03	3.68E+02	7.59E+02	1
2,4,5-Trichlorophenol	1.62E-06	EPI	6.64E-05	2.91E-02	W9	7.03E-06	W9	1.78E+03	EPI	2.67E+00	CALC	1.20E+03	EPI	1.05E-07				
2,4,6-Trichlorophenol	2.60E-06	EPI	1.07E-04	2.61E-02	W9	6.30E-06	W9	1.78E+03	EPI	2.67E+00	CALC	8.00E+02	EPI	9.77E-08				
1,1,2-Trichloropropane	3.17E-04	EPI	1.30E-02	5.78E-02	W9	9.32E-06	W9	9.49E+01	EPI	1.42E-01	CALC	1.90E+03	EPI	2.41E-05	2.53E+04	5.22E+03	6.03E+02	1
1,2,3-Trichloropropane	3.43E-04	EPI	1.41E-02	7.10E-02	W9	7.90E-06	W9	1.16E+02	EPI	1.74E-01	CALC	1.75E+03	EPI	2.87E-05	2.32E+04	4.79E+03	6.10E+02	1
Triethylamine	1.49E-04	EPI	6.11E-03	8.81E-02	W9	7.88E-06	W9	5.08E+01	EPI	7.62E-02	CALC	6.86E+04	EPI	2.21E-05	2.64E+04	5.45E+03	1.72E+04	1
2,4,6-Trinitrotoluene	2.08E-08	EPI	8.53E-07	2.94E-02	W9	7.90E-06	W9	2.81E+03	EPI	4.22E+00	CALC	1.15E+02	EPI	7.15E-08				

Chemical	**H (atm-m^3/mole)**	**Ref.**	**H' (unitless)**	**D_a (cm^2/s)**	**Ref.**	**D_w (cm^2/s)**	**Ref.**	**K_{oc} (cm^3/g)**	**Ref.**	**K_d (cm^3/g)**	**Ref.**	**S (mg/L-water)**	**Ref.**	**D_A (cm^2/s)**	**Res/Ind. VF (m^3/kg)**	**Comm/ VF (m^3/kg)**	**Soil SAT (mg/kg)**	**VOC**
Uranium (soluable salts)										4.50E+02	Baes							
Vanadium										1.00E+03	SSG							
Vinyl acetate	5.11E-04	EPI	2.10E-02	8.50E-02	W9	9.20E-06	W9	5.58E+00	EPI	8.37E-03	CALC	2.00E+04	EPI	9.57E-05	1.27E+04	2.62E+03	3.68E+03	1
Vinyl bromide	1.23E-02	EPI	5.04E-01	8.69E-02	W9	1.17E-05	W9	2.17E+01	EPI	3.26E-02	CALC	5.08E+03	EPI	1.62E-03	3.09E+03	6.38E+02	1.34E+03	1
Vinyl chloride	2.78E-02	EPI	1.14E+00	1.06E-01	W9	1.23E-05	W9	2.17E+01	EPI	3.26E-02	CALC	8.80E+03	EPI	3.50E-03	2.10E+03	4.34E+02	2.95E+03	1
m-Xylene	7.18E-03	EPI	2.94E-01	7.00E-02	W9	7.80E-06	W9	3.75E+02	EPI	5.63E-01	CALC	1.61E+02	EPI	2.60E-04	7.70E+03	1.59E+03	1.24E+02	1
o-Xylene	5.18E-03	EPI	2.12E-01	8.70E-02	W9	1.00E-05	W9	3.83E+02	EPI	5.74E-01	CALC	1.06E+02	EPI	2.33E-04	8.14E+03	1.68E+03	8.18E+01	1
Xylenes	5.18E-03	EPI	2.12E-01	7.37E-02	W9	9.34E-06	W9	3.83E+02	EPI	5.74E-01	CALC	1.06E+02	EPI	1.97E-04	8.84E+03	1.83E+03	8.18E+01	1
Zinc										6.20E+01	SSG							

Notes:
MW – Molecular weight
H' – Dimensionless Henry's Law Constant
D_w – Diffusivity in water
K_d – Soil-water partition coefficient
D_A – Apparent diffusivity (calculated for VOCs only)
SAT – Soil saturation limit (calculated for VOCs not solid at soil temperature only)
H – Henry's Law Constant
D_a – Diffusivity in air
K_{oc} – Soil organic carbon partition coefficient
S - Solubility in water
VF – Volatilization factor (calculated for VOCs only)
VOC – Volatile organic compound

EPI= US EPA. 2012. Estimation Programs Interface (EPI) Suite™ for Microsoft® Windows, v 4.11. Washington, DC, USA.
W9= US EPA. 2006. Water9, Version 3.0. Wastewater Treatment Model
CALC =Calculated;
SSG=US EPA. 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Office of Emergency and Remedial Response, Washington, D.C. OSWER 9355.4-24. December.
http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg_main.pdf
Baes= Baes, C.F. 1984. Oak Ridge National Laboratory. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture

a -Hnery's Law Constants obtained from 1) EPI Suite Version 4.11 (a. experimental value; b. bond method, then c. group method) 2) US EPA Soil Screening Guidance (2002).

d -H' values = H*41 (US EPA Soil Screening Guidance, 2002)

c- Da and Dw values obtained from 1) US EPA (2006) Water 9 Wastewater Treatment Model; 2) US EPA Soil Screening Guidance (2002)

d- Koc values obtained from US EPA EPI Suite, Version 4.11 (a. MCI method; b. Kow method)

b -foc = 1.5E-03: Soil Survey Laboratory Database for New Mexico, National Resources Conservation Service, U.S. Dept of Agriculture
e- Kd for organics = Koc * foc. Kds for inorganics obtained from 1) US EPA Soil Screening Guidance (2002); 2) Baes, C.F. 1984. Oak Ridge National Laboratory. *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture.*

The Kd value for elemental mercury is based on the Kd for mercury 2+

The Kd value for methyl mercury Is based on the Kd for mercury 2+

The Kd value for mercury salts is based on the Kd for mercury 2+

The Kd values for nitrate and nitrite are based on the Kd for nitrogen

The Kd value for perchlorate is based on the Kd for chlorine

Table B-3: Physical and Chemical Constants for the Dermal Tap-Water Pathway

Chemical	CAS. NO.	MW (g/mole)	Ref.	Kp (cm/hr)	Ref.	FA (unitless)	Ref.	τ_{event} (hr/event)	B (unitless)	b	c	t* (hr)	DA_event carc	DA_event noncarc	DA_event mutagen
Acenaphthene	83-32-9	154.21	EPI	8.60E-02	EPI	1	E	7.67E-01	4.11E-01	6.20E-01	6.47E-01	1.84E+00		1.47E-01	
Acetaldehyde	75-07-0	44.05	EPI	5.27E-04	EPI	1	E	1.85E-01	1.35E-03	3.04E-01	3.34E-01	4.45E-01			
Acetone	67-64-1	58.08	EPI	5.12E-04	EPI	1	E	2.22E-01	1.50E-03	3.04E-01	3.34E-01	5.33E-01		2.13E+00	
Acrylonitrile	107-13-1	53.06	EPI	1.16E-03	EPI	1	E	2.08E-01	3.25E-03	3.05E-01	3.36E-01	5.00E-01	1.74E-04	9.48E-02	
Acetophenone	98-86-2	120.15	EPI	3.72E-03	EPI	1	E	4.94E-01	1.57E-02	3.13E-01	3.44E-01	1.19E+00		2.37E-01	
Acrolein	107-02-8	56.06	EPI	7.48E-04	EPI	1	E	2.16E-01	2.15E-03	3.05E-01	3.35E-01	5.19E-01		1.19E-03	
Aldrin	309-00-2	364.92	EPI	2.93E-01	EPI	1	E	1.16E+01	2.15E+00	4.07E+00	2.26E+00	4.77E+01	5.47E-06	7.11E-05	
Aluminum	7429-90-5	26.98	P	1.00E-03	E	1	E	1.49E-01	2.00E-03	3.04E-01	3.35E-01	3.57E-01		2.37E+00	
Anthracene	120-12-7	178.24	EPI	1.42E-01	EPI	1	E	1.05E+00	7.29E-01	9.82E-01	9.22E-01	4.04E+00		7.11E-01	
Antimony	7440-36-0	121.76	P	1.00E-03	E	1	E	5.05E-01	4.24E-03	3.06E-01	3.36E-01	1.21E+00		1.42E-04	
Arsenic	7440-38-2	74.92	P	1.00E-03	E	1	E	2.76E-01	3.33E-03	3.05E-01	3.36E-01	6.62E-01	6.26E-05	7.11E-04	
Barium	7440-39-3	137.33	P	1.00E-03	E	1	E	6.17E-01	4.51E-03	3.06E-01	3.36E-01	1.48E+00		3.32E-02	
Benzene	71-43-2	78.11	EPI	1.49E-02	EPI	1	E	2.87E-01	5.06E-02	3.35E-01	3.68E-01	6.90E-01	1.71E-03	9.48E-03	
Benzidine	92-87-5	184.24	EPI	1.13E-03	EPI	1	E	1.13E+00	5.90E-03	3.07E-01	3.37E-01	2.71E+00	4.08E-07	7.11E-03	1.32E-07
Benzo(a)anthracene	56-55-3	228.3	EPI	5.52E-01	EPI	1	E	1.99E+00	3.21E+00	7.99E+00	3.29E+00	8.47E+00	1.29E-04		4.16E-05
Benzo(a)pyrene	50-32-8	252.32	EPI	7.13E-01	EPI	1	E	2.72E+00	4.36E+00	1.38E+01	4.42E+00	1.18E+01	1.29E-05		4.16E-06
Benzo(b)fluoranthene	205-99-2	252.32	EPI	4.17E-01	EPI	1	E	2.72E+00	2.55E+00	5.37E+00	2.64E+00	1.13E+01	1.29E-04		4.16E-05
Benzo(k)fluoranthene	207-08-9	252.32	EPI	6.91E-01	EPI	1	E	2.72E+00	4.22E+00	1.31E+01	4.29E+00	1.18E+01	1.29E-03		4.16E-04
Beryllium	7440-41-7	9.01	P	1.00E-03	E	1	E	1.18E-01	1.15E-03	3.04E-01	3.34E-01	2.83E-01		3.32E-05	
a-BHC (HCH)	319-84-6	290.83	EPI	2.06E-02	EPI	1	E	4.47E+00	1.35E-01	3.92E-01	4.29E-01	1.07E+01	1.49E-05	1.90E-02	
b-BHC (HCH)	319-85-7	290.83	EPI	2.06E-02	EPI	1	E	4.47E+00	1.35E-01	3.92E-01	4.29E-01	1.07E+01	5.22E-05		
g-BHC	58-89-9	290.83	EPI	2.06E-02	EPI	0.9	E	4.47E+00	1.35E-01	3.92E-01	4.29E-01	1.07E+01	8.53E-05	7.11E-04	
1,1-Biphenyl	92-52-4	154.21	EPI	9.87E-02	EPI	1	E	7.67E-01	4.71E-01	6.80E-01	6.98E-01	1.84E+00	1.14E-02	1.19E+00	
Bis(2-chloroethyl) ether	111-44-4	143.01	EPI	1.78E-03	EPI	1	E	6.64E-01	8.19E-03	3.08E-01	3.39E-01	1.59E+00	8.53E-05		
Bis(2-chloroisopropyl) ether	108-60-1	171.07	EPI	7.64E-03	EPI	1	E	9.53E-01	3.84E-02	3.27E-01	3.59E-01	2.29E+00	1.34E-03		
Bis(2-ethylhexyl) phthalate	117-81-7	390.57	EPI	1.13E+00	EPI	0.8	E	1.62E+01	8.59E+00	4.99E+01	8.62E+00	7.28E+01	6.71E-03	4.74E-02	
Bis(chloromethyl) ether	542-88-1	114.96	EPI	8.55E-04	EPI	1	E	4.62E-01	3.53E-03	3.05E-01	3.36E-01	1.11E+00	4.27E-07		
Boron	7440-42-8	10.81	P	1.00E-03	E	1	E	1.21E-01	1.26E-03	3.04E-01	3.34E-01	2.90E-01		4.74E-01	
Bromodichloromethane	75-27-4	163.83	EPI	4.02E-03	EPI	1	E	8.68E-01	1.98E-02	3.15E-01	3.47E-01	2.08E+00	1.51E-03	4.74E-02	
Bromomethane	74-83-9	94.94	EPI	2.84E-03	EPI	1	E	3.57E-01	1.06E-02	3.10E-01	3.40E-01	8.57E-01		3.32E-03	
1,3-Butadiene	106-99-0	54.09	EPI	1.64E-02	EPI	1	E	2.11E-01	4.64E-02	3.32E-01	3.65E-01	5.06E-01	2.76E-05		
2-Butanone (Methyl ethyl ketone, MEK)	78-93-3	72.11	EPI	9.62E-04	EPI	1	E	2.66E-01	3.14E-03	3.05E-01	3.35E-01	6.39E-01		1.42E+00	
tert-Butyl methyl ether (MTBE)	1634-04-4	88.15	EPI	2.11E-03	EPI	1	E	3.27E-01	7.62E-03	3.08E-01	3.38E-01	7.85E-01	5.22E-02		
Cadmium	7440-43-9	112.41	P	1.00E-03	E	1	E	4.47E-01	4.08E-03	3.06E-01	3.36E-01	1.07E+00		3.07E-05	

Chemical	CAS. NO.	MW (g/mole)	Ref.	Kp (cm/hr)	Ref.	FA (unitless)	Ref.	τ_{event} (hr/event)	B (unitless)	b	c	t* (hr)	DA_event carc	DA_event noncarc	DA_event mutagen
Carbon disulfide	75-15-0	76.13	EPI	1.14E-02	EPI	1	E	2.80E-01	3.83E-02	3.27E-01	3.59E-01	6.73E-01		2.37E-01	
Carbon tetrachloride	56-23-5	153.82	EPI	1.63E-02	EPI	1	E	7.63E-01	7.78E-02	3.52E-01	3.87E-01	1.83E+00	1.34E-03	9.48E-03	
Chlordane	12789-03-6	409.78	EPI	1.07E-01	EPI	0.7	E	2.07E+01	8.33E-01	1.12E+00	1.01E+00	7.96E+01	2.68E-04	1.19E-03	
2-Chloroacetophenone	532-27-4	154.6	EPI	4.06E-03	EPI	1	E	7.71E-01	1.94E-02	3.15E-01	3.46E-01	1.85E+00			
2-Chloro-1,3-butadiene	126-99-8	88.54	EPI	2.38E-02	EPI	1	E	3.29E-01	8.61E-02	3.58E-01	3.93E-01	7.89E-01		4.74E-02	
1-Chloro-1,1-difluoroethane	75-68-3	100.5	EPI	9.89E-03	EPI	1	E	3.84E-01	3.81E-02	3.27E-01	3.59E-01	9.21E-01			
Chlorobenzene	108-90-7	112.56	EPI	2.82E-02	EPI	1	E	4.48E-01	1.15E-01	3.78E-01	4.14E-01	1.08E+00		4.74E-02	
1-Chlorobutane	109-69-3	92.57	EPI	2.69E-02	EPI	1	E	3.46E-01	9.95E-02	3.67E-01	4.03E-01	8.31E-01		9.48E-02	
Chlorodifluoromethane	75-45-6	86.47	EPI	2.68E-03	EPI	1	E	3.20E-01	9.59E-03	3.09E-01	3.40E-01	7.68E-01			
Chloroform	67-66-3	119.38	EPI	6.83E-03	EPI	1	E	4.89E-01	2.87E-02	3.21E-01	3.53E-01	1.17E+00	4.94E-03	2.37E-02	
Chloromethane	74-87-3	50.49	EPI	3.28E-03	EPI	1	E	2.01E-01	8.96E-03	3.09E-01	3.39E-01	4.83E-01	7.22E-03		
b-Chloronaphthalene	91-58-7	162.62	EPI	7.49E-02	EPI	1	E	8.55E-01	3.67E-01	5.79E-01	6.11E-01	2.05E+00		1.90E-01	
o-Chloronitrobenzene	88-73-3	157.56	EPI	6.30E-03	EPI	1	E	8.01E-01	3.04E-02	3.22E-01	3.54E-01	1.92E+00	3.13E-04	7.11E-03	
p-Chloronitrobenzene	100-00-5	157.56	EPI	7.93E-03	EPI	1	E	8.01E-01	3.83E-02	3.27E-01	3.59E-01	1.92E+00	1.49E-02	2.37E-03	
2-Chlorophenol	95-57-8	128.56	EPI	7.99E-03	EPI	1	E	5.51E-01	3.48E-02	3.25E-01	3.57E-01	1.32E+00		1.19E-02	
2-Chloropropane	75-29-6	78.54	EPI	1.04E-02	EPI	1	E	2.89E-01	3.54E-02	3.25E-01	3.57E-01	6.94E-01			
o-Chlorotoluene	95-49-8	126.59	EPI	5.72E-02	EPI	1	E	5.37E-01	2.48E-01	4.76E-01	5.15E-01	1.29E+00		4.74E-02	
Chromium III	16065-83-1	52	P	1.00E-03	E	1	E	2.05E-01	2.77E-03	3.05E-01	3.35E-01	4.93E-01		4.62E-02	
Chromium VI	18540-29-9	52	P	2.00E-03	E	1	E	2.05E-01	5.55E-03	3.07E-01	3.37E-01	4.93E-01	4.69E-06	1.78E-04	1.52E-06
Chromium (Total)		52	P	1.00E-03	E	1	E	2.05E-01	2.77E-03	3.05E-01	3.35E-01	4.93E-01	1.71E-05	3.96E-02	
Chrysene	218-01-9	228.3	EPI	5.96E-01	EPI	1	E	1.99E+00	3.46E+00	9.15E+00	3.54E+00	8.52E+00	1.29E-02		4.16E-03
Copper	7440-50-8	63.55	P	1.00E-03	E	1	E	2.38E-01	3.07E-03	3.05E-01	3.35E-01	5.72E-01		9.48E-02	
Crotonaldehyde	123-73-9	70.09	EPI	1.59E-03	EPI	1	E	2.59E-01	5.12E-03	3.06E-01	3.37E-01	6.22E-01	4.94E-05	2.37E-03	
Cumene (isopropylbenzene)	98-82-8	120.2	EPI	8.97E-02	EPI	1	E	4.95E-01	3.78E-01	5.89E-01	6.20E-01	1.19E+00		2.37E-01	
Cyanide	57-12-5	27.03	EPI	7.54E-04	EPI	1	E	1.49E-01	1.51E-03	3.04E-01	3.34E-01	3.57E-01		1.42E-03	
Cyanogen	460-19-5	52.04	EPI	8.90E-04	EPI	1	E	2.05E-01	2.47E-03	3.05E-01	3.35E-01	4.93E-01		2.37E-03	
Cyanogen bromide	506-68-3	105.92	EPI	2.55E-04	EPI	1	E	4.11E-01	1.01E-03	3.04E-01	3.34E-01	9.88E-01		2.13E-01	
Cyanogen chloride	506-77-4	61.47	EPI	3.94E-04	EPI	1	E	2.32E-01	1.19E-03	3.04E-01	3.34E-01	5.57E-01		1.19E-01	
DDD	72-54-8	320.05	EPI	2.51E-01	EPI	0.8	E	6.51E+00	1.73E+00	2.89E+00	1.85E+00	2.62E+01	3.91E-04		
DDE	72-55-9	318.03	EPI	5.45E-01	EPI	0.8	E	6.34E+00	3.74E+00	1.05E+01	3.81E+00	2.73E+01	2.76E-04		
DDT	50-29-3	354.49	EPI	6.28E-01	EPI	0.7	E	1.01E+01	4.55E+00	1.50E+01	4.61E+00	4.42E+01	2.76E-04	1.19E-03	
Dibenz(a,h)anthracene	53-70-3	278.36	EPI	9.53E-01	EPI	0.6	E	3.80E+00	6.12E+00	2.61E+01	6.16E+00	1.69E+01	1.29E-05		4.16E-06
1,2-Dibromo-3-chloropropane	96-12-8	236.33	EPI	6.85E-03	EPI	1	E	2.21E+00	4.05E-02	3.28E-01	3.61E-01	5.31E+00	1.17E-04	4.74E-04	3.79E-05
Dibromochloromethane	124-48-1	208.28	EPI	2.89E-03	EPI	1	E	1.54E+00	1.60E-02	3.13E-01	3.44E-01	3.70E+00	1.12E-03	4.74E-02	
1,2-Dibromoethane	106-93-4	187.86	EPI	2.78E-03	EPI	1	E	1.18E+00	1.47E-02	3.12E-01	3.43E-01	2.84E+00	4.69E-05	2.13E-02	
1,4-Dichloro-2-butene	764-41-0	125	EPI	1.66E-02	EPI	1	E	5.26E-01	7.14E-02	3.48E-01	3.83E-01	1.26E+00			

Chemical	**CAS. NO.**	**MW (g/mole)**	**Ref.**	**Kp (cm/hr)**	**Ref.**	**FA (unitless)**	**Ref.**	**τ_{event} (hr/event)**	**B (unitless)**	**b**	**c**	**t* (hr)**	**DA_event carc**	**DA_event noncarc**	**DA_event mutagen**
1,2-Dichlorobenzene	95-50-1	147	EPI	4.46E-02	EPI	1	E	6.99E-01	2.08E-01	4.45E-01	4.84E-01	1.68E+00		2.13E-01	
1,4-Dichlorobenzene	106-46-7	147	EPI	4.53E-02	EPI	1	E	6.99E-01	2.11E-01	4.48E-01	4.86E-01	1.68E+00	1.74E-02	1.66E-01	
3,3-Dichlorobenzidine	91-94-1	253.13	EPI	1.28E-02	EPI	1	E	2.75E+00	7.83E-02	3.53E-01	3.87E-01	6.59E+00	2.09E-04		
Dichlorodifluoromethane	75-71-8	120.91	EPI	8.95E-03	EPI	1	E	4.99E-01	3.79E-02	3.27E-01	3.59E-01	1.20E+00		4.74E-01	
1,1-Dichloroethane	75-34-3	98.96	EPI	6.75E-03	EPI	1	E	3.76E-01	2.58E-02	3.19E-01	3.51E-01	9.03E-01	1.65E-02	4.74E-01	
1,2-Dichloroethane	107-06-2	98.96	EPI	4.20E-03	EPI	1	E	3.76E-01	1.61E-02	3.13E-01	3.44E-01	9.03E-01	1.03E-03	1.42E-02	
cis-1,2-Dichloroethene	156-59-2	96.94	EPI	9.55E-03	EPI	1	E	3.66E-01	3.62E-02	3.26E-01	3.58E-01	8.80E-01		4.74E-03	
trans-1,2-Dichloroethene	156-60-5	96.94	EPI	9.55E-03	EPI	1	E	3.66E-01	3.62E-02	3.26E-01	3.58E-01	8.80E-01		4.74E-02	
1,1-Dichloroethene	75-35-4	96.94	EPI	1.17E-02	EPI	1	E	3.66E-01	4.43E-02	3.31E-01	3.63E-01	8.80E-01		1.19E-01	
2,4-Dichlorophenol	120-83-2	163	EPI	2.06E-02	EPI	1	E	8.59E-01	1.01E-01	3.68E-01	4.04E-01	2.06E+00		7.11E-03	
1,2-Dichloropropane	78-87-5	112.99	EPI	7.53E-03	EPI	1	E	4.51E-01	3.08E-02	3.22E-01	3.54E-01	1.08E+00	2.61E-03	2.13E-01	
1,3-Dichloropropene	542-75-6	110.97	EPI	8.34E-03	EPI	1	E	4.39E-01	3.38E-02	3.24E-01	3.56E-01	1.05E+00	9.39E-04	7.11E-02	
Dicyclopentadiene	77-73-6	132.21	EPI	3.60E-02	EPI	1	E	5.78E-01	1.59E-01	4.09E-01	4.47E-01	1.39E+00		1.90E-01	
Dieldrin	60-57-1	380.91	EPI	3.26E-02	EPI	0.8	E	1.43E+01	2.45E-01	4.74E-01	5.13E-01	3.42E+01	5.87E-06	1.19E-04	
Diethyl phthalate	84-66-2	222.24	EPI	3.60E-03	EPI	1	E	1.84E+00	2.06E-02	3.16E-01	3.47E-01	4.43E+00		1.90E+00	
Di-n-butyl phthalate (Dibutyl phthalate)	84-74-2	278.35	EPI	4.20E-02	EPI	0.9	E	3.80E+00	2.70E-01	4.94E-01	5.32E-01	9.12E+00		2.37E-01	
2,4-Dimethylphenol	105-67-9	122.17	EPI	1.09E-02	EPI	1	E	5.07E-01	4.63E-02	3.32E-01	3.65E-01	1.22E+00		4.74E-02	
4,6-Dinitro-o-cresol	534-52-1	198.14	EPI	3.15E-03	EPI	1	E	1.35E+00	1.71E-02	3.14E-01	3.45E-01	3.24E+00		1.90E-04	
2,4-Dinitrophenol	51-28-5	184.11	EPI	1.87E-03	EPI	1	E	1.13E+00	9.76E-03	3.09E-01	3.40E-01	2.71E+00		4.74E-03	
2,4-Dinitrotoluene	121-14-2	182.14	EPI	3.08E-03	EPI	1	E	1.10E+00	1.60E-02	3.13E-01	3.44E-01	2.64E+00	3.03E-04	4.74E-03	
2,6-Dintitrotoluene	606-20-2	182.14	EPI	3.70E-03	EPI	1	E	1.10E+00	1.92E-02	3.15E-01	3.46E-01	2.64E+00	6.26E-05	7.11E-04	
2,4/2,6-Dintrotoluene Mixture	25321-14-6	182.14	EPI	4.16E-03	EPI	1	E	1.10E+00	2.16E-02	3.17E-01	3.48E-01	2.64E+00	1.38E-04		
1,4-Dioxane	123-91-1	88.11	EPI	3.32E-04	EPI	1	E	3.27E-01	1.20E-03	3.04E-01	3.34E-01	7.85E-01	9.39E-04	7.11E-02	
1,2-Diphenylhydrazine	122-66-7	184.24	EPI	1.30E-02	EPI	1	E	1.13E+00	6.79E-02	3.46E-01	3.80E-01	2.71E+00	1.17E-04		
Endosulfan	115-29-7	406.92	EPI	2.86E-03	EPI	1	E	1.99E+01	2.22E-02	3.17E-01	3.48E-01	4.79E+01		1.42E-02	
Endrin	72-20-8	380.91	EPI	3.26E-02	EPI	0.8	E	1.43E+01	2.45E-01	4.74E-01	5.13E-01	3.42E+01		7.11E-04	
Epichlorohydrin	106-89-8	92.53	EPI	9.44E-04	EPI	1	E	3.46E-01	3.49E-03	3.05E-01	3.36E-01	8.31E-01	9.48E-03	1.42E-02	
Ethyl acetate	141-78-6	88.11	EPI	1.53E-03	EPI	1	E	3.27E-01	5.52E-03	3.07E-01	3.37E-01	7.85E-01		2.13E+00	
Ethyl acrylate	140-88-5	100.12	EPI	3.24E-03	EPI	1	E	3.82E-01	1.25E-02	3.11E-01	3.42E-01	9.16E-01	1.96E-03		
Ethyl chloride	75-00-3	64.52	EPI	6.07E-03	EPI	1	E	2.41E-01	1.88E-02	3.15E-01	3.46E-01	5.79E-01			
Ethyl ether	60-29-7	74.12	EPI	2.35E-03	EPI	1	E	2.73E-01	7.78E-03	3.08E-01	3.39E-01	6.55E-01		4.74E-01	
Ethyl methacrylate	97-63-2	114.15	EPI	6.98E-03	EPI	1	E	4.58E-01	2.87E-02	3.21E-01	3.53E-01	1.10E+00		2.13E-01	
Ethylbenzene	100-41-4	106.17	EPI	4.93E-02	EPI	1	E	4.13E-01	1.95E-01	4.35E-01	4.74E-01	9.91E-01	8.53E-03	2.37E-01	
Ethylene oxide	75-21-8	44.05	EPI	5.60E-04	EPI	1	E	1.85E-01	1.43E-03	3.04E-01	3.34E-01	4.45E-01	3.03E-04		
Fluoranthene	206-44-0	202.26	EPI	3.08E-01	EPI	1	E	1.43E+00	1.68E+00	2.78E+00	1.81E+00	5.72E+00		9.48E-02	
Fluorene	86-73-7	166.22	EPI	1.10E-01	EPI	1	E	8.95E-01	5.45E-01	7.59E-01	7.61E-01	2.15E+00		9.48E-02	

Chemical	**CAS. NO.**	**MW (g/mole)**	**Ref.**	**Kp (cm/hr)**	**Ref.**	**FA (unitless)**	**Ref.**	**τ_{event} (hr/event)**	**B (unitless)**	**b**	**c**	**t* (hr)**	**DA_event carc**	**DA_event noncarc**	**DA_event mutagen**
Fluoride	7782-41-4	19	P	1.00E-03	E	1	E	1.34E-01	1.68E-03	3.04E-01	3.34E-01	3.22E-01		1.42E-01	
Furan	110-00-9	68.08	EPI	5.05E-03	EPI	1	E	2.53E-01	1.60E-02	3.13E-01	3.44E-01	6.06E-01		2.37E-03	
Heptachlor	76-44-8	373.32	EPI	5.44E-02	EPI	0.8	E	1.29E+01	4.04E-01	6.14E-01	6.42E-01	3.10E+01	2.09E-05	1.19E-03	
Hexachlorobenzene	118-74-1	284.78	EPI	2.54E-01	EPI	0.9	E	4.13E+00	1.65E+00	2.69E+00	1.77E+00	1.65E+01	5.87E-05	1.90E-03	
Hexachloro-1,3-butadiene	87-68-3	260.76	EPI	8.10E-02	EPI	0.9	E	3.03E+00	5.03E-01	7.13E-01	7.25E-01	7.27E+00	1.20E-03	2.37E-03	
Hexachlorocyclopentadiene	77-47-4	272.77	EPI	1.03E-01	EPI	1	E	3.54E+00	6.54E-01	8.86E-01	8.56E-01	1.39E+01		1.42E-02	
Hexachloroethane	67-72-1	236.74	EPI	4.15E-02	EPI	1	E	2.22E+00	2.46E-01	4.75E-01	5.13E-01	5.34E+00	2.35E-03	1.66E-03	
n-Hexane	110-54-3	86.18	EPI	2.01E-01	EPI	1	E	3.19E-01	7.18E-01	9.67E-01	9.12E-01	1.24E+00		1.42E-01	
HMX	2691-41-0	296.16	EPI	4.36E-05	EPI	1	E	4.78E+00	2.89E-04	3.03E-01	3.34E-01	1.15E+01		1.19E-01	
Hydrazine anhydride	302-01-2	32.05	EPI	4.36E-05	EPI	1	E	1.59E-01	9.49E-05	3.03E-01	3.33E-01	3.81E-01	3.13E-05		
Hydrogen cyanide	74-90-8	27.03	EPI	7.54E-04	EPI	1	E	1.49E-01	1.51E-03	3.04E-01	3.34E-01	3.57E-01		1.42E-03	
Indeno(1,2,3-c,d)pyrene	193-39-5	276.34	EPI	1.24E+00	EPI	0.6	E	3.70E+00	7.93E+00	4.28E+01	7.97E+00	1.66E+01	1.29E-04		4.16E-05
Iron	7439-89-6	55.85	P	1.00E-03	E	1	E	2.16E-01	2.87E-03	3.05E-01	3.35E-01	5.18E-01		1.66E+00	
Isobutanol (Isobutyl alcohol)	78-83-1	74.12	EPI	1.92E-03	EPI	1	E	2.73E-01	6.36E-03	3.07E-01	3.38E-01	6.55E-01		7.11E-01	
Isophorone	78-59-1	138.21	EPI	3.54E-03	EPI	1	E	6.24E-01	1.60E-02	3.13E-01	3.44E-01	1.50E+00	9.88E-02	4.74E-01	
Lead	7439-92-1	207.2	P	1.00E-03	E	1	E	1.52E+00	5.54E-03	3.07E-01	3.37E-01	3.65E+00			
Lead (tetraethyl-)	78-00-2	323.45	EPI	1.37E-02	EPI	1	E	6.80E+00	9.48E-02	3.64E-01	3.99E-01	1.63E+01		2.37E-07	
Maleic hydrazide	123-33-1	112.09	EPI	1.02E-04	EPI	1	E	4.46E-01	4.15E-04	3.04E-01	3.34E-01	1.07E+00		1.19E+00	
Manganese	7439-96-5	54.94	P	1.00E-03	E	1	E	2.13E-01	2.85E-03	3.05E-01	3.35E-01	5.12E-01		1.33E-02	
Mercury (elemental)	7439-97-6	200.59	EPI	1.00E-03	E	1	E	1.39E+00	5.45E-03	3.07E-01	3.37E-01	3.35E+00			
Mercury (methyl)	22967-92-6	215.63	EPI	1.00E-03	E	1	E	1.69E+00	5.65E-03	3.07E-01	3.37E-01	4.06E+00		2.37E-04	
Mercury Chloride (Mercury Salts)	7487-94-7	271.5	EPI	1.00E-03	E	1	E	3.48E+00	6.34E-03	3.07E-01	3.38E-01	8.35E+00		4.98E-05	
Methacrylonitrile	126-98-7	67.09	EPI	1.86E-03	EPI	1	E	2.49E-01	5.86E-03	3.07E-01	3.37E-01	5.99E-01		2.37E-04	
Methomyl	16752-77-5	162.21	EPI	4.82E-04	EPI	1	E	8.50E-01	2.36E-03	3.05E-01	3.35E-01	2.04E+00		5.93E-02	
Methyl acetate	79-20-9	74.08	EPI	7.92E-04	EPI	1	E	2.73E-01	2.62E-03	3.05E-01	3.35E-01	6.55E-01		2.37E+00	
Methyl acrylate	96-33-3	86.09	EPI	1.75E-03	EPI	1	E	3.19E-01	6.25E-03	3.07E-01	3.38E-01	7.65E-01		7.11E-02	
Methyl isobutyl ketone	108-10-1	100.16	EPI	3.19E-03	EPI	1	E	3.82E-01	1.23E-02	3.11E-01	3.42E-01	9.17E-01		1.90E-01	
Methyl methacrylate	80-62-6	100.12	EPI	3.55E-03	EPI	1	E	3.82E-01	1.37E-02	3.12E-01	3.43E-01	9.16E-01		3.32E+00	
Methyl styrene (alpha)	98-83-9	118.18	EPI	6.99E-02	EPI	1	E	4.82E-01	2.92E-01	5.13E-01	5.50E-01	1.16E+00		1.66E-01	
Methyl styrene (mixture)	25013-15-4	118.18	EPI	6.60E-02	EPI	1	E	4.82E-01	2.76E-01	4.99E-01	5.37E-01	1.16E+00		1.42E-02	
Methylcyclohexane	108-87-2	98.19	EPI	1.10E-01	EPI	1	E	3.72E-01	4.19E-01	6.28E-01	6.54E-01	8.94E-01			
Methylene bromide (Dibromomethane)	74-95-3	173.84	EPI	2.23E-03	EPI	1	E	9.88E-01	1.13E-02	3.10E-01	3.41E-01	2.37E+00		2.37E-02	
Methylene chloride	75-09-2	84.93	EPI	3.54E-03	EPI	1	E	3.14E-01	1.25E-02	3.11E-01	3.42E-01	7.53E-01	4.69E-02	1.42E-02	1.52E-02
Molybdenum	7439-98-7	95.96	P	1.00E-03	E	1	E	3.62E-01	3.77E-03	3.06E-01	3.36E-01	8.69E-01		1.19E-02	
Naphthalene	91-20-3	128.18	EPI	4.66E-02	EPI	1	E	5.48E-01	2.03E-01	4.41E-01	4.80E-01	1.32E+00		4.74E-02	
Nickel	7440-02-0	58.69	EPI	2.00E-04	E	1	E	2.24E-01	5.89E-04	3.04E-01	3.34E-01	5.37E-01		1.90E-03	

Chemical	CAS. NO.	MW (g/mole)	Ref.	Kp (cm/hr)	Ref.	FA (unitless)	Ref.	τ_{event} (hr/event)	B (unitless)	b	c	t* (hr)	DA_event carc	DA_event noncarc	DA_event mutagen
Nitrate	14797-55-8	62	EPI	1.00E-03	E	1	E	2.34E-01	3.03E-03	3.05E-01	3.35E-01	5.61E-01		3.79E+00	
Nitrite	14797-65-0	47.01	EPI	1.00E-03	E	1	E	1.93E-01	2.64E-03	3.05E-01	3.35E-01	4.62E-01		2.37E-01	
Nitrobenzene	98-95-3	123.11	EPI	5.41E-03	EPI	1	E	5.14E-01	2.31E-02	3.17E-01	3.49E-01	1.23E+00		4.74E-03	
Nitroglycerin	55-63-0	227.09	EPI	9.94E-04	EPI	1	E	1.96E+00	5.76E-03	3.07E-01	3.37E-01	4.71E+00	5.52E-03	2.37E-04	
N-Nitrosodiethylamine	55-18-5	102.14	EPI	8.72E-04	EPI	1	E	3.92E-01	3.39E-03	3.05E-01	3.36E-01	9.41E-01	6.26E-07		2.02E-07
N-Nitrosodimethylamine	62-75-9	74.08	EPI	2.51E-04	EPI	1	E	2.73E-01	8.31E-04	3.04E-01	3.34E-01	6.55E-01	1.84E-06	1.90E-05	5.95E-07
N-Nitrosodi-n-butylamine	924-16-3	158.25	EPI	1.13E-02	EPI	1	E	8.08E-01	5.47E-02	3.37E-01	3.71E-01	1.94E+00	1.74E-05		
N-Nitrosodiphenylamine	86-30-6	198.23	EPI	1.45E-02	EPI	1	E	1.35E+00	7.85E-02	3.53E-01	3.88E-01	3.25E+00	1.92E-02		
N-Nitrosopyrrolidine	930-55-2	100.12	EPI	3.21E-04	EPI	1	E	3.82E-01	1.24E-03	3.04E-01	3.34E-01	9.16E-01	4.47E-05		
m-Nitrotoluene	99-08-1	137.14	EPI	1.13E-02	EPI	1	E	6.15E-01	5.09E-02	3.35E-01	3.68E-01	1.48E+00		2.37E-04	
o-Nitrotoluene	88-72-2	137.14	EPI	8.99E-03	EPI	1	E	6.15E-01	4.05E-02	3.28E-01	3.61E-01	1.48E+00	4.27E-04	2.13E-03	
p-Nitrotoluene	99-99-0	137.14	EPI	1.00E-02	EPI	1	E	6.15E-01	4.50E-02	3.31E-01	3.64E-01	1.48E+00	5.87E-03	9.48E-03	
Pentachlorobenzene	608-93-5	250.34	EPI	1.68E-01	EPI	0.9	E	2.65E+00	1.02E+00	1.42E+00	1.19E+00	1.02E+01		1.90E-03	
Pentachlorophenol	87-86-5	266.34	EPI	1.27E-01	EPI	0.9	E	3.26E+00	7.97E-01	1.07E+00	9.83E-01	1.25E+01	2.35E-04	1.19E-02	
Perchlorate	14797-73-0	99.45	EPI	1.00E-03	E	1	E	3.79E-01	3.84E-03	3.06E-01	3.36E-01	9.08E-01		1.66E-03	
Phenanthrene	85-01-8	178.24	EPI	1.44E-01	EPI	1	E	1.05E+00	7.39E-01	9.95E-01	9.31E-01	4.04E+00		7.11E-02	
Phenol	108-95-2	94.11	EPI	4.34E-03	EPI	1	E	3.53E-01	1.62E-02	3.13E-01	3.44E-01	8.48E-01		7.11E-01	
Polychlorinatedbiphenyls															
Aroclor 1016	12674-11-2	257.55	EPI	3.05E-01	EPI	0.6	E	2.91E+00	1.88E+00	3.29E+00	2.00E+00	1.18E+01	1.34E-03	1.66E-04	
Aroclor 1221	11104-28-2	188.66	EPI	1.68E-01	EPI	0.6	E	1.20E+00	8.88E-01	1.20E+00	1.06E+00	4.60E+00	4.69E-05		
Aroclor 1232	11141-16-5	188.66	EPI	1.68E-01	EPI	0.6	E	1.20E+00	8.88E-01	1.20E+00	1.06E+00	4.60E+00	4.69E-05		
Aroclor 1242	53469-21-9	291.99	EPI	5.45E-01	EPI	0.6	E	4.53E+00	3.58E+00	9.71E+00	3.65E+00	1.94E+01	4.69E-05		
Aroclor 1248	12672-29-6	291.99	EPI	4.75E-01	EPI	0.6	E	4.53E+00	3.12E+00	7.61E+00	3.20E+00	1.92E+01	4.69E-05		
Aroclor 1254	11097-69-1	326.44	EPI	7.51E-01	EPI	0.6	E	7.07E+00	5.22E+00	1.93E+01	5.27E+00	3.10E+01	4.69E-05	4.74E-05	
Aroclor 1260	11096-82-5	395.33	EPI	9.86E-01	EPI	0.6	E	1.72E+01	7.54E+00	3.89E+01	7.58E+00	7.69E+01	4.69E-05		
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)	35065-30-6	395.33	EPI	2.96E+00	EPI	0.6	E	1.72E+01	2.26E+01	3.33E+02	2.27E+01	7.95E+01	7.22E-06	1.66E-05	
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)	35065-29-3	395.33	EPI	2.96E+00	EPI	0.6	E	1.72E+01	2.26E+01	3.33E+02	2.27E+01	7.95E+01	7.22E-05	1.66E-04	
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)	39635-31-9	395.33	EPI	2.96E+00	EPI	0.6	E	1.72E+01	2.26E+01	3.33E+02	2.27E+01	7.95E+01	2.41E-05	5.53E-05	
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)	52663-72-6	360.88	EPI	1.43E+00	EPI	0.5	E	1.10E+01	1.04E+01	7.30E+01	1.05E+01	5.00E+01	2.41E-05	5.53E-05	
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)	69782-90-7	360.88	EPI	1.66E+00	EPI	0.5	E	1.10E+01	1.21E+01	9.76E+01	1.22E+01	5.02E+01	2.41E-05	5.53E-05	
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)	38380-08-4	360.88	EPI	1.66E+00	EPI	0.5	E	1.10E+01	1.21E+01	9.76E+01	1.22E+01	5.02E+01	2.41E-05	5.53E-05	
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)	32774-16-6	360.88	EPI	1.24E+00	EPI	0.5	E	1.10E+01	9.06E+00	5.53E+01	9.09E+00	4.97E+01	2.41E-08	5.53E-08	
2',3,4,4',5-Pentachlorobiphenyl (PCB 123)	65510-44-3	326.44	EPI	1.00E+00	EPI	0.6	E	7.07E+00	6.95E+00	3.32E+01	6.99E+00	3.15E+01	2.41E-05	5.53E-05	
2',3',4,4',5-Pentachlorobiphenyl (PCB 118)	31508-00-6	326.44	EPI	1.24E+00	EPI	0.6	E	7.07E+00	8.62E+00	5.02E+01	8.65E+00	3.18E+01	2.41E-05	5.53E-05	
2',3,3',4,4'-Pentachlorobiphenyl (PCB 105)	32598-14-4	326.44	EPI	7.51E-01	EPI	0.6	E	7.07E+00	5.22E+00	1.93E+01	5.27E+00	3.10E+01	2.41E-05	5.53E-05	
2,3,4,4',5-Pentachlorobiphenyl (PCB 114)	74472-37-0	326.44	EPI	1.00E+00	EPI	0.6	E	7.07E+00	6.95E+00	3.32E+01	6.99E+00	3.15E+01	2.41E-05	5.53E-05	

Chemical	CAS. NO.	MW (g/mole)	Ref.	Kp (cm/hr)	Ref.	FA (unitless)	Ref.	τ_{event} (hr/event)	B (unitless)	b	c	t* (hr)	DA_event carc	DA_event noncarc	DA_event mutagen
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)	57465-28-8	326.44	EPI	1.00E+00	EPI	0.6	E	7.07E+00	6.95E+00	3.32E+01	6.99E+00	3.15E+01	7.22E-09	1.66E-08	
3,3',4,4'-Tetrachlorobiphenyl (PCB 77)	32598-13-3	291.99	EPI	9.17E-01	EPI	0.6	E	4.53E+00	6.03E+00	2.54E+01	6.07E+00	2.01E+01	7.22E-06	1.66E-05	
3,4,4',5-Tetrachlorobiphenyl (PCB 81)	70362-50-4	291.99	EPI	5.84E-01	EPI	0.6	E	4.53E+00	3.84E+00	1.10E+01	3.91E+00	1.95E+01	2.41E-06	5.53E-06	
Propylene oxide	75-56-9	58.08	EPI	7.74E-04	EPI	1	E	2.22E-01	2.27E-03	3.05E-01	3.35E-01	5.33E-01	3.91E-04		
Pyrene	129-00-0	202.26	EPI	2.01E-01	EPI	1	E	1.43E+00	1.10E+00	1.55E+00	1.26E+00	5.53E+00		7.11E-02	
RDX	121-82-4	222.12	EPI	3.36E-04	EPI	1	E	1.84E+00	1.93E-03	3.04E-01	3.35E-01	4.42E+00	8.53E-04	7.11E-03	
Selenium	7782-49-2	78.96	P	1.00E-03	E	1	E	2.91E-01	3.42E-03	3.05E-01	3.36E-01	6.98E-01		1.19E-02	
Silver	7440-22-4	107.87	P	6.00E-04	E	1	E	4.22E-01	2.40E-03	3.05E-01	3.35E-01	1.01E+00		4.74E-04	
Strontium	7440-24-6	87.62	P	1.00E-03	E	1	E	3.25E-01	3.60E-03	3.05E-01	3.36E-01	7.80E-01		1.42E+00	
Styrene	100-42-5	104.15	EPI	3.72E-02	EPI	1	E	4.02E-01	1.46E-01	3.99E-01	4.37E-01	9.65E-01		4.74E-01	
Sulfolane	126-33-0	120.17	EPI	1.02E-04	EPI	1	EPI	4.94E-01	4.30E-04	3.04E-01	3.34E-01	1.19E+00		2.37E-03	
2,3,7,8-TCDD	1746-01-6	321.98	EPI	8.08E-01	EPI	0.5	E	6.67E+00	5.58E+00	2.19E+01	5.63E+00	2.94E+01	7.22E-10	1.66E-09	
2,3,7,8-TCDF	51207-31-9	305.98	EPI	6.57E-01	EPI	1	E	5.43E+00	4.42E+00	1.42E+01	4.48E+00	2.36E+01	7.22E-09		
1,2,4,5-Tetrachlorobenzene	95-94-3	215.89	EPI	1.17E-01	EPI	1	E	1.70E+00	6.61E-01	8.95E-01	8.62E-01	6.66E+00		7.11E-04	
1,1,1,2-Tetrachloroethane	630-20-6	167.85	EPI	1.59E-02	EPI	1	E	9.14E-01	7.92E-02	3.53E-01	3.88E-01	2.19E+00	3.61E-03	7.11E-02	
1,1,2,2-Tetrachloroethane	79-34-5	167.85	EPI	6.94E-03	EPI	1	E	9.14E-01	3.46E-02	3.25E-01	3.57E-01	2.19E+00	4.69E-04	4.74E-02	
Tetrachloroethene	127-18-4	165.83	EPI	3.34E-02	EPI	1	E	8.91E-01	1.65E-01	4.13E-01	4.51E-01	2.14E+00	4.47E-02	1.42E-02	
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	287.15	EPI	4.74E-04	EPI	1	E	4.26E+00	3.09E-03	3.05E-01	3.35E-01	1.02E+01		4.74E-03	
Thallium	7440-28-0	204.38	P	1.00E-03	E	1	E	1.46E+00	5.50E-03	3.07E-01	3.37E-01	3.52E+00		2.37E-05	
Toluene	108-88-3	92.14	EPI	3.11E-02	EPI	1	E	3.44E-01	1.15E-01	3.77E-01	4.14E-01	8.27E-01		1.90E-01	
Toxaphene	8001-35-2	413.82	EPI	5.18E-02	EPI	0.8	E	2.18E+01	4.05E-01	6.15E-01	6.42E-01	5.23E+01	8.53E-05		
Tribromomethane (Bromoform)	75-25-2	252.73	EPI	2.35E-03	EPI	1	E	2.73E+00	1.44E-02	3.12E-01	3.43E-01	6.56E+00	1.19E-02	4.74E-02	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.38	EPI	1.75E-02	EPI	1	E	1.18E+00	9.21E-02	3.62E-01	3.97E-01	2.82E+00		7.11E+01	
1,2,4-Trichlorobenzene	120-82-1	181.45	EPI	7.05E-02	EPI	1	E	1.09E+00	3.65E-01	5.77E-01	6.09E-01	2.62E+00	3.24E-03	2.37E-02	
1,1,1-Trichloroethane	71-55-6	133.41	EPI	1.26E-02	EPI	1	E	5.87E-01	5.60E-02	3.38E-01	3.72E-01	1.41E+00		4.74E+00	
1,1,2-Trichloroethane	79-00-5	133.41	EPI	5.04E-03	EPI	1	E	5.87E-01	2.24E-02	3.17E-01	3.48E-01	1.41E+00	1.65E-03	9.48E-03	
Trichloroethylene	79-01-6	131.39	EPI	1.16E-02	EPI	1	E	5.71E-01	5.11E-02	3.35E-01	3.68E-01	1.37E+00	2.04E-03	1.19E-03	4.36E-04
Trichlorofluoromethane	75-69-4	137.37	EPI	1.27E-02	EPI	1	E	6.17E-01	5.73E-02	3.39E-01	3.73E-01	1.48E+00		7.11E-01	
2,4,5-Trichlorophenol	95-95-4	197.45	EPI	3.62E-02	EPI	1	E	1.34E+00	1.96E-01	4.36E-01	4.74E-01	3.21E+00		2.37E-01	
2,4,6-Trichlorophenol	88-06-2	197.45	EPI	3.46E-02	EPI	1	E	1.34E+00	1.87E-01	4.29E-01	4.68E-01	3.21E+00	8.53E-03	2.37E-03	
1,1,2-Trichloropropane	598-77-6	147.43	EPI	9.60E-03	EPI	1	E	7.03E-01	4.48E-02	3.31E-01	3.64E-01	1.69E+00		1.19E-02	
1,2,3-Trichloropropane	96-18-4	147.43	EPI	7.52E-03	EPI	1	E	7.03E-01	3.51E-02	3.25E-01	3.57E-01	1.69E+00	3.13E-06	9.48E-03	1.01E-06
Triethylamine	121-44-8	101.19	EPI	3.90E-03	EPI	1	E	3.87E-01	1.51E-02	3.13E-01	3.43E-01	9.29E-01			
2,4,6-Trinitrotoluene	118-96-7	227.13	EPI	9.63E-04	EPI	1	E	1.96E+00	5.58E-03	3.07E-01	3.37E-01	4.71E+00	3.13E-03	1.19E-03	
Uranium (soluable salts)	--	238.03	P	1.00E-03	E	1	E	2.26E+00	5.93E-03	3.07E-01	3.37E-01	5.42E+00		7.11E-03	
Vanadium	7440-62-2	50.94	EPI	1.00E-03	E	1	E	2.03E-01	2.75E-03	3.05E-01	3.35E-01	4.86E-01		3.11E-04	

Chemical	CAS. NO.	MW (g/mole)	Ref.	Kp (cm/hr)	Ref.	FA (unitless)	Ref.	τ_{event} (hr/event)	B (unitless)	b	c	t* (hr)	DA_event carc	DA_event noncarc	DA_event mutagen
Vinyl acetate	108-05-4	86.09	P	1.57E-03	EPI	1	E	3.19E-01	5.60E-03	3.07E-01	3.37E-01	7.65E-01		2.37E+00	
Vinyl bromide	593-60-2	106.95	EPI	4.35E-03	EPI	1	E	4.17E-01	1.73E-02	3.14E-01	3.45E-01	1.00E+00			
Vinyl chloride	75-01-4	62.5	EPI	8.38E-03	EPI	1	E	2.35E-01	2.55E-02	3.19E-01	3.51E-01	5.64E-01	1.30E-04	7.11E-03	3.06E+05
m-Xylene	108-38-3	106.17	EPI	5.32E-02	EPI	1	E	4.13E-01	2.11E-01	4.47E-01	4.86E-01	9.91E-01		4.74E-01	
o-Xylene	95-47-6	106.17	EPI	5.00E-02	EPI	1	E	4.13E-01	1.98E-01	4.38E-01	4.76E-01	9.91E-01		4.74E-01	
Xylenes	1330-20-7	106.17	EPI	5.00E-02	EPI	1	E	4.13E-01	1.98E-01	4.38E-01	4.76E-01	9.91E-01		4.74E-01	
Zinc	7440-66-6	65.38	P	6.00E-04	E	1	E	2.44E-01	1.87E-03	3.04E-01	3.35E-01	5.86E-01		7.11E-01	

K_p – Dermal permeability coefficient in water
FA – Fraction absorbed
T_{event} – Lag time per event
B – Ratio of the permeability coefficient of chemical through the stratum corneum relative to its permeability coefficient across the viable epidermis
b, c – Correlation coefficients (see RAGS Part E).
t* - Time to reach steady state
DA_{event} Carc. – Absorbed dose per event, carcinogens
DA_{event} Noncarc – Absorbed dose per event, noncarcinogens
DA_{event} Mutagens – Absorbed dose per event, mutagens

E = US EPA. 2004. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Interim Guidance. Office of Solid Waste and Emergency Response, Washington, D.C. http://www.epa.gov/oswer/riskassessment/ragse/index.htm
EPI= US EPA. 2012. Estimation Programs Interface (EPI) Suite™ for Microsoft® Windows, v 4.11. Washington, DC, USA.

APPENDIX C

TOXICITY DATA

Table C-1: Human Health Benchmarks Used for Calculating SSLs

Chemical	SF_o (mg/kg-day)$^{-1}$	Ref.	IUR (ug/m^3)$^{-1}$	Ref.	RfD_o (mg/kg-day)	Ref.	RfCi (mg/m^3)	Ref.	Mutagen	GIABS	Ref.	Dermal ABS	Ref.
Acenaphthene					6.00E-02	IRIS				1	E	0.13	E
Acetaldehyde			2.20E-06	IRIS			9.00E-03	IRIS		1	E		
Acetone					9.00E-01	IRIS	3.10E+01	ATSDR		1	E		
Acrylonitrile	5.40E-01	IRIS	6.80E-05	IRIS	4.00E-02	ATSDR	2.00E-03	IRIS		1	E		
Acetophenone					1.00E-01	IRIS				1	E		
Acrolein					5.00E-04	IRIS	2.00E-05	IRIS		1	E		
Aldrin	1.72E+01	IRIS	4.90E-03	IRIS	3.00E-05	IRIS				1	E	0.1	E
Aluminum					1.00E+00	PPRTV	5.00E-03	PPRTV		1	E		
Anthracene					3.00E-01	IRIS				1	E	0.13	E
Antimony					4.00E-04	IRIS				0.15	E		
Arsenic	1.50E+00	IRIS	4.30E-03	IRIS	3.00E-04	IRIS	1.50E-05	CalEPA		1	E	0.03	E
Barium					2.00E-01	IRIS	5.00E-04	HEAST		0.07	E		
Benzene	5.50E-02	IRIS	7.80E-06	IRIS	4.00E-03	IRIS	3.00E-02	IRIS		1	E		
Benzidine	2.30E+02	IRIS	6.70E-02	IRIS	3.00E-03	IRIS			M	1	E	0.1	E
Benzo(a)anthracene	7.30E-01	PPRTV	1.10E-04	CalEPA					M	1	E	0.13	E
Benzo(a)pyrene	7.30E+00	IRIS	1.10E-03	CalEPA					M	1	E	0.13	E
Benzo(b)fluoranthene	7.30E-01	EPA TEF	1.10E-04	CalEPA					M	1	E	0.13	E
Benzo(k)fluoranthene	7.30E-02	EPA TEF	1.10E-04	CalEPA					M	1	E	0.13	E
Beryllium			2.40E-03	IRIS	2.00E-03	IRIS	2.00E-05	IRIS		0.007	E		
a-BHC (HCH)	6.30E+00	IRIS	1.80E-03	IRIS	8.00E-03	ATSDR				1	E	0.1	E
b-BHC (HCH)	1.80E+00	IRIS	5.30E-04	IRIS						1	E	0.1	E
g-BHC	1.10E+00	CalEPA	3.10E-04	CalEPA	3.00E-04	IRIS				1	E	0.04	E
1,1-Biphenyl	8.20E-03	IRIS			5.00E-01	IRIS	4.00E-04	PPRTV		1	E		
Bis(2-chloroethyl) ether	1.10E+00	IRIS	3.30E-04	IRIS						1	E		
Bis(2-chloroisopropyl) ether	7.00E-02	HEAST								1	E		
Bis(2-ethylhexyl) phthalate	1.40E-02	IRIS	2.40E-06	CalEPA	2.00E-02	IRIS				1	E	0.1	E
Bis(chloromethyl) ether	2.20E+02	IRIS	6.20E-02	IRIS						1	E		
Boron					2.00E-01	IRIS	2.00E-02	HEAST		1	E		
Bromodichloromethane	6.20E-02	IRIS	3.70E-05	CalEPA	2.00E-02	IRIS				1	E		
Bromomethane					1.40E-03	IRIS	5.00E-03	IRIS		1	E		
1,3-Butadiene	3.40E+00	CalEPA	3.00E-05	IRIS			2.00E-03	IRIS		1	E		
2-Butanone (Methyl ethyl ketone, MEK)					6.00E-01	IRIS	5.00E+00	IRIS		1	E		

Chemical	**SF_o (mg/kg-day)$^{-1}$**	**Ref.**	**IUR (ug/m^3)$^{-1}$**	**Ref.**	**RfD_o (mg/kg-day)**	**Ref.**	**RfCi (mg/m^3)**	**Ref.**	**Mutagen**	**GIABS**	**Ref.**	**Dermal ABS**	**Ref.**
tert-Butyl methyl ether (MTBE)	1.80E-03	CalEPA	2.60E-07	CalEPA			3.00E+00	IRIS		1	E		
Cadmium			1.80E-03	IRIS	1.00E-03	IRIS	1.00E-05	ATSDR		0.025	E	0.001	E
Carbon disulfide					1.00E-01	IRIS	7.00E-01	IRIS		1	E		
Carbon tetrachloride	7.00E-02	IRIS	6.00E-06	IRIS	4.00E-03	IRIS	1.00E-01	IRIS		1	E		
Chlordane	3.50E-01	IRIS	1.00E-04	IRIS	5.00E-04	IRIS	7.00E-04	IRIS		1	E	0.04	E
2-Chloroacetophenone							3.00E-05	IRIS		1	E	0.1	E
2-Chloro-1,3-butadiene			3.00E-04	IRIS	2.00E-02	HEAST	2.00E-02	IRIS		1	E		
1-Chloro-1,1-difluoroethane							5.00E+01	IRIS		1	E		
Chlorobenzene					2.00E-02	IRIS	5.00E-02	PPRTV		1	E		
1-Chlorobutane					4.00E-02	PPRTV				1	E		
Chlorodifluoromethane							5.00E+01	IRIS		1	E		
Chloroform	1.90E-02	IRIS	2.30E-05	IRIS	1.00E-02	IRIS	9.80E-02	ATSDR		1	E		
Chloromethane	1.30E-02	HEAST	1.80E-06	HEAST			9.00E-02	IRIS		1	E		
b-Chloronaphthalene					8.00E-02	IRIS				1	E		
o-Chloronitrobenzene	3.00E-01	PPRTV			3.00E-03	PPRTV	1.00E-05	PPRTV		1	E	0.1	E
p-Chloronitrobenzene	6.30E-03	PPRTV			1.00E-03	PPRTV	6.00E-04	PPRTV		1	E	0.1	E
2-Chlorophenol					5.00E-03	IRIS				1	E		
2-Chloropropane							1.00E-01	HEAST		1	E		
o-Chlorotoluene					2.00E-02	IRIS				1	E		
Chromium III					1.50E+00	IRIS				0.013	E		
Chromium VI	5.00E-01	NJ	8.40E-02	IRIS	3.00E-03	IRIS	1.00E-04	IRIS	M	0.025	E		
Chromium (Total)	7.14E-02	NJ, adjusted	1.20E-02	IRIS	1.29E+00	IRIS, adjusted	1.43E-05	IRIS, adjusted		0.013	E		
Chrysene	7.30E-03	EPA TEF	1.10E-05	CalEPA					M	1	E	0.13	E
Copper					4.00E-02	HEAST				1	E		
Crotonaldehyde	1.90E+00	HEAST			1.00E-03	PPRTV				1	E		
Cumene (isopropylbenzene)					1.00E-01	IRIS	4.00E-01	IRIS		1	E		
Cyanide					6.00E-04	IRIS	8.00E-04	IRIS		1	E		
Cyanogen					1.00E-03	IRIS				1	E		
Cyanogen bromide					9.00E-02	IRIS				1	E		
Cyanogen chloride					5.00E-02	IRIS				1	E		
DDD	2.40E-01	IRIS	6.90E-05	CalEPA						1	E	0.1	E
DDE	3.40E-01	IRIS	9.70E-05	CalEPA						1	E	0.1	E
DDT	3.40E-01	IRIS	9.70E-05	IRIS	5.00E-04	IRIS				1	E	0.03	E
Dibenz(a,h)anthracene	7.30E+00	EPA TEF	1.20E-03	CalEPA					M	1	E	0.13	E

Chemical	SF_o (mg/kg-day)$^{-1}$	Ref.	IUR (ug/m^3)$^{-1}$	Ref.	RfD_o (mg/kg-day)	Ref.	RfCi (mg/m^3)	Ref.	Mutagen	GIABS	Ref.	Dermal ABS	Ref.
1,2-Dibromo-3-chloropropane	8.00E-01	PPRTV	6.00E-03	PPRTV	2.00E-04	PPRTV	2.00E-04	IRIS	M	1	E	0.1	E
Dibromochloromethane	8.40E-02	IRIS	2.70E-05	CalEPA	2.00E-02	IRIS				1	E	0.1	E
1,2-Dibromoethane	2.00E+00	IRIS	6.00E-04	IRIS	9.00E-03	IRIS	9.00E-03	IRIS		1	E		
1,4-Dichloro-2-butene			4.20E-03	PPRTV						1	E		
1,2-Dichlorobenzene					9.00E-02	IRIS	2.00E-01	HEAST		1	E		
1,4-Dichlorobenzene	5.40E-03	CalEPA	1.10E-05	CalEPA	7.00E-02	ATSDR	8.00E-01	IRIS		1	E		
3,3-Dichlorobenzidine	4.50E-01	IRIS	3.40E-04	CalEPA						1	E	0.1	E
Dichlorodifluoromethane					2.00E-01	IRIS	1.00E-01	PPRTV		1	E		
1,1-Dichloroethane	5.70E-03	CalEPA	1.60E-06	CalEPA	2.00E-01	PPRTV				1	E		
1,2-Dichloroethane	9.10E-02	IRIS	2.60E-05	IRIS	6.00E-03	PPRTV	7.00E-03	PPRTV		1	E		
cis-1,2-Dichloroethene					2.00E-03	IRIS				1	E		
trans-1,2-Dichloroethene					2.00E-02	IRIS	6.00E-02	PPRTV		1	E		
1,1-Dichloroethene					5.00E-02	IRIS	2.00E-01	IRIS		1	E		
2,4-Dichlorophenol					3.00E-03	IRIS				1	E	0.1	E
1,2-Dichloropropane	3.60E-02	CalEPA	1.00E-05	CalEPA	9.00E-02	ATSDR	4.00E-03	IRIS		1	E		
1,3-Dichloropropene	1.00E-01	IRIS	4.00E-06	IRIS	3.00E-02	IRIS	2.00E-02	IRIS		1	E		
Dicyclopentadiene					8.00E-2	PPRTV	3.00E-4	PPRTV		1	E		
Dieldrin	1.60E+01	IRIS	4.60E-03	IRIS	5.00E-05	IRIS				1	E	0.1	E
Diethyl phthalate					8.00E-01	IRIS				1	E	0.1	E
Di-n-butyl phthalate (Dibutyl phthalate)					1.00E-01	IRIS				1	E	0.1	E
2,4-Dimethylphenol					2.00E-02	IRIS				1	E	0.1	E
4,6-Dinitro-o-cresol					8.00E-05	PPRTV				1	E	0.1	E
2,4-Dinitrophenol					2.00E-03	IRIS				1	E	0.1	E
2,4-Dinitrotoluene	3.10E-01	CalEPA	8.90E-05	CalEPA	2.00E-03	IRIS				1	E	0.102	E
2,6-Dintitrotoluene	1.50E+00	PPRTV			3.00E-04	PPRTV				1	E	0.099	E
2,4/2,6-Dintrotoluene Mixture	6.80E-01	IRIS								1	E	0.1	E
1,4-Dioxane	1.00E-01	IRIS	5.00E-06	IRIS	3.00E-02	IRIS	3.00E-02	IRIS		1	E	0.1	E
1,2-Diphenylhydrazine	8.00E-01	IRIS	2.20E-04	IRIS						1	E	0.1	E
Endosulfan					6.00E-03	IRIS				1	E	0.1	E
Endrin					3.00E-04	IRIS				1	E	0.1	E
Epichlorohydrin	9.90E-03	IRIS	1.20E-06	IRIS	6.00E-03	PPRTV	1.00E-03	IRIS		1	E		
Ethyl acetate					9.00E-01	IRIS	7.00E-02	PPRTV		1	E		
Ethyl acrylate	4.80E-02	HEAST								1	E		
Ethyl chloride							1.00E+01	IRIS		1	E		

Chemical	SF_o (mg/kg-day)$^{-1}$	Ref.	IUR (ug/m^3)$^{-1}$	Ref.	RfD_o (mg/kg-day)	Ref.	RfCi (mg/m^3)	Ref.	Mutagen	GIABS	Ref.	Dermal ABS	Ref.
Ethyl ether					2.00E-01	IRIS				1	E		
Ethyl methacrylate					9.00E-02	HEAST	3.00E-01	PPRTV		1	E		
Ethylbenzene	1.10E-02	CalEPA	2.50E-06	CalEPA	1.00E-01	IRIS	1.00E+00	IRIS		1	E		
Ethylene oxide	3.10E-01	CalEPA	8.80E-05	CalEPA			3.00E-02	CalEPA		1	E		
Fluoranthene					4.00E-02	IRIS				1	E	0.13	E
Fluorene					4.00E-02	IRIS				1	E	0.13	E
Fluoride					6.00E-02	IRIS	1.30E-02	CalEPA		1	E		
Furan					1.00E-03	IRIS				1	E	0.03	E
Heptachlor	4.50E+00	IRIS	1.30E-03	IRIS	5.00E-04	IRIS				1	E	0.1	E
Hexachlorobenzene	1.60E+00	IRIS	4.60E-04	IRIS	8.00E-04	IRIS				1	E	0.1	E
Hexachloro-1,3-butadiene	7.80E-02	IRIS	2.20E-05	IRIS	1.00E-03	PPRTV				1	E	0.1	E
Hexachlorocyclopentadiene					6.00E-03	IRIS	2.00E-04	IRIS		1	E	0.1	E
Hexachloroethane	4.00E-02	IRIS	1.10E-05	CalEPA	7.00E-04	IRIS	3.00E-02	IRIS		1	E	0.1	E
n-Hexane					6.00E-02	HEAST	7.00E-01	IRIS		1	E		
HMX					5.00E-02	IRIS				1	E	0.006	E
Hydrazine anhydride	3.00E+00	IRIS	4.90E-03	IRIS			3.00E-05	PPRTV		1	E	0.1	E
Hydrogen cyanide					6.00E-04	IRIS	8.00E-04	IRIS		1	E		
Indeno(1,2,3-c,d)pyrene	7.30E-01	EPA TEF	1.10E-04	CalEPA					M	1	E	0.13	E
Iron					7.00E-01	PPRTV				1	E		
Isobutanol (Isobutyl alcohol)					3.00E-01	IRIS				1	E	0.1	E
Isophorone	9.50E-04	IRIS			2.00E-01	IRIS	2.00E+00	CalEPA		1	E	0.1	E
Lead										1	E		
Lead (tetraethyl-)					1.00E-07	IRIS				1	E	0.1	E
Maleic hydrazide					5.00E-01	IRIS				1	E	0.1	E
Manganese					1.40E-01	IRIS	5.00E-05	IRIS		0.04	E		
Mercury (elemental)							3.00E-04	IRIS		1	E		
Mercury (methyl)					1.00E-04	IRIS				1	E		
Mercuric Chloride (Mercury Salts)					3.00E-04	IRIS	3.00E-05	CalEPA		0.07	E		
Methacrylonitrile					1.00E-04	IRIS	3.00E-02	PPRTV		1	E		
Methomyl					2.50E-02	IRIS				1	E	0.1	E
Methyl acetate					1.00E+00	PPRTV				1	E		
Methyl acrylate					3.00E-02	HEAST	2.00E-02	PPRTV		1	E		
Methyl isobutyl ketone					8.00E-02	HEAST	3.00E+00	IRIS		1	E		
Methyl methacrylate					1.40E+00	IRIS	7.00E-01	IRIS		1	E		

Chemical	**SF$_o$ (mg/kg-day)$^{-1}$**	**Ref.**	**IUR (ug/m^3)$^{-1}$**	**Ref.**	**RfD$_o$ (mg/kg-day)**	**Ref.**	**RfCi (mg/m^3)**	**Ref.**	**Mutagen**	**GIABS**	**Ref.**	**Dermal ABS**	**Ref.**
Methyl styrene (alpha)					7.00E-02	HEAST				1	E		
Methyl styrene (mixture)					6.00E-03	HEAST	4.00E-02	HEAST		1	E		
Methylcyclohexane							3.00E+00	HEAST		1	E		
Methylene bromide (Dibromomethane)					1.00E-02	HEAST	4.00E-03	PPRTV		1	E		
Methylene chloride	2.00E-03	IRIS	1.00E-08	IRIS	6.00E-03	IRIS	6.00E-01	IRIS	M	1	E		
Molybdenum					5.00E-03	IRIS				1	E		
Naphthalene			3.40E-05	CalEPA	2.00E-02	IRIS	3.00E-03	IRIS		1	E	0.13	E
Nickel (soluble salts)			2.60E-04	CalEPA	2.00E-02	IRIS	9.00E-05	ATSDR		0.04	E		
Nitrate					1.60E+00	IRIS				1	E		
Nitrite					1.00E-01	IRIS				1	E		
Nitrobenzene			4.00E-05	IRIS	2.00E-03	IRIS	9.00E-03	IRIS		1	E		
Nitroglycerin	1.70E-02	PPRTV			1.00E-04	PPRTV				1	E	0.1	E
N-Nitrosodiethylamine	1.50E+02	IRIS	4.30E-02	IRIS					M	1	E	0.1	E
N-Nitrosodimethylamine	5.10E+01	IRIS	1.40E-02	IRIS	8.00E-06	PPRTV	4.00E-05	PPRTV	M	1	E	0.1	E
N-Nitrosodi-*n*-butylamine	5.40E+00	IRIS	1.60E-03	IRIS						1	E	0.1	E
N-Nitrosodiphenylamine	4.90E-03	IRIS	2.60E-06	CalEPA						1	E	0.1	E
N-Nitrosopyrrolidine	2.10E+00	IRIS	6.10E-04	IRIS						1	E	0.1	E
m-Nitrotoluene					1.00E-04	PPRTV				1	E	0.1	E
o-Nitrotoluene	2.20E-01	PPRTV			9.00E-04	PPRTV				1	E		
p-Nitrotoluene	1.60E-02	PPRTV			4.00E-03	PPRTV				1	E	0.1	E
Pentachlorobenzene					8.00E-04	IRIS				1	E	0.1	E
Pentachlorophenol	4.00E-01	IRIS	5.10E-06	CalEPA	5.00E-03	IRIS				1	E	0.25	E
Perchlorate					7.00E-04	IRIS				1	E		
Phenanthrene					3.00E-02	IRIS				1	E	0.13	E
Phenol					3.00E-01	IRIS	2.00E-01	CalEPA		1	E	0.1	E
Polychlorinatedbiphenyls													
Aroclor 1016	7.00E-02	IRIS	2.00E-05	IRIS	7.00E-05	IRIS				1	E	0.14	E
Aroclor 1221	2.00E+00	IRIS	5.70E-04	IRIS						1	E	0.14	E
Aroclor 1232	2.00E+00	IRIS	5.70E-04	IRIS						1	E	0.14	E
Aroclor 1242	2.00E+00	IRIS	5.70E-04	IRIS						1	E	0.14	E
Aroclor 1248	2.00E+00	IRIS	5.70E-04	IRIS						1	E	0.14	E
Aroclor 1254	2.00E+00	IRIS	5.70E-04	IRIS	2.00E-05	IRIS				1	E	0.14	E
Aroclor 1260	2.00E+00	IRIS	5.70E-04	IRIS						1	E	0.14	E
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)	1.30E+01	WHO TEF	3.80E-03	WHO TEF	7.00E-06	WHO TEF	4.00E-04	WHO TEF		1	E	0.14	E

Chemical	SF_o (mg/kg-day)$^{-1}$	Ref.	IUR (ug/m^3)$^{-1}$	Ref.	RfD_o (mg/kg-day)	Ref.	RfCi (mg/m^3)	Ref.	Mutagen	GIABS	Ref.	Dermal ABS	Ref.
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)	1.30E+00	WHO TEF	3.80E-04	WHO TEF	7.00E-05	WHO TEF	4.00E-03	WHO TEF		1	E	0.14	E
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)	3.90E+03	WHO TEF	1.14E+00	WHO TEF	2.33E-08	WHO TEF	1.33E-06	WHO TEF		1	E	0.14	E
2',3,4,4',5-Pentachlorobiphenyl (PCB 123)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2',3',4,4',5-Pentachlorobiphenyl (PCB 118)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2',3,3',4,4'-Pentachlorobiphenyl (PCB 105)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2,3,4,4',5-Pentachlorobiphenyl (PCB 114)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)	1.30E+04	WHO TEF	3.80E+00	WHO TEF	7.00E-09	WHO TEF	4.00E-07	WHO TEF		1	E	0.14	E
3,3',4,4'-Tetrachlorobiphenyl (PCB 77)	1.30E+01	WHO TEF	3.80E-03	WHO TEF	7.00E-06	WHO TEF	4.00E-04	WHO TEF		1	E	0.14	E
3,4,4',5-Tetrachlorobiphenyl (PCB 81)	3.90E+01	WHO TEF	1.14E-02	WHO TEF	2.33E-06	WHO TEF	1.33E-04	WHO TEF		1	E	0.14	E
Propylene oxide	2.40E-01	IRIS	3.70E-06	IRIS			3.00E-02	IRIS		1	E		
Pyrene					3.00E-02	IRIS				1	E	0.13	E
RDX	1.10E-01	IRIS			3.00E-03	IRIS				1	E	0.015	E
Selenium					5.00E-03	IRIS	2.00E-02	CalEPA		1	E		
Silver					5.00E-03	IRIS				0.04	E		
Strontium					6.00E-01	IRIS				1	E		
Styrene					2.00E-01	IRIS	1.00E+00	IRIS		1	E		
Sulfolane					1.00E-03	PPRTV	2.00E-03	PPRTV		1	E	0.1	E
2,3,7,8-TCDD	1.30E+05	CalEPA	3.80E+01	CalEPA	7.00E-10	IRIS	4.00E-08	CalEPA		1	E	0.03	E
2,3,7,8-TCDF	1.30E+04	WHO TEF	3.80E+00	WHO TEF						1	E	0.03	E
1,2,4,5-Tetrachlorobenzene					3.00E-04	IRIS				1	E	0.1	E
1,1,1,2-Tetrachloroethane	2.60E-02	IRIS	7.40E-06	IRIS	3.00E-02	IRIS				1	E		
1,1,2,2-Tetrachloroethane	2.00E-01	IRIS	5.80E-05	CalEPA	2.00E-02	IRIS				1	E		
Tetrachloroethene	2.10E-03	IRIS	2.60E-07	IRIS	6.00E-03	IRIS	4.00E-02	IRIS		1	E		
Tetryl (Trinitrophenylmethylnitramine)					2.00E-03	PPRTV				1	E	0.00065	E
Thallium					1.00E-05	PPRTV				1	E		
Toluene					8.00E-02	IRIS	5.00E+00	IRIS		1	E		
Toxaphene	1.10E+00	IRIS	3.20E-04	IRIS						1	E	0.1	E
Tribromomethane (Bromoform)	7.90E-03	IRIS	1.10E-06	IRIS	2.00E-02	IRIS				1	E	0.1	E
1,1,2-Trichloro-1,2,2-trifluoroethane					3.00E+01	IRIS	3.00E+01	HEAST		1	E		
1,2,4-Trichlorobenzene	2.90E-02	PPRTV			1.00E-02	IRIS	2.00E-03	PPRTV		1	E		

Chemical	**SF_o (mg/kg-day)$^{-1}$**	**Ref.**	**IUR (ug/m^3)$^{-1}$**	**Ref.**	**RfD_o (mg/kg-day)**	**Ref.**	**RfCi (mg/m^3)**	**Ref.**	**Mutagen**	**GIABS**	**Ref.**	**Dermal ABS**	**Ref.**
1,1,1-Trichloroethane					2.00E+00	IRIS	5.00E+00	IRIS		1	E		
1,1,2-Trichloroethane	5.70E-02	IRIS	1.60E-05	IRIS	4.00E-03	IRIS	2.00E-04	PPRTV		1	E		
Trichloroethylene	4.6E-02	IRIS	4.10E-06	IRIS	5.00E-04	IRIS	2.00E-03	IRIS	M	1	E		
Trichlorofluoromethane					3.00E-01	IRIS	7.00E-01	HEAST		1	E		
2,4,5-Trichlorophenol					1.00E-01	IRIS				1	E	0.1	E
2,4,6-Trichlorophenol	1.10E-02	IRIS	3.10E-06	IRIS	1.00E-03	PPRTV				1	E	0.1	E
1,1,2-Trichloropropane					5.00E-03	IRIS				1	E		
1,2,3-Trichloropropane	3.00E+01	IRIS			4.00E-03	IRIS	3.00E-04	IRIS	M	1	E		
Triethylamine							7.00E-03	IRIS		1	E		
2,4,6-Trinitrotoluene	3.00E-02	IRIS			5.00E-04	IRIS				1	E	0.032	E
Uranium (soluable salts)					3.00E-03	IRIS	4.00E-05	ATSDR		1	E		
Vanadium					5.04E-03	IRIS	1.00E-04	ATSDR		0.026	E		
Vinyl acetate					1.00E+00	HEAST	2.00E-01	IRIS		1	E		
Vinyl bromide			3.20E-05	HEAST			3.00E-03	IRIS		1	E		
Vinyl chloride	7.20E-01	IRIS	4.40E-06	IRIS	3.00E-03	IRIS	1.00E-01	IRIS	M	1	E		
m-Xylene					2.00E-01	IRIS	1.00E-01	IRIS		1	E		
o-Xylene					2.00E-01	IRIS	1.00E-01	IRIS		1	E		
Xylenes					2.00E-01	IRIS	1.00E-01	IRIS		1	E		
Zinc					3.00E-01	IRIS				1	E		

Notes:
CSF_o – Oral Cancer Slope Factor
IUR– Inhalation Unit Risk
RfD_o – Oral Reference Dose
RfC – Inhalation Reference Concentration
Dermal ABS – Dermal absorption coefficient
GIABS – Gastrointestinal absorption coefficient adjusted – Toxicity data for total chromium has been adjusted based on a ratio of 6:1 (CrIII:CrVI)
E = US EPA. 2004. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Interim Guidance. Office of Solid Waste and Emergency Response, Washington, D.C. http://www.epa.gov/oswer/riskassessment/ragse/index.htm
EPA TEF – US EPA (1993) toxicity equivalency factors applied to polycyclic aromatic hydrocarbons
ATSDR – Agency for Toxic Substances and Disease Registry
Cal EPA – California Environmental Protection Agency
HEAST – Health Effects Assessment Summary Tables
IRIS – Integrated Risk Information System
PPTRV – Provisional Peer Reviewed Toxicity Value
NJ – New Jersey Department of Environmental Protection (2009)

WHO TEF – World Health Organization Toxicity Equivalency Factor

-Toxicity data for total chromium has been adjusted based on a ratio of 6:1 (CrIII:CrVI)

-For GI absorption, a value of 1 was used for all organics as directed in RAGS Part E. A default value of 1 was used for inorganics not listed in RAGS Part E.
-Pyrene toxicity data used as surrogate data for phenanthrene.
-Aroclor 1016 is considered the lowest risk, so it was assigned a "lowest risk" value from IRIS. All other Aroclors were assigned a "highest risk" value from IRIS.
-Toxicity data for total xylenes used as a surrogate for all other isomers of xylene (o-, m-, and p-xylene)
-The RfDo value for vanadium is based on RfD for vanadium pentoxide, and adjusted for molecular weight.
-The RfDo value for cadmium is based on the RfDo for food. An RfDo of 0.0005 mg/kg-d was used for the tap water pathways as directed in IRIS (US EPA, 2014).

APPENDIX D

Guidance for Risk-based Remediation of Polychlorinated Biphenyls (PCBs) at RCRA Corrective Action Sites

Guidance for Risk-based Remediation of Polychlorinated Biphenyls (PCBs) at RCRA Corrective Action Sites[3]

July 2014

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[3] This document is intended as guidance for employees of the New Mexico Environment Department's (NMED) Hazardous Waste Bureau (HWB) and Resource Conservation and Recovery Act (RCRA)-regulated facilities within the State of New Mexico. This guidance does not constitute rule-making and may not be relied upon to create a right or benefit, substantive or procedural, enforceable at law or in equity, by any person. HWB may take action at variance to this guidance and reserves the right to modify this guidance at any time without public notice.

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ACRONYMNS AND ABBREVIATIONS

µg/g	microgram per gram
µg/L	microgram per liter
AOC	Area of Concern
AT	Averaging Time
BMP	Best Management Practices
BW	Body Weight
CSF	Cancer Slope Factor
CWA	Clean Water Act
DD	Daily Dose
ECD	Electron Capture Detector
ED	Exposure Duration
EF	Exposure Frequency
ELCD	Electrolytic Conductivity Detector
GC/MS	Gas Chromatography/Mass Spectral Detector
HR	High Resolution
HRGC	High Resolution Gas Chromatography
HRMS	High Resolution Mass Spectral Detector
HWB	Hazardous Waste Bureau
IR	Ingestion Rate
IRIS	Integrated Risk Information System
LADD	Lifetime Average Daily Dose
mg/m^3	milligram per cubic meter
mg/kg	milligram per kilogram
mg/L	milligram per liter
ng/L	nanogram per liter
NMED	New Mexico Environment Department
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo-dioxins
PCDF	Polychlorinated Dibenzo-furans
pg/L	picogram per liter
ppb	parts per billion
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
SWMU	Solid Waste Management Unit
TCDD	2,3,7,8-tetrachloro-dibenzo-dioxin
TCDF	2,3,7,8-tetrachloro-dibenzo-furan
TEF	Toxicity Equivalency Factor
TEQ	Toxicity Equivalency Quotient

TRV	Toxicity Reference Value
TSS	Total Suspended Solids
US EPA	United States Environmental Protection Agency

Guidance for Risk-based Remediation of Polychlorinated Biphenyls at RCRA Corrective Action Sites

1.0 SCOPE

This document focuses on remedial activities at sites where polychlorinated biphenyls (**PCBs**) have been identified or are suspected of being present as one of the contaminants of potential concern. The intent of this document is to expedite the remedial action process and provide a cost-effective and consistent method for the evaluation and reduction of the risk posed to human health and the environment by PCBs.

This document **does not** discuss the complex regulations governing PCBs or the sampling methodologies for PCBs or other associated contaminants. This document **does** assume that the nature and extent of PCB contamination have been defined using a site conceptual model and **does** discuss and recommend analytical methods applicable to evaluating the risk to human and ecological health for PCBs in environmental media.

This paper **does not** discuss the risk posed to ground water quality by PCB contamination; state ground water standards and federal drinking water standards[4] exist for the protection of ground water. No state or federal soil/sediment standards exist to protect ground water from the transport of PCBs from contaminated soil/sediments; however, the risk associated with the transport of PCBs from contaminated soil/sediments to ground water should be evaluated to ensure that state and federal standards for ground water are not exceeded. Methods for the evaluation of this threat to ground water are **not**, at this time, specifically addressed in this document.

2.0 BACKGROUND INFORMATION

PCBs are a class of chlorinated organic compounds which found widespread application since their introduction into commerce in 1923. Their properties include thermal stability; resistance to acids, bases and oxidation; and resistance to direct electrical current. They were commonly used in transformers and capacitors, hydraulic and heat transfer equipment, compressors and vacuum pumps, plasticizers (surface coatings and sealants), and some paints and inks. Domestic production of commercial PCBs ceased in 1977; however, PCBs in existence at that time are still in use today.

The general chemical structure of chlorinated biphenyls is as follows:

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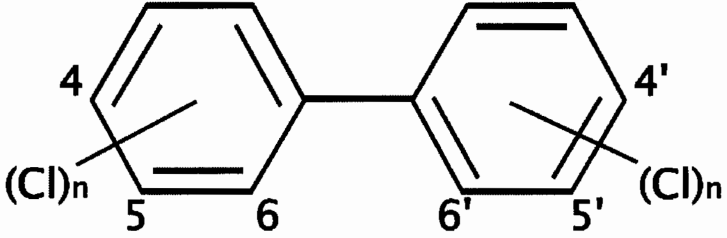
[4] PCBs in ground water may not exceed the Safe Drinking Water Act's maximum contaminant level of 0.5 micrograms per liter (µg/L) in drinking water (Title 40 Code of Federal Regulations Parts 141-147 and 149) or the State of New Mexico's Water Quality Control Commission Regulations' standard of 1 µg/L in ground water with 10,000 milligrams per liter (mg/L) or less total dissolved solids (Title 20 New Mexico Annotated Code Chapter 6.2).



The number and position of chlorines in the biphenyl molecule determine the physical and chemical properties of the PCB molecule. There are a total of 209 possible *congeners*[5] of PCBs, each one resulting from the chlorination of different substitution positions and varying degrees of chlorination. In general, PCB molecules with higher degrees of chlorination are more resistant to biodegradation and are more persistent in the environment.

PCB congeners may be found in commercial preparations or complex mixtures known by the names Askarel, Aroclor, Clophen, Phenoclor, Kanechlor, and Pyralène. In the United States, PCB mixtures were marketed under the trade name of Aroclor. Each Aroclor has a four-digit numeric designation: the first two digits are "12" (indicating the biphenyl parent molecule) followed by two more digits indicating the percent chlorine content by weight in the mixture. For example, Aroclor 1254 has 54% chlorine by weight. Aroclor 1016 is the exception: it contains 41% chlorine by weight (ATSDR, 1995).

PCBs are a group of environmentally persistent organic chemicals that possess the inherent properties of compounds that bioaccumulate (i.e., high octanol/water partition coefficient and low water solubility). PCBs also have the following properties of environmental relevance: low vapor pressure and low flammability.

PCBs are toxic to humans and other animals (Eisler, 1986; ATSDR, 1995; and US EPA, 1996 and 1997a). PCBs adversely impact reproduction in wildlife and in experimental animals. Other common toxic effects in mammals and birds include thymic atrophy (a wasting syndrome), microsomal enzyme induction, porphyria (manifestations include intermittent nervous system dysfunction and/or sensitivity of skin to sunlight) and related liver damage, chloracne, estrogenic activity, immunosuppression, and tumor promotion. PCBs can be transferred to young mammals (including humans) transplacentally and in breast milk.

The United States Environmental Protection Agency (**US EPA**) and International Agency for Research on Cancer classified PCBs as Group B2; probable human carcinogens, based on sufficient evidence of carcinogenicity (manifested as hepatocellular carcinomas) in experimental animals and inadequate (due to confounding exposures to other potential carcinogens or lack of exposure quantification), yet suggestive evidence of excess risk of liver cancer in humans (US EPA, 2010 and US EPA, 2014). Recent studies have indicated that all PCB mixtures can cause

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[5] *Congener* means any single, unique, well-defined chemical compound in the PCB category.

cancer; however, different mixtures exhibit different carcinogenic potencies (Cogliano, 1998). In addition, environmental processes may alter the PCB mixtures affecting its carcinogenic potency (see *Environmental Processes*).

The stability and lipophilicity of PCBs promote their biomagnification (i.e., the uptake of a chemical through ingestion resulting in the concentration of the chemical in tissue being greater than that of its food) once they enter the aquatic and terrestrial food chains. Through the food chain, living organisms selectively bioaccumulate persistent congeners of PCBs. Environmentally-aged PCB mixtures appear to be more toxic and persistent in the organism than commercial PCB mixtures. Biomagnification through trophic transfer governs PCB levels in animals, especially those occupying the top of the food web. Therefore, PCBs in food sources represent the most important exposure source to humans and wildlife.

In certain situations, PCBs can become contaminated with the far more toxic polychlorinated dibenzofurans (**PCDFs**) and chlorinated dibenzo-dioxins (**PCDDs**). Therefore, the presence of PCDFs and PCDDs should always be investigated if any of the following processes existed or are suspected of existing:

- Combustion or incineration of PCB-contaminated waste or waste oils, or highly variable waste streams (such as municipal and commercial waste for which PCB contamination is suspected);
- Manufacture of PCBs[6];
- Pyrolysis of PCBs;
- Photolysis of PCBs;
- Incidental fire of transformers and capacitors containing PCBs; or
- Treatment with chlorinating compounds (e.g., hydrochloric acid, chlorine, etc.).

3.0 ENVIRONMENTAL PROCESSES

PCBs occur as mixtures of congeners in the environment. *Partitioning*[7], chemical and biological transformation, and preferential bioaccumulation may change the composition of the PCB mixture over time: the environmentally-aged PCB mixture may vary considerably from the original congener composition (US EPA, 1996b and ATSDR, 1995). Altered PCB mixtures have been known to persist in the environment for many years.

PCBs adsorb to organic matter, sediments, and soil. Their affinity to adsorb increases with the chlorine content of the PCBs and the amount of organic matter present. PCBs can volatilize or disperse as aerosols providing an effective means of transport in the environment. Congeners with low chlorine content tend to be more volatile and more water soluble.

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[6] The concentration of PCDFs in commercial PCB samples ranged from 0.2 mircrograms per gram (µg/g) to 13.6 µg/g (ATSDR, 1993). Eisler (1986) reported PCDFs impurities ranging from 0.8 to 33 milligrams per kilogram (mg/kg) in some domestic and foreign PCB mixtures.

[7] *Partitioning* includes environmental processes by which different fractions of a mixture separate into air, water, sediment, and soil.

The highly chlorinated Aroclors (Aroclor 1248, 1254, and 1260) resist both chemical and biological transformation (i.e., degradation) in the environment. Biological degradation of highly chlorinated Aroclors to lower chlorinated PCBs can occur under anaerobic conditions[8]. The extent of this dechlorination[9] is limited by the PCB chlorine content and soil/sediment PCB concentrations. Anaerobic bacteria in soil/sediments remove chlorines from low chlorinated PCBs (1 to 4 chlorines) and open the carbon rings through oxidation. PCBs with higher chlorine content are extremely resistant to oxidation and hydrolysis. Photolysis can also slowly break down highly chlorinated PCB congeners.

PCBs bioaccumulate and biomagnify through the food chain because they are highly lipid-soluble. The mixture of congeners found in biotic tissue will differ dramatically from the mixture of congeners originally released to the environment because bioaccumulation and biomagnification concentrate PCB congeners of higher chlorine content up through the food chain. This is because different congeners can exhibit different rates of metabolism and elimination in living organisms (Van den Berg, et al., 1998 and Cogliano, 1998).

By altering the congener composition of PCB mixtures, these environmental processes can substantially increase or decrease the toxicity of environmental PCBs mixture (Cogliano, 1998). Therefore, information on these environmental processes along with the results of congener-specific analyses of environmental and biota samples should be used to substantiate modeling of exposure to and health risks resulting from environmental PCBs.

4.0 PCB CLEANUP LEVELS

PCB-contaminated soil/sediments should be remediated to either 1) a default concentration of 1 mg/kg or part per million (**ppm**) *total PCBs* (defined as the sum of congeners, Aroclors or *homologues*[10]), 2) a risk-based generic screening level (see media-specific screening levels in Appendix A of Volume 1) or 3) a *site-specific risk-based PCB concentration level*[11] established through performing a health risk evaluation. Site-specific risk-based PCB concentrations may be calculated from equations presented in *Risk Evaluation*. Once the calculations have been completed for all receptors, the lowest computed risk-based PCB concentration in a medium would represent the PCB remediation goal for that medium. These PCB remediation goals may be refined, if necessary, in the higher-level, site-specific risk assessment.

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[8] However, certain fungi have been demonstrated to degrade PCBs under aerobic conditions.

[9] Note that dechlorination is not synonymous with detoxification because it may result in the formation of carcinogenic congeners.

[10] A *homologue* is a subcategory of PCBs having an equal number of chlorine substituents. *Substituent* means an atom or group that replaces another atom or group in a molecule. PCB homologues can be quantified using EPA Method 680 or estimated using regression equations such as those found in NOAA, 1993.

[11] A *risk-based PCB concentration level* means the PCB concentration above which some adverse health effects may be produced in human and/or ecological receptors, and below which adverse health effects are unlikely to occur.

Table D-1 presents the corrective action cleanup options for the remediation of PCB-contaminated soil/sediments and data quality recommendations regarding the PCB analyses of environmental media samples.

Table D-1. PCB Cleanup Options In Soil/Sediment and Data Quality Recommendations[12]

Cleanup Option	**Corrective Action Steps**		**Data Quality Recommendations**
Default Option 1	1	Delineate the nature and horizontal and vertical extent of contamination	Estimate total PCBs as the sum of Aroclors or homologues (using a quantitation limit of 50 parts per billion [ppb] or 1 ppb, respectively) in environmental media
	2	Remediate to 1 ppm	
	3	Conduct post-remediation monitoring, as necessary	
Default Option 2	1	Delineate the nature and horizontal and vertical extent of contamination	Estimate total PCBs as the sum of Aroclors or homologues (using a quantitation limit of 50 parts per billion [ppb] or 1 ppb, respectively) in environmental media
	2	Remediate to generic risk-based screening level (See Appendix A of Volume 1))	
	3	Conduct post-remediation monitoring, as necessary	
Site-Specific, Risk-Based	1	Delineate the nature and horizontal and vertical extent of contamination	Estimate total PCBs as the sum of Aroclors or homologues (using a quantitation limit of 50 ppb or 1 ppb, respectively) and/or congener-specific environmental and biota concentrations (using a quantitation limit in the low parts per trillion)
	2	Perform health risk evaluation	
	3	Establish risk-based concentrations for all human and environmental receptors	
	4	Remediate to the lowest risk-based concentration	
	5	Conduct post-remediation monitoring, as necessary	

The following is a listing of potential PCB target analytes[13]. The 12 PCB congeners indicated in boldface italics are those which are recommended for quantitation as potential target analytes when performing a risk-based cleanup. The 16 additional congeners listed in plain text may provide valuable information, but are not required for the evaluation of risk. The analyses of all 209 congeners would greatly improve the estimate of total PCB concentrations.

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[12] Modified from Valoppi, et al., 1999.

[13] The number in parentheses refers to the identification system used to specify a particular congener.

Table D-2. Potential PCB Target Analytes

2,4′-Dichlorobiphenyl (8)
2,2′,5-Trichlorobiphenyl (18)
2,4,4′-Trichlorobiphenyl (28)
2,2′,3,5′-Tetrachlorobiphenyl (44)
2,2′,5,5′-Tetrachlorobiphenyl (52)
2,3′,4,4′-Tetrachlorobiphenyl (66)
3,3′,4,4′-Tetrachlorobiphenyl (77)
3,4,4′,5-Tetrachlorobiphenyl (81)
2,2′4,5,5′-Pentachlorobiphenyl (101)
2,3,3′,4,4′-Pentachlorobiphenyl (105)
2,3,4,4′,5-Pentachlorobiphenyl (114)
2,3′,4,4′,5-Pentachlorobiphenyl (118)
2′,3,4,4′,5′-Pentachlorobiphenyl (123)
3,3′,4,4′,5-Pentachlorobiphenyl(126) 2,2′,3,3′,4,4′-Hexachlorobiphenyl (128)
2,2′,3,4,4′,5′-Hexachlorobiphenyl (138)
2,2′,4,4′,5,5′-Hexachlorobiphenyl (153)
2,3,3′,4,4′,5-Hexachlorobiphenyl (156)
2,3,3′,4,4′,5′-Hexachlorobiphenyl (157)
2,3′,4,4′,5,5′-Hexachlorobiphenyl (167)
3,3′,4,4′,5,5′-Hexachlorobiphenyl (169)
2,2′,3,3′,4,4′,5-Heptachlorobiphenyl (170)
2,2′,3,4,4′,5,5′-Heptachlorobiphenyl (180)
2,2′,3,4′,5,5′,6-Heptachlorobiphenyl (187)
2,3,3′,4,4′,5,5′-Heptachlorobiphenyl (189)
2,2′,3,3′,4,4′,5,6-Octachlorobiphenyl (195)
2,2′,3,3′,4,4′,5,5′,6-Nonachlorobiphenyl (206)
2,2′,3,3′,4,4′,5,5′,6,6′-Decachlorobiphenyl (209)

The 16 PCB congeners in plain text have been indicated as target analytes by the National Oceanic and Atmospheric Administration based on their toxicity, ubiquitousness in the marine environment, presence in commercial Aroclor mixtures, etc. (NOAA, 1993).

5.0 ANALYTICAL METHODS

Aroclors are often used to characterize PCB exposures; however, the use of Aroclors in estimating the human health or ecological risk can be both imprecise and inappropriate because the PCB mixtures to which humans and other biota may be exposed may be considerably different from the original Aroclor mixtures released to the environment. In addition, traditional analytical methods for Aroclor analyses produce estimates that are prone to errors. Both qualitative and quantitative errors may arise from interpreting gas chromatography (**GC**) data.

GCs configured with electron capture detectors (**ECD**) or electrolytic conductivity detectors (**ELCD**) are particularly prone to error. The GC/ECD and GC/ELCD produce a chromatogram that is compared with the characteristic chromatographic patterns of the different Aroclors (US EPA, 1996a). For environmentally weathered and altered mixtures, an absence of these characteristic patterns can suggest the absence of Aroclors even if some congeners are present in high concentrations. Additionally, and commonly, the presence of interferents may also mask the characteristic response pattern of the Aroclors. The "pattern recognition" technique is inherently subjective, and different analysts may reach different conclusions regarding the presence or absence of Aroclors.

GCs configured with mass spectral detectors (**GC/MS**) allow identification of individual chemical compounds. GC/MS also produces a chromatogram, and additionally includes mass spectral information about the chemical identity of each peak in the chromatogram. Therefore, GC/MS adds a qualitative line of evidence above that included in GC/ECD or GC/ELCD techniques. GC/MS may be subject to interference, misinterpretation, or other problems.

High resolution (**HR**) isotope dilution GC/high resolution MS (**HRGC/HRMS**), while not as common technique as GC-ECD or GC-MS, is a specific GC/MS technique that has proven reliable for PCB analysis. In HRGC/HRMS exhaustive sample clean-up techniques are employed, and isotopic tracers are used to support identification.

Therefore, the HWB recommends the use of HRGC/HRMS analyses in evaluating health risks to humans and the environment. If HRGC/HRMS methods are not employed, then site specific data must be used to demonstrate that the methods employed are appropriate to the site, or HRGC/HRMS confirmation must be integrated into the analytical plan, for instance on a one in 20 sample basis, or a for a minimum number of samples, or as otherwise agreed. Both detections and non-detections should be confirmed.

Results of GC techniques may be expressed as Aroclors, congeners, homologues, or as total PCBs in units of weight/weight [mg/kg, µg/kg, nanogram per kilogram (ng/kg)] or weight/volume [µg/L or pictogram per liter (pg/L)]. It is necessary to specify the reporting requirements prior to analysis and negotiate the analytical list and reporting limits. Results must be reported on a dry weight basis for soil, sediment and waste samples (excluding liquids).

In addition to the traditional GC analysis, a number of biological and immunological assays are now available, as well as field GC. These may be suited for use as screening methods to guide day-to-day remediation efforts, but are not suited to evaluating health risks to humans and the environment as stand-alone methodologies.

Table D-3. Analytical Methods for PCBs

Method	Technology	Report As[1]	Approximate Detection Limits	Comments
SW-846 8082A	GC/ECD or GC/ELCD	Aroclors Congeners	50-100 µg/kg	Must supply site-specific performance data or use HRGC/HRMS confirmation
SW-8270D	GC/MS	Aroclors	>1000 µg/kg[2]	Detection limits may not support project data quality objectives
SW-846 8275A	GC/MS	Congeners	200 µg/kg	
Method 1668B	HRGC/HRMS	Congeners	<1µg/kg, often in the ng/kg range[2]	Use this method for confirmation

NOTES:

[1] Reporting types have been limited to those mentioned in the subject methods. Laboratories may offer additional reporting modalities, such as homologues and total PCBs.

[2] Detection Limits not specified in the method. Various sample preparation options and matrix effects may affect results

6.0 STORM WATER RUNOFF MONITORING RECOMMENDATIONS

The potential for transport to human or ecological receptors (including ground and surface water) should be evaluated for all corrective action sites impacted or suspected of being impacted by PCBs. PCB concentrations in storm water runoff resulting from contaminated soil/sediments should be monitored **and** the soils remediated to ensure that there is no release or runoff from the Solid Waste Management Unit (**SWMU**) or Area of Concern (**AOC**) which results in a total PCB concentration in excess of the Clean Water Act (**CWA**)-recommended freshwater aquatic life chronic criterion of 0.014 µg/L[14] (unfiltered water) to a *water of the State*.[15] Likewise, concentrations of PCB-contaminated stream bottom, lake or reservoir deposits should not result in total PCB concentrations in unfiltered water which exceeds the CWA-recommended freshwater aquatic life chronic criterion of 0.014 µg/L.

The evaluation of a site's PCB concentrations and erosion potential will aid in determining and prioritizing the corrective actions and best management practices (**BMPs**) necessary to protect surface water quality. Each facility should develop a method for evaluating the erosion potential[16] and present the methodology to the NMED HWB for approval prior to implementation. This evaluation should be conducted on all known or suspected PCB sites. All PCB sites with elevated erosion potentials should implement BMPs to reduce transport of PCB-contaminated sediments and soils. BMP effectiveness should be evaluated and monitored regularly through a formalized inspection and maintenance program. BMPs should be implemented as interim actions or stabilization measures which are consistent with a final remedy and should not be misconstrued as a final remedy.

NMED's HWB believes that controlling the total suspended solids (**TSS**) load of storm water runoff may effectively control PCB migration in surface water because PCBs are hydrophobic, tend to adsorb to soil and organic particles, and are transported in suspended sediments during storm runoff events. Therefore, the TSS should be monitored to aid in predicting and, therefore, potentially controlling the transport of PCBs into *watercourses*[17].

Storm water samples should be collected from storm water events which are greater than 0.1 inches in magnitude (US EPA, 1992). Grab samples should be collected within the first 30 minutes or as soon as practical, but not more than 1 hour after runoff discharge begins. A sufficient quantity of runoff should be collected (i.e., 5 liters) because additional analyses for PCBs may be required based upon the TSS analytical results. The runoff samples should be analyzed for TSS using Method 2540D of the most recent edition of the *Standard Methods for the Examination of Water and* Wastewater.

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[14] This concentration is the Clean Water Act §304(a) recommended chronic criterion for aquatic life (http://water.epa.gov/scitech/swguidance/standards/current/index.cfm).

[15] *Water(s) of the State* means all interstate and intrastate water including, natural ponds and lakes, playa lakes, reservoirs, perennial streams and their tributaries, intermittent streams, sloughs, prairie potholes and wetlands (Title 20 New Mexico Annotated Code Chapter 6.1).

[16] NMED HWB recommends the approach to evaluating erosion potential presented in the *Matrix Approach to Contaminant Transport Potential* (Mays and Veenis, 1998).

[17] *Watercourse* means any river, creek, arroyo, canyon, draw, or wash, or any other channel having definite banks and beds with visible evidence of the occasional flow of water (Title 20 New Mexico Annotated Code Chapter 6.1).

Grab samples should be used for monitoring. Composite samples may **not** be used for monitoring; however, flow-weighted composite samples may be used in the development and validation of storm water contaminant transport modeling.

The following bullets describe recommended trigger levels and actions based on the analytical results of TSS analyses:

- If TSS is less than 100 mg/L, no action is required.
- If TSS is greater than 100 mg/L, but less than 1,000 mg/L, then the effectiveness of existing BMPs should be evaluated and repaired as necessary, and additional BMPs may need to be implemented to reduce TSS loading
- If the TSS is greater than 1,000 mg/L, then the remaining portion of the sample should be centrifuged and the solids analyzed for PCBs using EPA SW-846 Method 8082 (US EPA, 1997d), EPA Method 680, or draft EPA Method 1668 (Alford-Stevens, et al., 1985 and US EPA, 1996a).

7.0 RISK EVALUATION

The risk to human health and the environment must be evaluated for all corrective action *solid waste management units/areas of concern*[18] (**SWMU/AOCs**) impacted or suspected of being impacted by PCBs and having a potential for transport to a human or ecological receptor. The risk posed by PCBs at these SWMU/AOCs may be modeled (based on adequate available data) and should be monitored to ensure an acceptable level of risk[19] (see *Storm Water Runoff Monitoring Recommendations).*

As discussed in *Environmental Processes*, the congener composition of environmentally-aged PCBs can dramatically differ from the original Aroclor mixture released to the environment. Consequently, environmental processes can affect both exposure to, and toxicity of, environmental PCBs. Therefore, the approach to evaluating health risks from environmental PCBs differs depending upon whether the PCB congener- or Aroclor-specific (or homologue-specific) data are available for the environmental media (see also *PCB Cleanup Levels*).

PCB congeners with chlorine atoms in positions 2 and 6 (ortho) are generally more readily metabolized, while those with chlorines in positions 4 and 4' (para) or positions 3, 4 or 3, 4, 5 on one or both rings tend to be more toxic and are retained mainly in fatty tissues (Eisler, 1986). Persistent congeners may retain biological activity long after the exposure. The most toxic PCB congeners can assume a conformation, generally similar to that of 2, 3, 7, 8-tetrachloro-dibenzo-dioxin (**TCDD**), and are approximate stereo analogs of this compound (Hoffman, et al., 1996).

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[18] *SWMU* means "any discernable unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released." *AOC* "...refers to releases which warrant investigation or remediation under the authorities discussed above, regardless of whether they are associated with a specific SWMU..."

[19] A risk or hazard is considered *acceptable* if an estimated risk/hazard is below pre-established target risk and/or hazard levels.

These dioxin-like congeners share a common mechanism of toxicity involving binding to the aryl hydrocarbon receptor; the same mechanism of action is believed to induce the toxicity of PCDDs and PCDFs. These congeners were assigned toxicity equivalency factors (**TEFs**) expressed as a fraction of the toxicity of 2,3,7,8-TCDD. Therefore, when PCB congener-specific analytical data are available, risk evaluation of human and ecological health should consider both dioxin-like and other adverse health effects. Two sections within this document (*Human Health, Carcinogenic Effects, Dioxin-like Toxicity Approach* and *Ecological Health, Dioxin-like PCBs*) provide guidance for applying these TEFs where congener-specific analyses are available. If only Aroclor/homologue concentrations are available for a site, total PCB concentrations reported as the sum of Aroclor/homologue concentrations should be used to estimate the risk to human health and the environment.

If a health risk evaluation is based on total PCB concentrations (estimated as the sum of Aroclors or PCB homologues) and the individual congeners comprising the PCB mixtures cannot be identified, the uncertainty and potential bias in the resulting risk estimates should be described in the risk assessment report. For example, if total PCB concentrations have been estimated based on Aroclor analyses, conservative assumptions should be made about the mixture composition and toxicity: the assumption that congeners with greater than four chlorines per PCB molecule comprise greater than 0.5% of total PCBs present in a given abiotic medium at the site triggers the selection of the highest cancer slope factor from Table D-3. Whereas, total PCB concentrations estimated based on the results of PCB homologue analyses may allow for a refinement of these conservative assumptions. More detailed information on an approach to evaluating the health risk from environmental PCBs and PCB data requirements can be found in US EPA (1996b); Van den Berg, et al. (1998); Cogliano (1998); Giesy and Kannan (1998) and Valoppi, et al. (1999).

7.1 Human Health

Since PCBs may cause both carcinogenic and non-carcinogenic adverse human health effects, separate risk assessments must be performed for each of these health effects.

7.1.1Carcinogenic Effects

The evaluation of carcinogenic risk from exposure to PCB mixtures (i.e., represented by total PCBs or PCB congeners) should follow the slope factor approach described in *PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures* (US EPA, 1996b) and as outlined below. This approach distinguishes among toxic potencies of different PCB mixtures by utilizing information regarding environmental processes. In the absence of PCB congener- or homologue-specific analyses (i.e., if total PCB concentrations were estimated based on Aroclor analyses), this approach requires conservative assumptions about the risk and persistence of PCB mixtures at the site.

If congener-specific concentrations are available and congener analyses indicate that congeners with more than 4 (four) chlorines comprise greater that 0.5 percent of total PCBs in a given medium, the slope factor approach should be supplemented by the analysis of dioxin toxicity equivalency quotient (**TEQ**). Risk from *dioxin-like congeners*[20] should be added to the risk estimated for the rest of the PCB mixture which does not exhibit dioxin-like toxicity.

If other dioxin-like compounds (i.e., PCDDs and/or PCDFs) are present at a site in addition to PCBs, TEQs for dioxin-like PCBs should be added to TEQs calculated for those other dioxin-like compounds to yield a total TEQ. A slope factor for 2,3,7,8-TCDD should be applied to this total TEQ. Under these circumstances, the concentrations of dioxin-like PCBs should be subtracted from the total PCB concentration to avoid overestimating risks from dioxin-like PCBs by evaluating them twice.

7.1.1.1 Slope Factor Approach

Site-specific carcinogenic risk evaluations should be performed using PCB cancer potency or slope factors specific to the exposure scenarios and pathways at a particular site. Table D-4 provides the criteria for using these slope factors (categorized into high, medium, and low levels of risk and PCB persistence) that address a variety of exposure scenarios and the toxicity of PCB mixtures in the environment. A review of recent research on PCB toxicity that formed the basis for the derivation of these slope factors and a discussion of uncertainties surrounding toxicity information can be found in US EPA (1996b) and Cogliano (1998).

The slope factors in Table D-4 represent the upper-bound slopes that are recommended for evaluating human health risk from carcinogenic effects of PCBs. Both the upper-bound and central-estimate slopes are available from the US EPA's Integrated Risk Information System (**IRIS**). The central-estimate slopes can be used to support the analysis of uncertainties inherent in available toxicity information on PCBs.

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[20] *Dioxin-like congeners* of PCBs are those with dioxin-like health effects and are evaluated using dioxin TEQs (Van den Berg, et al., 1998). A complete listing of PCB congeners can be found at http:\\www.epa.gov/grtlakes/toxteam/pcbid/table.htm (US EPA's Great Lakes website).

Table D-4. PCB Cancer Slope Factor Values by Level of Risk and Persistence[21]

CRITERIA FOR USE	LEVEL OF RISK AND PERSISTENCE	PCB CANCER SLOPE FACTOR VALUES[22] [risk per mg/kg-day]
Food chain exposure	High	2.0
Sediment/soil ingestion		
Dust/aerosol inhalation		
Dermal exposure (if an absorption factor has been applied)		
Presence of dioxin-like, tumor-promoting, or persistent congeners		
Early-life (less than 6 years old) exposure by all pathways and to all mixtures		
Congeners with greater than four chlorines per PCB molecule comprise greater than 0.5% of the total PCBs present		
Congeners with greater than four chlorines per PCB molecule comprise less than 0.5% of the total PCBs present (all pathways except soil ingestion by adults)		
Ingestion of water-soluble (less chlorinated) congeners	Medium	0.4
Inhalation of evaporated (less chlorinated) congeners		
Dermal exposure (if no absorption factor has been applied)		
Congeners with greater than four chlorines per PCB molecule comprise less than 0.5% of the total PCBs present (soil ingestion by adults only)	Low	0.07

The cancer slope factors in Table D-4 characterize the toxic potency of different environmental mixtures of PCBs. Information on potential exposure pathways and PCB mixture composition at a given site guides in the selection of the appropriate cancer slope factors for risk assessment.

The highest slope factor in Table D-4 (2.0 per mg/kg-day) corresponds to the high risk and persistence of environmental PCB mixtures and, as such, should be selected for pathways (including food chain exposures, ingestion of soil and sediment, inhalation of dust or aerosol,

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[21] Modified from Cogliano, 1998 and US EPA, 1996b and 1998c.

[22] See IRIS (US EPA, 2014).

exposure to dioxin-like, tumor-promoting or persistent congeners, and early-life exposure) where environmental processes act to increase risk.

A lower slope factor (0.4 per mg/kg-day) corresponds to the low risk and persistence of environmental PCB mixtures and is appropriate for exposure pathways (such as ingestion of water-soluble congeners and inhalation of evaporated congeners) where environmental processes act to decrease risk.

Finally, the lowest slope factor in Table D-4 (0.07 per mg/kg-day) corresponds to the lowest risk and persistence of environmental PCB mixtures and should be selected for soil ingestion by adults when congener or homologue analyses confirm that congeners with greater than four chlorine atoms per PCB molecule comprise less than 0.5% of the total PCBs present at the site.

Once the appropriate slope factor has been selected, it is multiplied by a lifetime average daily dose (**LADD**) to estimate the risk of cancer (see US EPA, 1996b for sample risk calculations). Because the use of Aroclors to characterize PCB exposures can be both imprecise and inappropriate, total PCBs or congener analyses should be used in the following LADD calculation:

$$\mathbf{LADD = (C_T \times IR \times ED \times EF) / (BW \times AT)} \qquad \textit{Equation D-1}$$

Where:

LADD =	Lifetime average daily dose (mg/kg-day)
C_T =	Total PCBs or total non-dioxin-like congener concentration in a medium (mg/L [water], mg/kg [soil], or milligram per cubic meter (mg/m^3) [air])
IR =	Intake rate (L/day [water], mg/day [soil], or mg/m^3 [air])
ED =	Exposure duration (years)
EF=	Exposure frequency (days/year)
BW =	Average body weight of the receptor over the exposure period (kg)
AT=	Averaging time - the period over which exposure is averaged (days)[23]

The cancer slope factors and recommended Aroclor fate and transport properties (Table D-5), should be used to evaluate the carcinogenic risk posed by PCB mixtures or PCB congeners which do not exhibit a dioxin-like toxicity.

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[23] For carcinogens, the averaging time is 25,550 days based on a lifetime exposure of 70 years.

Table D-5. Cancer Slope Factors and Fate & Transport Properties For PCBs

	CRITERIA: Congeners with equal to or greater than four (4) chlorines comprise . . .	**CARCINOGENIC EFFECTS**	
		Dioxin-like PCBs	**Other PCB Congeners[24]**
CANCER SLOPE FACTORS[25] (mg/kg-day)$^{-1}$	. . . **greater than 0.5%** of the total PCBs present	1.3E+05[26]	2.0
	. . . **less than 0.5%** of the total PCBs present	NA[27]	0.07
FATE & TRANSPORT PROPERTIES	. . . **greater than 0.5%** of the total PCBs present	Aroclor 1254	Aroclor 1254
	. . . **less than 0.5%** of the total PCBs present	Aroclor 1016	Aroclor 1016

For example, if a PCB mixture contains 45% congeners with greater than four chlorines, the cancer slope factor for 2,3,7,8-TCDD and the fate and transport properties of Aroclor 1254 would be used.

If the following special exposure conditions exist, a slope factor of 0.4 may be applied to PCBs which do not exhibit dioxin-like toxicity: ingestion of water-soluble congeners, inhalation of evaporated congeners or dermal exposure (with no applied absorption factor).

7.1.1.2 Dioxin-like Toxicity Approach

Dioxin-like PCBs are some of the moderately chlorinated PCB congeners (see Table D-5) which have been demonstrated to produce dioxin-like effects[28] in humans. The dioxin-like toxicity approach should be implemented **only** when congener-specific concentrations are available for environmental media at a site. In this approach, individual dioxin-like PCB congener concentrations are multiplied by TEFs that represent the potency of a given congener relative to 2,3,7 8-TCDD (see Table 2-2 in Volume I).

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[24] *Other PCB congeners* mean those congeners which do not exhibit dioxin-like toxicity.

[25] PCB cancer slope factors can be found in IRIS (US EPA, 2014).

[26] US EPA, 2014

[27] *NA* means not applicable. Do not evaluate dioxin-like PCBs if they comprise less than 0.5% of the total PCBs present; evaluate the other PCB congeners.

[28] Dioxin-like congeners can react with the aryl hydrocarbon receptor, the toxicity mechanism that is believed to initiate the adverse effects of PCDDs and PCDFs.

Table 2-2 of Volume I lists the TEF values derived for dioxin-like PCB congeners. Using TEF values in the risk evaluation allows for the estimation of a combined risk resulting from an exposure to a mixture of dioxin-like PCB congeners (assuming that the risks are additive).

The carcinogenic risk resulting from exposure to dioxin-like PCBs should be estimated by calculating the TEQ. The TEQ is the sum of each congener-specific concentration in the medium multiplied by its corresponding congener-specific TEF value. Multiplying the congener-specific medium concentration by the corresponding congener-specific TEF value provides a relative (i.e., "toxicity-weighted") measure of the dioxin concentration within a medium.

The TEQ for dioxin-like PCBs should be calculated as indicated in the following equation:

$$\mathbf{TEQ = \Sigma\ (C_{mi}\ x\ TEF_i)} \qquad \textit{Equation D-2}$$

Where:

TEQ = Toxicity equivalency quotient (mg/L [water] or mg/kg [soil or sediment])
C_{mi} = Concentration of *i*th congener in medium (mg/L [water] or mg/kg [soil or sediment])
TEF_i = Toxicity equivalency factor for *i*th congener (unitless)

Once the dioxin TEQ has been determined, the LADD should be calculated using the following equation:

$$\mathbf{LADD = (TEQ\ x\ IR\ x\ ED\ x\ EF)\ /\ (BW\ x\ AT)} \qquad \textit{Equation D-3}$$

Where:

LADD = Lifetime average daily dose (mg/kg-day)
TEQ = Toxicity equivalency quotient (mg/L [water], mg/kg [soil], or mg/m^3 [air])
IR = Intake rate (L/day [water], mg/day [soil], or mg/m^3 [air])
ED = Exposure duration (years)
EF = Exposure frequency (days/year)
BW = Average body weight of the receptor over the exposure period (kg)
AT = Averaging time - the period over which exposure is averaged (days)

The following equation can be used to estimate carcinogenic risk from dioxin-like PCBs:

$$\mathbf{Cancer\ Risk = LADD\ x\ CSF_{TCDD}} \qquad \textit{Equation D-4}$$

Where:

LADD =Lifetime average daily dose (mg/kg-day)
CSF_{TCDD} =Cancer slope factor for 2,3,7,8-TCDD[29]

7.1.2 Non-Carcinogenic Effects

For Aroclors having reference doses (**RfDs**) specified in IRIS (e.g., Aroclor 1254, 1016, etc.), the non-carcinogenic risk should also be evaluated. The evaluation of non-carcinogenic risk should follow the approach typical for other non-PCB chemicals. However, fate and transport properties of the recommended Aroclor (see Table D-6) should be used to evaluate the risk posed.

Table D-6. Toxicological and Fate & Transport Properties For PCBs With Human Health Non-Carcinogenic Effects and Ecological Health Non-Dioxin-Like Effects

CRITERIA: Congeners with equal to or greater than four (4) chlorines comprise . . .	**NON-CARCINOGENIC EFFECTS AND FATE AND TRANSPORT PROPERTIES**
. . . **greater than 0.5%** of the total PCBs present	Aroclor 1254
. . . **less than 0.5%** of the total PCBs present	Aroclor 1016

The RfD derived for Aroclor 1254 should typically be used when conducting a risk assessment. The RfD derived for Aroclor 1016 can be used when at least 99.5% of the mass of the PCB mixture has fewer than four (4) chlorine atoms per molecule as determined by a chromatography/spectroscopy analytical method. Using Table D-6, determine which Aroclor most accurately represents the PCB mixture of concern. Use the RfD and fate and transport properties of this Aroclor as a surrogate to evaluate the non-carcinogenic effects of the PCB mixture.

7.2 Ecological Health

Since PCBs adversely impact both community- and class-specific guild measurement receptors, risks must be estimated for each receptor within both groups. Plants and invertebrates should be evaluated as community measurement receptors (see *Exposure Assessment for Community Measurement Receptors, Section 7.2.1.1*).

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[29] The cancer slope factor for 2,3,7,8-TCDD should be obtained from the most recent IRIS (US EPA, 2014). The current oral cancer slope factor for 2,3,7,8-TCDD of 1.3E+05 $(mg/kg\text{-}day)^{-1}$ is based on the administered dose from a 105-week dietary rat study and was adopted for inhalation exposure (US EPA, 2014).

When congener-specific concentrations are available, risk from exposure to dioxin-like PCBs should be estimated separately and added to the risk estimated for the remainder of the PCB mixture which does not exhibit dioxin-like toxicity. The resulting risk is likely to be overestimated if toxicity data from total PCBs is applied to those congeners which do not exhibit dioxin-like toxicity. This overestimation of risk should be addressed within the uncertainty analysis of the risk assessment report.

In the absence of PCB congener-specific data, total PCB concentrations, reported as the sum of Aroclor or homologue concentrations, should be used to estimate receptor exposure to PCBs and the toxicity value of the most toxic Aroclor present should be used in the site-specific ecological risk assessment.

7.2.1 Dioxin-like PCBs

Ecological risks to community- and class-specific guild measurement receptors from dioxin-like PCBs should be estimated by calculating a TEQ and then dividing it by the toxicity value for 2,3,7,8-TCDD (which is assumed to be the most toxic dioxin).

If in addition to PCBs, other dioxin-like compounds (i.e., PCDDs and/or PCDFs) are present at a site, TEQs for dioxin-like PCBs should be added to the TEQs calculated for those other dioxin-like compounds to yield a total TEQ. The 2,3,7,8-TCDD toxicity value should be applied to this total TEQ. For this evaluation, the concentrations of dioxin-like PCBs should be subtracted from the total PCB concentrations to avoid overestimating risks from dioxin-like PCBs by evaluating them twice.

The TEF values listed in Table 2-1 of Volume I and in Table D-7 below should be used in the TEQ calculation to convert the exposure media concentration of individual congeners to a relative measure of concentration within a medium.

Table D-7. Fish Toxicity Equivalency Factor Values For Dioxin-Like PCBs[30]

CONGENER	FISH TOXICITY EQUIVALENCY FACTOR VALUES[31]
3,3′,4,4′-Tetrachlorobiphenyl (77)[11]	0.0001
3,4,4′,5-Tetrachlorobiphenyl (81)	0.0005
2,3,3′,4,4′-Pentachlorobiphenyl (105)	<0.000005[32]
2,3,4,4′,5-Pentachlorobiphenyl (114)	<0.000005
2,3′,4,4′,5-Pentachlorobiphenyl (118)	<0.000005
2′,3,4,4′,5′-Pentachlorobiphenyl (123)	<0.000005
3,3′,4,4′,5-Pentachlorobiphenyl (126)	0.005
2,3,3′,4,4′,5-Hexachlorobiphenyl (156)	<0.000005
2,3,3′,4,4′,5′-Hexachlorobiphenyl (157)	<0.000005
2,3′,4,4′,5,5′-Hexachlorobiphenyl (167)	<0.000005
3,3′,4,4′,5,5′-Hexachlorobiphenyl (169)	<0.000005
2,3,3′,4,4′,5,5′-Heptachlorobiphenyl (189)	<0.000005

Because congener-specific fate and transport data are not available for each of the dioxin-like PCBs listed in Table 2-1 of Volume I and Table D-7, the fate and transport properties of Aroclor 1254 should be used in exposure modeling.

7.2.1.1 Exposure Assessment for Community Measurement Receptors

To evaluate the exposure of water, sediment and soil communities to dioxin-like PCBs, a media-specific TEQ should be calculated. The TEQ is the sum of each congener-specific concentration (in the respective media to which the community is exposed) multiplied by its corresponding congener-specific TEF value derived for fish (Table D-7).

The TEQ for community measurement receptors exposed to dioxin-like PCBs should be calculated as indicated in the following equation:

$$\mathbf{TEQ = \Sigma\ (C_{mi} \times TEF_i)} \qquad \textit{Equation D-5}$$

Where:

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[30] Modified from the *Report from the Workshop on the Application of 2,3,7,8-TCDD Toxicity Equivalency Factors to Fish and Wildlife* (US EPA, 1998b).

[31] The surrogate TEF values for fish are presented because invertebrate-specific TEF values have not yet been developed.

[32] For all fish TEFs of "<0.000005," use the value of 0.000005 as a conservative estimate.

TEQ = Toxicity equivalency quotient (µg/L [water] or µg/kg [dry weight soil or sediment])
C_{mi} = Concentration of *i*th congener in abiotic media (µg/L [water] or µg/kg [dry weight soil or sediment])
TEF_i = Toxicity equivalency factor (fish) for *i*th congener (unitless) (Table D-7)

Risk to the water, sediment or soil community is subsequently evaluated by comparing the media-specific TEQ to the media-specific toxicity value for 2,3,7,8-TCDD:

$$\mathbf{Risk = TEQ / TRV_{TCDD}} \qquad \textit{Equation D-6}$$

where:

TEQ = Toxicity equivalency quotient (µg/L [water] or µg/kg [dry weight soil or sediment])
TRV_{TCDD} = Toxicity reference value for 2,3,7,8-TCDD (µg/L [water] or µg/kg [dry weight soil or sediment])

7.2.1.2 Exposure Assessment for Class-Specific Guild Measurement Receptors

To evaluate the exposure of class-specific guild measurement receptors to dioxin-like PCBs, congener-specific daily doses of food items (i.e., abiotic media, plants, animals, etc.) ingested by a measurement receptor (**DD_i**) should be converted to a TEQ-based daily dose (**DD_{TEQ}**). This DD_{TEQ} can subsequently be compared to the 2,3,7,8-TCDD toxicity values for an evaluation of the risk posed to class-specific guild measurement receptors.

The DD_{TEQ} for each measurement receptor should be calculated as shown in the following equation:

$$\mathbf{DD_{TEQ} = \Sigma\ DD_i \times TEF_{MR}} \qquad \textit{Equation D-7}$$

Where:

DD_{TEQ} = Daily dose of PCB TEQ (µg/kg fresh body weight-day)
DD_i = Daily dose of *i*th congener (µg/kg fresh body weight-day)
TEF_{MR} = Toxicity equivalency factor (specific to measurement receptor) (unitless) (Table D-8)

Risk to the class-specific guild being evaluated can be estimated by dividing the DD_{TEQ} by the toxicity reference value for 2,3,7,8-TCDD:

$$\mathbf{Risk = TEQ / TRV_{TCDD}} \qquad \textit{Equation D-8}$$

Where:

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[33] The congener-specific daily doses of food items ingested by a measurement receptor should be calculated in accordance with the most current EPA and/or State guidance.

DD_{TEQ} = Daily dose of PCB TEQ (μg/kg fresh body weight-day)
TRV_{TCDD} = Toxicity reference value for 2,3,7,8-TCDD (μg/kg fresh body weight-day)

7.2.2 Other PCB Congeners

In addition to the dioxin-like PCB congeners, the remaining PCBs should be evaluated like other bioaccumulating organic contaminants by assessing ecological risks to community- and class-specific guild measurement receptors. The fate and transport properties of Aroclor 1254[34] should be used in the exposure modeling when evaluating the risk from PCB mixtures containing congeners with equal to or greater than 4 chlorines in quantities **greater** than 0.5% of the total PCBs. And, the fate and transport properties of Aroclor 1016[35] should be used in the exposure modeling when evaluating risks from PCB mixtures containing **less** than 0.5 % of PCB congeners with more than 4 chlorines (see Table D-6).

8.0 CONCLUSION

PCBs, which are a class of organic compounds that are persistent in the environment, are toxic to both humans and biota. PCBs may in certain instances become contaminated with more toxic PCDFs and PCDDs. Therefore, the potential presence of these compounds should also be evaluated and possibly investigated.

Based on federal and state regulations and standards, the NMED recommends that PCB-contaminated sediment/soils be remediated to either 1 mg/kg total PCBs or the most stringent of the calculated health risk-based concentrations in order to adequately protect human health and the environment.

Unless soil/sediments are remediated to 1 mg/kg total PCBs, the risk posed by PCBs to human health and the environment should be evaluated using a risk-based approach. All corrective action SWMU/AOCs impacted or suspected of being impacted by PCBs and having a potential for transport to a human or ecological receptor should be evaluated and monitored, as necessary, to protect human health and the environment.

PCB concentrations in soil/sediments should also be protective of both surface water and ground water resources; PCB concentrations in surface water should not exceed 0.014 μg/L and PCB concentrations in ground water cannot exceed 0.5 μg/L (drinking water) or 1 μg/L in ground water with 10,000 mg/L or less total dissolved solids).

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[34] Approximately 77% of Aroclor 1254 is composed of PCB congeners with more than 4 chlorines.

[35] Approximately 99% of Aroclor 1016 is comprised of PCB congeners with 4 or less chlorines.

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VOLUME 2
SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENTS

PHASE I
Scoping Assessment

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Attachments

Attachment A: Screening Level Ecological Risk Assessment Scoping Assessment Site Assessment Checklist
Attachment B: Ecological Site Exclusion Criteria Checklist and Decision Tree
Attachment C: Tier 1 Toxicity Reference Values (TRVs) and Ecolgical Screening Levels (ESLs) and Tier 2 TRVs

Acronymns and Abbreviations

AOC	Areas of Concern
AUF	Area Use Factor
BAF	Bioaccumulation/Biomagnification Factor
bgs	below ground surface
COPEC	Constituent of Potential Ecological Concern
EPC	Exposure Point Concentration
ESL	Ecological Screening Level
ft	foot
GAERPC	Guidance for Assessing Ecological Risks Posed by Chemicals
HI	Hazard Index
HQ	Hazard Quotient
kg	kilogram
LOAEL	Lowest-observed adverse effect level
LULC	land use and land cover
mg	milligram
NMED	New Mexico Environment Department
NOAEL	No-observed adverse effect level
PCSEM	Preliminary Conceptual Site Exposure Model
PUF	Plant Uptake Factor
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SLERA	Screening Level Ecological Risk Assessment
SLHQ	Screening Level Hazard Quotient
SSG	Soil Screening Guidance
SWMU	Solid Waste Management Unit
T&E	Threatened and Endangered
TRV	Toxicity Reference Value
UCL	Upper Confidence Level
US EPA	United States Environmental Protection Agency

1.0 INTRODUCTION

The purpose of an ecological risk assessment is to evaluate the potential adverse effects that chemical contamination has on the plants and animals that make up ecosystems. The risk assessment process provides a way to develop, organize and present scientific information so that it is relevant to environmental decisions.

The New Mexico Environment Department (NMED) has developed a tiered procedure for the evaluation of ecological risk. Volume II of this *Risk Assessment Guidance for Investigations and Remediation* (SSG) outlines the steps for the Phase I Assessment, to include a qualitative scoping assessment and a quantitative screening assessment. If more detailed assessments are required or the Phase II Assessment is needed, additional guidance may be found in the *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Risk Assessment* (GAERPC) (NMED, 2014). Briefly, the tiers of the procedure are organized as follows:

PHASE I – SCOPING AND SCREENING ASSESSMENTS

- Scoping Assessment
- Screening Assessment (Tier 1 and 2)

PHASE II - SITE-SPECIFIC ASSESSMENTS

- Site-Specific Ecological Risk Assessment (Tier 3)

As discussed above and illustrated in Figure 1, the Scoping Assessment is the first phase of the Screening-Level Ecological Risk Assessment process as defined by the NMED GAERPC. This document provides specific procedures to assist the facility in conducting the first phase (Scoping and Screening Assessments), Screening-Level Ecological Risk Assessment process outlined in the GAERPC. The purpose of the Scoping Assessment is to gather information, which will be used to determine if there is "any reason to believe that ecological receptors and/or complete exposure pathways exist at or in the locality of the site" (NMED, 2014). The scoping assessment step also serves as the initial information-gathering phase for sites clearly in need of a more detailed assessment of potential ecological risk. This document outlines the methodology for conducting a Scoping Assessment, and includes a Site Assessment Checklist (Attachment A), which serves as tool for gathering information about the facility property and surrounding areas. Although the GAERPC provides a copy of the US Environmental Protection Agency (US EPA) Checklist for Ecological Assessment/Sampling (US EPA, 1997), the attached Site Assessment Checklist provides an expanded, user-friendly template, which both guides the user as to what information to collect and furnishes an organized structure in which to enter the information.

After the Site Assessment Checklist has been completed, the assessor must use the collected information to generate a Scoping Assessment Report and Preliminary Conceptual Site Exposure Model (PCSEM). Guidance for performing these tasks is provided in this document, and in the GAERPC. The Scoping Assessment Report and PCSEM are subsequently used to address the first in a series of Technical Decision Points of the tiered GAERPC process. Technical Decision Points are questions which must be answered by the assessor after the completion of certain phases in the process. The resulting answer to the question determines the next step to be undertaken by the facility. The first Technical Decision Point, as illustrated in Figure 1, is to decide: *Is Ecological Risk Suspected?*

If the answer to the first Technical Decision Point is "no" (that is, ecological risk is not suspected), the assessor may use the Exclusion Criteria Checklist and Decision Tree (Attachment B) to help confirm or deny that possibility. However, it is unlikely that any site containing potential ecological habitat or receptors will meet the Site Exclusion Criteria.

If ecological risk is suspected, the facility will usually be directed to proceed to the Tier 1 Screening Level Ecological Risk Assessment (SLERA) and refined Tier 2 SLERA. A SLERA is a simplified risk assessment that can be conducted with limited site-specific data by defining assumptions for parameters that lack site-specific data (US EPA, 1997). Values used for screening are consistently biased in the direction of overestimating risk to ensure that sites that might pose an ecological risk are properly identified. The completed Site Assessment Checklist is a valuable source of information needed for the completion of the SLERA. Additional information on performing a SLERA can be found in the GAERPC (NMED, 2014) and in a number of EPA guidance documents (e.g., US EPA, 1997; US EPA, 1998).

2.0 SCOPING ASSESSMENT

The Scoping Assessment serves as the initial information gathering and evaluation for the Phase I process. A Scoping Assessment consists of the following steps:

- Compile and Assess Basic Site Information (using Site Assessment Checklist)
- Conduct Site Visit
- Identify Preliminary Contaminants of Potential Ecological Concern
- Develop a Preliminary Conceptual Site Exposure Model
- Prepare a Scoping Assessment Report

The following subsections provide guidance for completing each step of the Scoping Assessment. For additional guidance, readers should refer to the GAERPC (NMED, 2014).

2.1 Compile and Assess Basic Site Information

The first step of the Scoping Assessment process is to compile and assess basic site information. Since the purpose of the Scoping Assessment is to determine if ecological habitats, receptors, and complete exposure pathways are likely to exist at the site, those items are the focus of the information gathering. The Site Assessment Checklist (Attachment A) should be used to complete this step. The questions in the Site Assessment Checklist should be addressed as completely as possible with the information available before conducting a site visit.

In many cases, a large portion of the Site Assessment Checklist can be completed using reference materials and general knowledge of the site. A thorough file search should be conducted to compile all potential reference materials. Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) and Facility Investigation (RFI) reports, inspection reports, RCRA Part B Permit Applications, and facility maps can all be good sources of the information needed for the Site Assessment Checklist.

Habitats and receptors which may be present at the site can be identified by contacting local and regional natural resource agencies. Habitat types may be determined by reviewing land use and land cover maps (LULC), which are available via the Internet at http://www.nationalatlas.gov/scripts. Additional sources of general information for the identification of ecological receptors and habitats are listed in the introduction section of the Site Assessment Checklist (Attachment A).

After all available information has been compiled and entered into the Site Assessment Checklist, the assessor should review the checklist and identify data gaps. Plans should then be made to obtain the missing information by performing additional research and/or by observation and investigation during the site visit.

2.2 Site Visit

When performing a Scoping Assessment, at least one site visit should be conducted to directly assess ecological features and conditions. As discussed in the previous section, completion of the Site Assessment Checklist should have begun during the compilation of basic site information. The site visit allows for verification of the information obtained from the review of references and other information sources. The current land and surface water usage and characteristics at the site can be observed, as well as direct and indirect evidence of receptors. In addition to the site, areas adjacent to the site and all areas where ecological receptors are likely to contact site-related chemicals (i.e., all areas which may have been impacted by the release or migration of chemicals from the site) should be observed or visited and addressed in the Site Assessment Checklist. The focus of the habitat and receptor observations should be on a community level. That is, dominant plant and animal species and habitats (e.g., wetlands, wooded areas) should be identified during the site visit. Photographs should be taken during the site visit and attached to the Scoping Assessment Report. Photographs are particularly useful for documenting the nature, quality, and distribution of vegetation, other ecological features, potential exposure pathways, and any evidence of contamination or impact. While the focus of the survey is on the community level, the U.S. Fish and Wildlife Service and the New Mexico Natural Heritage Program should be contacted prior to the site visit. The intent is to determine if state listed and/or federal listed Threatened & Endangered (T&E) species or sensitive habitats may be present at the site, or if any other fish or wildlife species could occur in the area (as indicated in the Site Assessment Checklist, Section IIID). A trained biologist or ecologist should conduct the biota surveys to appropriately characterize major habitats and to determine whether T&E species are present or may potentially use the site. The site assessment should also include a general survey for T&E species and any sensitive habitats (e.g. wetlands, perennial waters, breeding areas), due to the fact that federal and state databases might not be complete.

Site visits should be conducted at times of the year when ecological features are most apparent (i.e., spring, summer, early fall). Visits during winter might not provide as much evidence of the presence or absence of receptors and potential exposure pathways.

In addition to observations of ecological features, the assessor should note any evidence of chemical releases (including visual and olfactory clues), drainage patterns, areas with apparent erosion, signs of groundwater discharge at the surface (such as seeps or springs), and any natural or anthropogenic site disturbances.

2.3 Identify Contaminants of Potential Ecological Concern

Contaminants of Potential Ecological Concern (COPECs) are chemicals which may pose a threat to individual species or biological communities. For the purposes of the Scoping Assessment, all chemicals known or suspected of being released at the site are considered COPECs. The identification of COPECs is usually accomplished by the review of historical information in which previous site activities and releases are identified, or by sampling data which confirm the presence of contaminants in environmental media at the site. If any non-chemical stressors such as mechanical disturbances or extreme temperature conditions are known to be present at the site, they too are to be considered in the assessment.

After the COPECs have been identified, they should be summarized and organized (such as in table or chart form) for presentation in the Scoping Assessment Report.

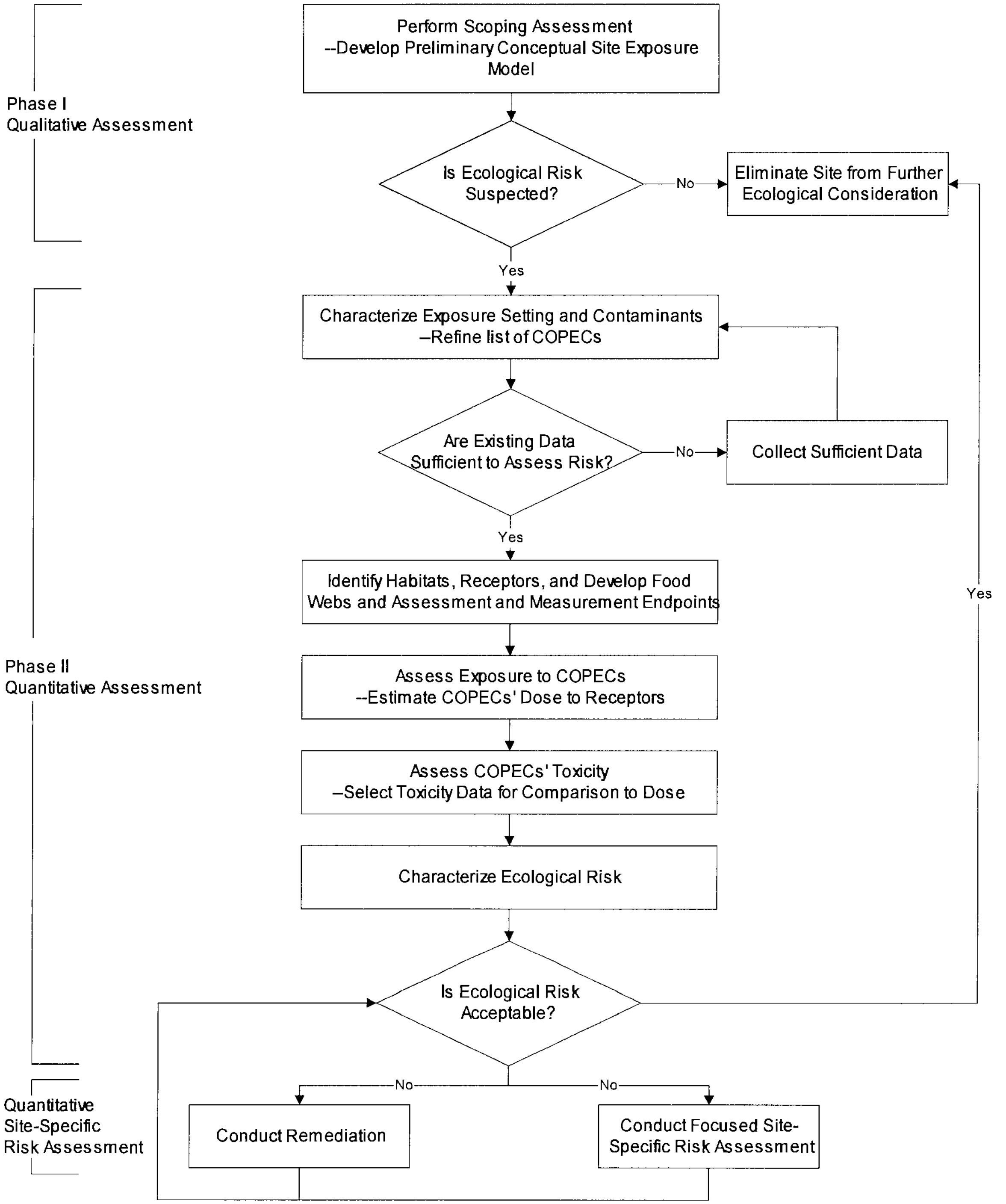
2.4 Developing the Preliminary Conceptual Site Exposure Model

A PCSEM provides a summary of potentially complete exposure pathways, along with potentially exposed receptor types. The PCSEM, in conjunction with the scoping report, is used to determine whether further ecological assessment (i.e., Screening-Level Assessment, Site-Specific Assessment) and/or interim measures are required.

A complete exposure pathway is defined as a pathway having all of the following attributes (US EPA, 1998; NMED, 2014):

- A source and mechanism for hazardous waste/constituent release to the environment
- An environmental transport medium or mechanism by which a receptor can come into contact with the hazardous waste/constituent
- A point of receptor contact with the contaminated media or via the food web, and
- An exposure route to the receptor.

If any of the above components are missing from the exposure pathway, it is not a complete pathway for the site. A discussion regarding all possible exposure pathways and the rationale/justification for eliminating any pathways should be included in the PCSEM narrative and in the Scoping Assessment Report.



Adapted from GAERPC (NMED 2000).

Figure 1. NMED Ecological Risk Assessment Process

The PCSEM is presented as both a narrative discussion and a diagram illustrating potential contaminant migration and exposure pathways to ecological receptors. A sample PCSEM diagram is presented in Figure 2. On the PCSEM diagram, the components of a complete exposure pathway are grouped into three main categories: sources, release mechanisms, and potential receptors. As a contaminant migrates and/or is transformed in the environment, sources and release mechanisms can be defined as primary, secondary, and tertiary.

For example, Figure 2 depicts releases from a landfill that migrate into soils, and reach nearby surface water and sediment via storm water runoff. In this situation, the release from the landfill is considered the primary release, with infiltration as the primary release mechanism. Soil becomes the secondary source, and storm water runoff is the secondary release mechanism to surface water and sediments, the tertiary source.

Subsequent ecological exposures to terrestrial and aquatic receptors will result from this release. The primary exposure routes to ecological receptors are direct contact, ingestion, and possibly inhalation. For example, plant roots will be in direct contact with contaminated sediments, and burrowing mammals will be exposed via dermal contact with soil and incidental ingestion of contaminated soil. In addition, exposures for birds and mammals will occur as they ingest prey items through the food web.

Although completing the Site Assessment Checklist will not provide the user with a readymade PCSEM, a majority of the components of the PCSEM can be found in the information provided by the Site Assessment Checklist. The information gathered for the completion of Section II of the Site Assessment Checklist, can be used to identify sources of releases. The results of Section III, Habitat Evaluation, can be used to both identify secondary and tertiary sources and to identify the types of receptors which may be exposed. The information gathered for completion of Section IV, Exposure Pathway Evaluation, will assist users in tracing the migration pathways of releases in the environment, thus helping to identify release mechanisms and sources.

Once all of the components of the conceptual model have been identified, complete exposure pathways and receptors that have the potential for exposure to site releases can be identified.

For further guidance on constructing a PCSEM, consult the GAERPC (NMED, 2014), and US EPA guidance on corrective action, to include the site conceptual exposure model builder (http://www.epa.gov/osw/hazard/correctiveaction/resources/guidance/index.htm).

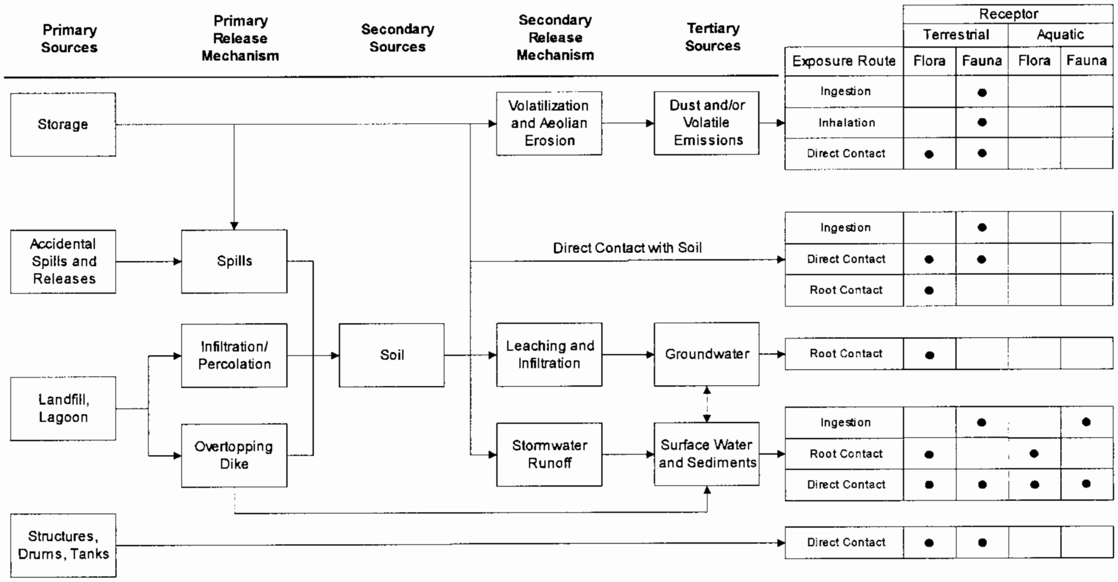
2.5 Assembling the Scoping Assessment Report

After completion of the previously described activities of the scoping assessment, the Scoping Assessment Report should be assembled to summarize the site information and present an evaluation of receptors and pathways at the site. The Scoping Assessment Report should be designed to support the decision made regarding the first Technical Decision Point (Is Ecological Risk Suspected?). The Scoping Assessment Report should, at a minimum, contain the following information:

- Existing Data Summary
- Site Visit Summary (including a completed Site Assessment Checklist)

- Evaluation of Receptors and Pathways
- Recommendations
- Attachments (e.g. photographs, field notes, telephone conversation logs with natural resource agencies)
- References/Data Sources

After completion, the Scoping Assessment Report and PCSEM should be submitted to NMED for review and approval. These documents will serve as a basis for decisions regarding future actions at the site.



Exposure Route	Terrestrial Flora	Terrestrial Fauna	Aquatic Flora	Aquatic Fauna
Ingestion		●		
Inhalation		●		
Direct Contact	●	●		
Ingestion		●		
Direct Contact	●	●		
Root Contact	●			
Root Contact	●			
Ingestion		●		●
Root Contact	●		●	
Direct Contact	●	●	●	●
Direct Contact	●	●		

Adapted from GAERPC (NMED 2000).

Figure 2. Example Preliminary Conceptual Site Exposure Model Diagram for a Hypothetical Site

2.6 Site Exclusion Criteria

If the assessor believes that the answer to the first Technical Decision Point (Is Ecological Risk Suspected?) is "no" based on the results of the PCSEM and Scoping Assessment Report, it should be determined whether the facility meets the NMED Site Exclusion Criteria.

Exclusion criteria are defined as those conditions at an affected property which eliminate the need for a SLERA. The three criteria are as follows:

- Affected property does not include viable ecological habitat.
- Affected property is not utilized by potential receptors.
- Complete or potentially complete exposure pathways do not exist due to affected property setting or conditions of affected property media.

The Exclusion Criteria Checklist and associated Decision Tree (Attachment B) can be used as a tool to help the user determine if an affected site meets the exclusion criteria. The checklist assists in making a conservative, qualitative determination of whether viable habitats, ecological receptors, and/or complete exposure pathways exist at or in the locality of the site where a release of hazardous waste/constituents has occurred. Thus, meeting the exclusion criteria means that the facility can answer "no" to the first Technical Decision Point.

If the affected property meets the Site Exclusion Criteria, based on the results of the checklist and decision tree, the facility must still submit a Scoping Assessment Report to NMED which documents the site conditions and justification for how the criteria have been met. Upon review and approval of the exclusion by the appropriate NMED Bureau, the facility will not be required to conduct any further evaluation of ecological risk. However, the exclusion is not permanent; a future change in circumstances may result in the affected property no longer meeting the exclusion criteria.

2.7 Technical Decision Point: Is Ecological Risk Suspected?

As discussed in the beginning of this document, the Scoping Assessment is the first phase of the GAERPC ecological risk assessment process (Figure 1). Following the submission of the Scoping Assessment Report and PCSEM, NMED will decide upon one of the following three recommendations for the site:

- No further ecological investigation at the site, or
- Continue the risk assessment process, and/or
- Undertake a removal or remedial action.

If the information presented in the Scoping Assessment Report supports the answer of "no" to the first Technical Decision Point, and the site meets the exclusion criteria, the site will likely be excused from further consideration of ecological risk. However, this is only true if it can be documented that a complete exposure pathway does not exist and will not exist in the future at the site based on current conditions. For those sites where valid pathways for potential exposure exist or are likely to exist in the future, further ecological risk assessment (usually in the form of a SLERA) will be required. However, if the Scoping Assessment indicates that a detailed assessment is warranted, the facility would not be required to conduct a SLERA. Instead the facility would move directly to Phase II and the Site-Specific Ecological Risk Assessment (Tier 3).

3.0 TIER 1 SCREENING LEVELS ECOLOGICAL RISK ASSESSMENT (SLERA)

If the PSCEM indicates complete exposure pathways, a SLERA is most likely the next step. The data collected during the scoping assessment is used to define facility-wide conditions and define the steps needed for the SLERA and includes the below items. The SLERA should contain a detailed discussion of each of these items.

- Characterization of the environmental setting, including current and future land uses. Ecological assessments must include the evaluation of present day conditions and land uses but also evaluate future land uses.
- Identification of known or likely chemical stressors (chemicals of potential ecological concern, COPECs). The characterization data from the site (e.g., facility investigation) is evaluated to determine what constituents are present in which media. Selection of COPEC should follow the same methodology as outlined in Volume I.
- Identification of the fate and transport pathways that are complete. This includes an understanding of how COPECs may be mobilized from one media to another.
- Identification of the assessment endpoints that should be used to assess impact of the receptors; what is the environmental value to be protected.
- Identification of the complete exposure pathways and exposure routes (as identified in the example in Figure 2). What are the impacted media (soil, surface water, sediment, groundwater, and/or plants) and how might the representative receptors be exposed (direct ingestion, inhalation, and/or direct contact)?
- Species likely to be impacted and selection of representative receptors. From the list of species likely to be present on-site, what species are to be selected to represent specific trophic levels?

3.1 Selection of Representative Species

Sites may include a wide range of terrestrial, semi-aquatic, and aquatic wildlife. A generalized food web is shown in Figure 3. Wildlife receptors for the SLERA should be selected to represent the trophic levels and habitats present or potentially present at the site and include any Federal threatened and endangered species and State sensitive species.

As there are typically numerous species of wildlife and plants present at a given facility or site and in the surrounding areas, only a few key receptors need to be selected for quantitative evaluation in the SLERA, which are representative of the ecological community and varying trophic levels in the food web. Possible receptors that may be evaluated in the SLERAs at each site include the following:

- Plant community,
- Deer mouse,
- Horned lark,
- Kit fox (evaluated at sites greater than 267 acres),
- Pronghorn (evaluated at sites greater than 342 acres), and
- Red-tailed hawk (evaluated at sites greater than 177 acres).

The above key receptors selected as the representative species represent the primary producers as well as the three levels of consumer (primary, secondary, and tertiary).

3.1.1 Plants

The plant community will be evaluated quantitatively in the SLERAs at all sites. Specific species of plants will not be evaluated separately; rather the plant community will be evaluated as a whole. The plant community provides a necessary food source directly or indirectly through the food web for wildlife receptors.

3.1.2 Deer Mouse

The deer mouse (Peromyscus maniculatus) is a common rodent throughout much of North America and it can thrive in a variety of habitats. The deer mouse was selected as a representative receptor because it is prevalent in the vicinity of most sites in New Mexico, and it represents one of the several species of omnivorous rodents that may be present at sites. Small rodents are also a major food source for larger omnivorous and carnivorous species. The deer mouse receptor will be evaluated at all sites, regardless of size. The deer mouse has a relatively small home range and could therefore be substantially exposed to COPECs at sites if their home range is located within a solid waste management unit (SWMU) or other corrective action site.

Based on a review of literature (OEHHA, 1999) and from the Natural Diversity Information Source (CDW, 2011), a dietary composition consisting of 26% invertebrates and 74% plant matter will be assumed for the deer mouse.

3.1.3 Horned Lark

The horned lark (*Eremophila alpestris*) is a common widespread terrestrial bird. It spends much of its time on the ground and its diet consists mainly of insects and seeds. The horned lark receptor was chosen because it is prevalent in New Mexico and represents one of the many small terrestrial bird species that could be present. Since the horned lark spends most of its time on the ground, it also provides a conservative measure of effect since it has a higher rate of incidental ingestion of soil than other song birds. The horned lark is also a major food source for omnivorous intermediate species, and top avian carnivores. The horned lark will be evaluated based on an omnivorous diet of invertebrates and plant matter. The horned lark receptor will be evaluated at all sites, regardless of size. The horned lark has a relatively small home range and could therefore be substantially exposed to COPECs at sites if their home range is located within a SWMU or other corrective action unit.

It will be assumed that the horned lark's diet consists of 75% plant matter, and 25% animal matter based on a study conducted by Doctor, *et al*, 2000.

3.1.4 Kit Fox

The kit fox (*Vulpes macrotis*) is native to the western United States and Mexico. Its diet consists of mostly small mammals. Although the kit fox's diet may also consist of plant matter during certain times of the year, the kit fox will be evaluated as a carnivore, with a diet consisting of 100% prey items. It was selected as a key receptor because it is sensitive species and is common in New Mexico, and the surrounding area at most sites in New Mexico provides suitable habitat for the kit fox. The kit fox also is representative of a mammalian carnivore within the food web.

The kit fox will only be evaluated at sites that are larger than 276 acres. A kit fox has a large home range size (2767 acres) (Zoellick & Smith, 1992) and it is assumed that risks are negligible from exposure to COPECs at sites that are less than 10% of the receptors home range. Unless the area use factor (AUF) is at least 10%, food items potentially contaminated with COPECs and incidental soil ingestion at the site would not contribute significantly to the receptor's diet and exposure to COPECs. The kit fox diet will be based on composition of 100% prey.

3.1.5 Red-Tailed Hawk

The red-tailed hawk (*Buteo jamaicensis*) was selected as a top carnivore avian key receptor. The red-tailed hawk is widespread throughout New Mexico and is one of the most common birds of prey. It hunts primarily rodents, rabbits, birds, and reptiles. The red-tailed hawk was chosen as a key receptor since it is a common species through New Mexico. The red-tailed hawk will only be evaluated at sites that are larger than 177 acres. The red-tailed hawk has a large home range size (1770 acres) (US EPA, 1993b), and risks to the red-tailed hawk from exposure to COPECs at sites smaller than 177 acres (10% of the home range) would be negligible. The red-tailed hawk diet will be based on composition of 100% prey.

3.1.6 Pronghorn Antelope

The pronghorn (*Antilocapra Americana*) is a popular big game species that occurs in western Canada, United States, and northern Mexico. Its diet consists mainly of sagebrush and other shrubs, grasses, and forbs. The pronghorn was selected as a key receptor representative of large herbivorous species of wildlife. The pronghorn will only be evaluated at sites that are larger than 342 acres. The pronghorn has a large home range size (3422 acres) (Reynolds, 1984), and risks to the pronghorn from exposure to COPECs at sites smaller than 342 acres (10% of the home range) would be negligible. It is assumed that 100% of the diet is from grazing.

3.2 Exposure Pathways

The scoping survey will provide a summary of potentially complete exposure pathways, along with potentially exposed receptor types. A complete exposure pathway is defined as a pathway having all of the following attributes:

- A source and mechanism for hazardous waste/constituent release to the environment,
- An environmental transport medium or mechanism by which a receptor can come into contact with the hazardous waste/constituent,
- A point of receptor contact with the contaminated media or via the food web, and
- An exposure route to the receptor.

If any of the above components are missing from the exposure pathway, it is not a complete pathway for the site. A discussion regarding all possible exposure pathways and the rationale/justification for eliminating any pathways will be included in the risk assessment.

Affected media that ecological receptors may be exposed to at sites are soil, biota, and surface water or groundwater (through springs). Surface water, sediment, and groundwater should be evaluated based on site-specific conditions.

Wildlife receptors could be exposed to COPECs that have been assimilated into biota. Ingestion of contaminated plant and animal matter, as a necessary component of the receptor's diet, will be evaluated quantitatively in the SLERAs. However, for the Tier-1 SLERA, it will conservatively be assumed that 100% of the wildlife receptors' dietary intake consists of site soil.

For soil, two soil intervals should be evaluated:

- For all non-burrowing receptors, the soil interval to be considered is between zero (0) and five (5) feet below ground surface (ft bgs).
- For all burrowing receptors and plants, the soil interval to be evaluated is 0 – 10 ft bgs.

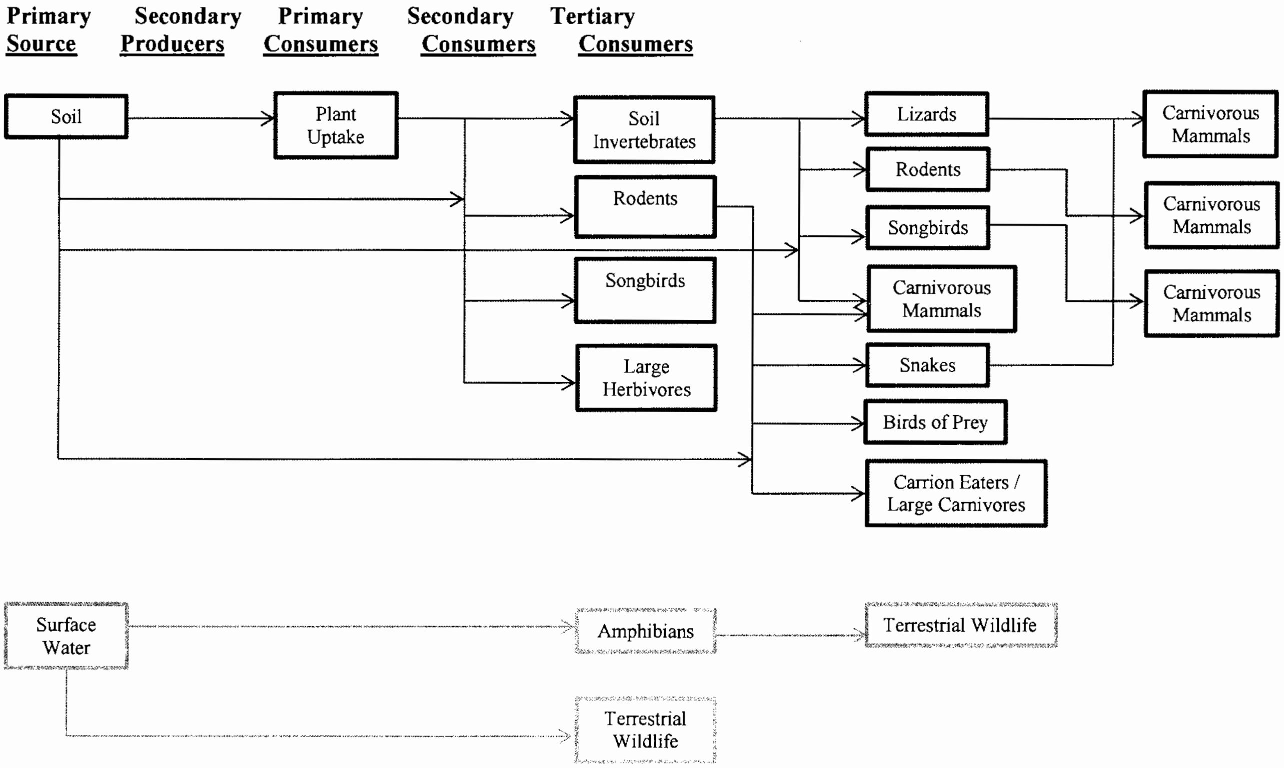


Figure 3. Generic Food Web.

3.3 SLERA Exposure Estimation

For the initial SLERA, conservative assumptions should be applied as follows:

- Maximum detected concentrations (0-10 ft bgs for all receptors) will be utilized in calculating exposure doses.
- 100% of the diet is assumed to contain the maximum concentration of each COPEC detected in the site media.
- Minimum reported body weights should be applied.
- Maximum dietary intake rates should be used.
- It will be assumed that 100% of the diet consists of direct ingestion of contaminated soil.
- It is assumed that the bioavailability is 100% at each site.
- Foraging ranges are initial set equal to the size of the site being evaluated. This means that the AUF in the SLERA is set to a value of one.

The equation and exposure assumptions for calculating the Tier 1 exposure doses for the deer mouse are presented in Equation 1.

Equation 1. Calculation of Tier 1 Exposure Dose for COPECs in Soil; Deer Mouse

$$Exposure\ Dose = \frac{(C_s \times (IR * ww{:}dw)\ \times AUF)}{BW}$$

Parameter	**Definition (units)**	**Value**	**Reference**
Exposure Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	calculated	--
C_s	Chemical concentration in soil (mg/kg)	Site-specific	Maximum detected concentration (0-10 ft bgs)
IR	Ingestion rate (kg food [ww]/day)	0.007	Maximum reported total dietary intake (US EPA, 1993b)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
AUF	Area use factor (the ratio of the site exposure area to the receptor foraging range) (unitless)	1	Maximum possible value
BW	Body weight (kg)	0.014	Minimum reported adult body weight (CDW, 2011)

The equation and exposure assumptions for calculating the Tier 1 exposure dose for the horned lark are presented in Equation 2.

Equation 2. Calculation of Tier 1 Exposure Dose for COPECs in Soil; Horned Lark

$$Exposure\ Dose = \frac{(C_s \times (IR * ww{:}dw) \times AUF)}{BW}$$

Parameter	Definition (units)	Value	Reference
Exposure Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_s	Chemical concentration in soil (mg/kg)	Site-specific	Maximum detected concentration (0-10 ft bgs)
IR	Ingestion rate (kg food [ww]/day)	0.024	Maximum reported total dietary intake; American robin (US EPA, 1993b)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
AUF	Area use factor (the ratio of the site exposure area to the receptor foraging range) (unitless)	1	Maximum possible value
BW	Body weight (kg)	0.025	Minimum reported adult body weight (Trost, 1972)

The equation and exposure assumptions for calculating the Tier 1 exposure doses for the kit fox are presented in Equation 3.

Equation 3. Calculation of Tier 1 Exposure Dose for COPECs in Soil; Kit Fox

$$Exposure\ Dose = \frac{(C_s \times \ (IR * ww{:}dw) \times AUF)}{BW}$$

Parameter	Definition (units)	Value	Reference
Exposure Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	calculated	--
C_s	Chemical concentration in soil (mg/kg)	Site-specific	Maximum detected concentration (0-10 ft bgs)
IR	Ingestion rate (kg food [ww]/day)	0.18	Maximum reported total dietary intake (OEHHA, 2003)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
AUF	Area use factor (the ratio of the site exposure area to the receptor foraging range) (unitless)	1	Maximum possible value
BW	Body weight (kg)	1.6	Minimum reported adult body weight (OEHHA, 2003)

The equation and exposure assumptions for calculating the Tier 1 exposure doses for the red-tailed hawk are presented in Equation 4.

Equation 4 Calculation of Tier 1 Exposure Dose for COPECs in Soil; Red-tailed Hawk

$$Exposure\ Dose = \frac{(C_s \times (IR * ww{:}dw) \times AUF)}{BW}$$

Parameter	Definition (units)	Value	Reference
Exposure Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_s	Chemical concentration in soil (mg/kg)	Site-specific	Maximum detected concentration (0-10 ft bgs)
IR	Ingestion rate (kg food [ww]/day)	0.12	Maximum reported total dietary intake (US EPA, 1993b)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
AUF	Area use factor (the ratio of the site exposure area to the receptor foraging range) (unitless)	1	Maximum possible value
BW	Body weight (kg)	0.96	Minimum reported adult body weight (US EPA, 1993b)

The equation and exposure assumptions for calculating the Tier 1 exposure doses for the pronghorn are presented in Equation 5.

Equation 5. Calculation of Tier 1 Exposure Dose for COPECs in Soil; Pronghorn

$$Exposure\ Dose = \frac{(C_s \times (IR * ww{:}dw) \times AUF)}{BW}$$

Parameter	Definition (units)	Value	Reference
Exposure Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	calculated	--
C_s	Chemical concentration in soil (mg/kg)	Site-specific	Maximum detected concentration (0-10 ft bgs)
IR	Ingestion rate (kg wet matter/day) Based on equation: $IR=a(BW)^b$ where: a=2.606, b=0.628	0.74	Dry matter intake rate for herbivores (based on Nagy, 2001)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
AUF	Area use factor (the ratio of the site exposure area to the receptor foraging range) (unitless)	1	Maximum possible value
BW	Body weight (kg)	47	Minimum reported adult body weight (O'Gara, 1978)

Exposure doses will not be calculated for plants. For the Tier 1 exposure assessment, it will be assumed that the exposure concentrations for plants are equal to the maximum detected concentrations of COPECs in soil (0-10 ft bgs).

3.4 Effects Assessment

The effects assessment evaluated the potential toxic effects on the receptors being exposed to the COPECs. The effects assessment includes selection of appropriate toxicity reference values (TRVs) for the characterization and evaluation of risk. TRVs are receptor and chemical specific exposure rates at which no adverse effects have been observed, or at which low adverse effects are observed. TRVs that are based on studies with no adverse effects are called no observed adverse effects levels (NOAELs). TRVs that are based on studies with low adverse effects are termed lowest observed adverse effects levels (LOAELs).

For the initial SLERA, the preference for TRVs is based on chronic or long term exposure, when available. The TRVs should be selected from peer-reviewed toxicity studies and from primary literature. Initial risk characterization should be conducted using the lowest appropriate chronic NOAEL for non-lethal or reproductive effects. If a TRV is not available and/or no surrogate data could be identified, the exclusion of potential toxicity associated with the COPEC will be qualitatively addressed in the uncertainty analysis of the risk assessment. Other factors that may be included in this discussion is frequency of detection, depth of detections, and special analysis of the detections. Attachment C, Tables C1 through C6, contains NOAEL- and LOAEL-based TRVs for the key ecological receptors.

3.5 Risk Characterization

Assessment endpoints are critical values to be protected (US EPA, 1997c). The assessment endpoint will be to ensure the survival and reproduction of all ecological receptors to maintain populations. This will be accomplished by determining whether COPECs at each site are present at levels that would adversely affect the population size of ecological receptors by limiting their abilities to reproduce.

For plants, the Tier 1 screening level hazard quotients for plants will be calculated by comparing exposure doses (i.e., maximum detected concentrations of COPECs; 0-10 ft bgs) to an effect concentration. The equation for screening level hazad quotient (SLHQ) for plants is shown in Equation 6. Attachment C, Table C-6, lists effect concentrations to be used in screening for plants.

Equation 6. Calculation of Screening-Level Hazard Quotients for Plant Receptors

$$SLHQ = \frac{C_s}{Effect\ Concentration}$$

Parameter	Definition (units)
SLHQ	Screening level hazard quotient (unitless)
C_s	Chemical concentration in soil (mg COPEC / kg soil dry weight)
Effect Concentration	Concentration at which adverse effects are not expected (mg/kg), see Attachment C, Table C-6.

Tier 1 SLHQs for wildlife receptors will be calculated by comparing estimated exposure doses derived using Equations 1 through 5 for each of the key receptors determined to have complete habitat and exposure pathways at the site to NOAEL-based TRVs. The derivation of SLHQ for the key receptors (except plants) is shown in Equation 7.

Equation 7 Calculation of Screening-Level Hazard Quotients for Wildlife Receptors

$$SLHQ = \frac{Dose}{TRV}$$

OR

$$SLHQ = \frac{C_s}{ESL}$$

Parameter	Definition (Units)
SLHQ	Screening-level hazard quotient (unitless)
Dose	Estimated receptor-specific contaminant intake, from Equations 1 through 5 (mg/kg of body weight/day)
TRV	NOAEL-based TRV (mg/kg/day), Refer to Attacment C, Tables C1 through C5
C_s	Chemical concentration in soil (mg COPEC / kg soil dry weight)
ESL	Ecological Screening Level (refer to Attacment C)

Rearraning the terms for the SLHQ in Equation 7, an Ecological Screening Level (ESL) was derived for comparison to chemical concentrations in soil. Equation 8. For the Tier 1 assessment, the maximum detected site concentration is applies as the chemical concentration in soil. Attachment C, Tables C-1 through C-5, contain the Tier 1 ESLs for the deer mouse, horned lark, kit fox, red-tailed hawk, and pronghorn antelope.

Equation 8 Use of the ESLs to Determine the SLHQ

$$SLHQ = \frac{C_s}{ESL}$$

Parameter	Definition (Units)
SLHQ	Screening-level hazard quotient (unitless)
C_s	Chemical concentration in soil (mg COPEC / kg soil dry weight)

ESL	Ecological Screening Level (refer to Attacment C, Table C1 through C5))

HQs are calculated for each receptor and each COPEC. For each receptor, additive risk must be evaluated. For the initial screening assessment, it is assumed that all COPECs have equal potential risk to the receptor. The overall hazard index (HI) is then calculated for each receptor using Equation 9:

$$HI = HQ_x + HQ_Y + \ldots + HQ_z \qquad \text{Equation 9}$$

Where:

HI = Hazard Index (unitless)
HQ_x = Hazard quotient for each COPEC (unitless)

NMED applies a target risk level for ecological risk assessments of 1.0. If the HI for any receptor is above this target risk level, then there is a potential for adverse effects on ecological receptors and additional evaluation following the Tier 2 SLERA process is required.

As with all risk assessments, the SLERA should include a discussion of the uncertainties. More detailed information may be found in the *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Risk Assessment (NMED, 2014).*

4.0 TIER 2 SLERA

The Tier 2 exposure assessment will consist of calculating refined estimates of exposure doses which will utilize exposure assumptions that are more realistic. The following assumptions will apply to Tier 2 exposure doses:

- Exposure Point Concentration (EPC) – 95 % upper confidence level of the mean (UCLs) will be utilized as the EPC (if sufficient data are available – refer to Volume I for determination of EPCs and UCLs).
- AUF – Site-specific value between 0 and 1, based on the ratio of the exposure area (size of SWMU or corrective action site) to the receptor's average home range size, as shown in Equation 1; if a receptor's home range size is less than the exposure area, a value of 1 will be assumed.

$$AUF = \frac{Exposure\ Area\ of\ Site\ (acres)}{Average\ Home\ Range\ (acres)} \qquad \textbf{Equation 10}$$

- Bioavailability – It will be assumed that the bioavailability is 100% at each site.
- Body weight – The average reported adult body weight will be applied.
- Ingestion rate – The average reported ingestion rate will be applied.
- Dietary composition – Receptor-specific percentages of plant, animal, and soil matter will be considered. Concentrations of COPECs in dietary elements (plant and animal matter) will be predicted by the use of bio-uptake and bioaccumulation modeling.

- Wet-weight to dry-weight conversion factor – Because body weight is reported as wet-weight (kg), and soil concentrations are reported as dry-weight (mg/kg), a wet-weight to dry-weight conversion factor will also be applied when calculating exposure doses.

The Tier 2 exposure doses for wildlife receptors will include one, two or all three of the following elements, depending on the receptor being evaluated: 1) ingestion of plant matter; 2) ingestion of animal (or invertebrate) matter; and 3) incidental ingestion of soil. Bio-uptake and bioaccumulation modeling will be utilized to predict the concentrations of COPECs in plants and animal/invertebrate matter that could be ingested by wildlife receptors. Evaluation of surface and/or groundwater should be discussed with NMED.

Plant uptake factors (PUFs) will be used to predict the concentrations of COPECs in plants. The PUFs for inorganic constituents are summarized in Table 1. For organic COPECs, the PUFs are based on the octanol-water partition coefficient (K_{ow}), which will be obtained from US EPA databases or primary literature.

If a PUF is not available, then a value of one (1) will be applied which assumes 100% assimilation. The equation and variables that will be used to predict COPEC concentrations in plants are shown in Equation 11.

Equation 11. Calculation of COPEC Concentrations in Plants

$$C_{plant} = C_{soil} \times PUF$$

Parameter	Definition (Units)	Value
C_{plant}	COPEC concentration in plant (mg/kg dry weight)	Calculated
C_{soil}	Concentration of COPEC in soil (EPC) (mg/kg dry weight)	Site-specific
PUF	Plant-uptake factor (unitless)	For inorganics (see Table 1) For organic constituents (Travis and Arms, 1988): $PUF = 1.588 - 0.578 \log K_{ow}$ K_{ow}- obtain from EPA, 2011b or most current

Table 1. Plant Uptake Factors for Inorganics

Analyte	Plant Uptake Factor (PUF)	Analyte	Plant Uptake Factor (PUF)
Aluminum	4.0E-03	Magnesium	1.0E+00
Antimony	2.0E-01	Manganese	2.5E-01
Arsenic	4.0E-02	Mercury	9.0E-01
Barium	1.5E-01	Molybdenum	2.5E-01
Beryllium	1.0E-02	Nickel	6.0E-02

Analyte	Plant Uptake Factor (PUF)	Analyte	Plant Uptake Factor (PUF)
Boron	4.0E+00	Potassium	1.0E+00
Cadmium	5.5E-01	Selenium	2.5E-02
Calcium	3.5E+00	Silver	4.0E-01
Chromium	7.5E-03	Sodium	7.5E-02
Cobalt	2.0E-02	Thallium	4.0E-03
Copper	4.0E-01	Tin	3.0E-02
Iron	4.0E-03	Vanadium	5.5E-03
Lead	4.5E-02	Zinc	1.5E+00
From Baes, *et.al,* 1994			

Concentrations of COPECs in animal matter (invertebrates and prey species) will be predicted by applying bioaccumulation or biomagnification factors (BAFs). The BAFs will be selected from primary literature sources. If BAF data are not available, a default value of 1 will be used, which will conservatively assume 100% assimilation. Methodology for determining BAFs for soil to plants, soil to earthworms, and soil to small mammals may be found in US EPA (2003(b) and 2005). The equation and variables for predicting concentrations in animal matter are shown in Equation 12.

Equation 12. Calculation of COPEC Concentrations in Prey

$$C_{prey} = C_{soil} \times BAF$$

Parameter	Definition (Units)	Value
C_{prey}	COPEC concentration in prey (mg/kg dry weight)	Calculated
C_{soil}	Concentration of COPEC in soil (EPC) (mg/kg dry weight)	Site-specific
BAF	Bioaccumulation/Biomagnification factor	Chemical-specific (see US EPA 2003(b) and 2005)

The equation and exposure assumptions that will be used to calculate the Tier 2 exposure doses for the deer mouse are shown in Equation 13.

Equation 13. Calculation of Tier 2 Exposure Dose for COPECs in Soil; Deer Mouse

$$Exposure\ Dose = \frac{\left[\left(C_{plant} \times \frac{IR_{plant}}{ww\!:dw}\right) + \left(C_{invert} \times \frac{IR_{invert}}{1/ww\!:dw}\right) + (C_{soil} \times IR_{soil} \times ST) \times AUF\right]}{BW}$$

Parameter	Definition (Units)	Value	Reference

Exposure dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_{plant}	COPEC concentration in plants (mg final COPEC/kg plant dry weight)	Calculated	See Equation 11
IR_{total}	Receptor-specific average ingestion rate based on total dietary intake (kg wet weight/day)	0.004	US EPA 1993b
IR_{plant}	Receptor-specific plant-matter ingestion rate (kg food wet weight/day)	0.003	Based on an average ingestion rate of 0.004 kg/day (US EPA, 1993b) and a diet of 74% plant matter (OEHHA, 1999)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
C_{invert}	Invertebrate EPC (mg final COPEC/kg invertebrate dry weight)	Calculated	See Equation 12
IR_{invert}	Receptor-specific animal matter ingestion rate (kg food wet weight/day)	0.001	Based on an average ingestion rate of 0.004 kg/day (US EPA, 1993b) and a diet of 26% invertebrate matter (OEHHA, 1999)
C_{soil}	Surface-soil EPC (mg final COPEC/kg soil dry weight)	Site-specific	95% UCL if available, or maximum (0-0.5 ft bgs)
IR_{soil}	Receptor-specific incidental soil ingestion rate (kg soil dry weight/day)	0.000018	Based on < 2% (Beyer et. al, 1994); Average ingestion rate of (0.004 kg/day wet weight * 0.22 ww:dw) * 2%.
ST	Bioavailability factor for constituents ingested in soil (assumed to be 1.0 for all constituents)	1.0	Conservative default (assume 100% bioavailability)
AUF	area use factor (maximum value = 1); ratio of area of site to average receptor foraging range (0.3 acres for deer mouse)	Site-specific	US EPA, 1993b
BW	average adult body weight (kg)	0.02	CDW, 2011

The equation and exposure assumptions that will be used to calculate the Tier 2 exposure doses for the horned lark are shown in Equation 14.

Equation 14. Calculation of Tier 2 Exposure Dose for COPECs in Soil; Horned Lark

$$Exposure\ Dose = \frac{\left[\left(C_{plant} \times \frac{IR_{plant}}{ww: dw}\right) + \left(C_{invert} \times \frac{IR_{invert}}{1/ww: dw}\right) + (C_{soil} \times IR_{soil} \times ST) \times AUF\right]}{BW}$$

Parameter	**Definition (Units)**	**Value**	**Reference**
Exposure dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_{plant}	COPEC concentration in plants (mg final	Calculated	See Equation 11

	COPEC/kg plant dry weight)		
IR_{total}	Receptor-specific average ingestion rate based on total dietary intake (kg food wet weight/day)	0.035	US EPA 1993b; based on average ingestion rate for American robin adjusted for horned lark body weight.
IR_{plant}	Receptor-specific plant-matter ingestion rate (kg food wet weight/day)	0.026	Based on average ingestion rate of 0.035 kg/day (US EPA 1993b) and a diet of 75% plant matter (Doctor, *et* al, 2000) and US EPA, 1993b
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
C_{invert}	Invertebrate EPC (mg final COPEC / kg invertebrate dry weight)	Site-specific	See Equation 12
IR_{invert}	Receptor-specific animal matter ingestion rate (kg food wet weight/day)	0.009	Based on average ingestion rate of 0.035 kg/day (US EPA 1993b) and a diet of 25% invertebrates (Doctor, et al, 2000) and US EPA, 1993b
C_{soil}	Surface-soil EPC (mg final COPEC / kg soil dw)	Site-specific	95% UCL if available, or maximum (0-0.5 ft bgs)
IR_{soil}	Receptor-specific incidental soil ingestion rate (kg/day dry weight)	0.00077	Based on 10% (Baer, *et al*, 1994). Average ingestion rate of (0.035 kg/day (wet weight) * 0.22 ww:dw) * 10%).
ST	Bioavailability factor for constituents ingested in soil (assumed to be 1 for all constituents)	1	Conservative default (assume 100% bioavailability)
AUF	Area use factor (maximum value = 1); ratio of area of site to average receptor foraging range (4 acres for horned lark)	Area of site (acres) / 4 acres	Beason, 1995
BW	Average adult body weight (kg)	0.033	Trost, 1972

The equation and exposure assumptions that will be used to calculate the Tier 2 exposure doses for the kit fox are shown in Equation 15.

Equation 15. Calculation of Tier 2 Exposure Dose for COPECs in Soil; Kit Fox

$$Exposure\ Dose = \frac{\left[\left(C_{prey} \times \frac{IR_{prey}}{1/ww:dw}\right) + (C_{soil} \times IR_{soil} \times ST) \times AUF\right]}{BW}$$

Parameter	**Definition (Units)**	**Value**	**Reference**
Exposure dose	Estimated receptor-specific contaminant intake	Calculated	--

	(mg/kg of body weight/day)		
C_{prey}	Prey EPC (mg final COPEC / kg prey dry weight)	Calculated	See Equation 12
IR_{prey}	Receptor-specific animal matter ingestion rate (kg food wet weight/day)	0.13	Based on an average ingestion rate of 0.13 kg/day (OEHHA, 2003) and a diet of 100% animal matter
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
C_{soil}	Surface and subsurface-soil (0-10 ft bgs) EPC (mg final COPEC / kg soil dw)	Site-specific	95% UCL if available, or maximum (0-10 ft bgs)
IR_{soil}	Receptor-specific incidental soil ingestion rate (kg soil dry weight/day)	0.0008	Based on 2.8% (Beyer et.al., 1994). Average ingestion rate of (0.13 kg/day (wet weight) *0.22 ww:dw) * 2.8%).
ST	Bioavailability factor for constituents ingested in soil (assumed to be 1for all constituents)	1	Conservative default (assume 100% bioavailability)
AUF	Area use factor (maximum value = 1); ratio of area of site to average receptor foraging range (1713 acres for kit fox)	Site-specific	--
BW	Average adult body weight (kg)	2.0	OEHHA, 2003

The equation and exposure assumptions that will be used to calculate the Tier 2 exposure doses for the red-tailed hawk are shown in Equation 16.

Equation 16. Calculation of Tier 2 Exposure Dose for COPECs in Soil; Red-Tailed Hawk

$$Exposure\ Dose = \frac{\left[\left(C_{prey} \times \frac{IR_{prey}}{1/ww:dw}\right) + (C_{soil} \times IR_{soil} \times ST) \times AUF\right]}{BW}$$

Parameter	Definition (Units)	Value	Reference
Exposure dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_{prey}	Prey EPC (mg final COPEC / kg prey dry weight)	Calculated	See Equation 12
IR_{prey}	receptor-specific animal matter ingestion rate (kg food wet weight/day)	0.1	Based on an average ingestion rate of 0.1 kg/day (US EPA 1993b) and a diet of 100% animal matter
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
C_{soil}	surface-soil EPC (mg final COPEC / kg soil dw)	Site-specific	95% UCL if available, or maximum (0-0.5 ft bgs)
IR_{soil}	receptor-specific incidental soil ingestion rate	0.0004	Based on < 2% (Beyer

	(kg soil dry weight/day)		et. al., 1994). Average ingestion rate of (0.12 kg/day (wet weight) *0.22) * 2%).
ST	bioavailability factor for constituents ingested in soil (assumed to be 1 for all constituents)	1	Conservative default (assume 100% bioavailability)
AUF	area use factor (maximum value = 1); ratio of area of site to average receptor foraging range (1770 acres for red-tailed hawk)	Site-specific	--
BW	average adult body weight (kg)	1.1	US EPA, 1993b

The equation and exposure assumptions that will be used to calculate the Tier 2 exposure doses for the pronghorn are shown in Equation 17.

Equation 17. Calculation of Tier 2 Exposure Dose for COPECs in Soil; Pronghorn

$$Exposure\ Dose = \frac{\left[\left(C_{plant} \times \frac{IR_{plant}}{1/ww:dw}\right) + (C_{soil} \times IR_{soil} \times ST) \times AUF\right]}{BW}$$

Parameter	**Definition (Units)**	**Value**	**Reference**
Exposure dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_{plant}	COPEC concentration in plants (mg final COPEC/kg plant dry weight)	Calculated	See Equation 11
IR_{plant}	receptor-specific plant-matter ingestion rate (kg food wet weight/day)	1.4	Based on an average ingestion rate of 1.4 kg/day (US FWS, 2005) and a diet of 100% plant matter
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
C_{soil}	surface-soil EPC (mg final COPEC / kg soil dw)		95% UCL if available, or maximum (0-0.5 ft bgs)
IR_{soil}	receptor-specific incidental soil ingestion rate (kg soil dry weight/day)	0.006	Based on < 2% (Beyer et. al., 1994). Average ingestion rate of (1.4 kg/day (wet weight) * 0.22 ww:dw) * 2%).
ST	bioavailability factor for constituents ingested in soil (assumed to be 1.0 for all constituents)	1	Conservative default (assume 100% bioavailability)
AUF	area use factor (maximum value = 1); ratio of area of site to average receptor foraging range (3422 acres for pronghorn)	Site-specific	Zoellick & Smith, 1992
BW	Average adult body weight (kg)	50	O'Gara, 1978

4.1.1 Toxicity Assessment – Tier 2

The Tier 2 TRVs will be based on LOAELs. The LOAEL will be used as it is more representative of population risks. Attachment C, Tables C1 through C6 lists Tier 2 TRVs for select constituents for each of the key ecological receptors.

4.1.2 Risk Characterization – Tier 2

Risk characterization for Tier 2 will be conducted by calculating HQs for plant and wildlife receptors using a similar method as in the Tier 1 SLERA. The equation and assumptions for calculating the Tier 2 HQs for wildlife receptors are shown in Equation 18.

Equation 18. Calculation of Tier 2 Hazard Quotients for Wildlife Receptors

$$HQ = \frac{Dose}{TRV}$$

Parameter	**Definition (Units)**
HQ	Hazard quotient (unitless)
Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)
TRV	Toxicity reference value (mg/kg/day) based on lowest observed adverse effects level (LOAEL), Refer to Attachment C

For plants, a qualitative discussion of the potential for adverse risk will be provided in the assessment. Comparison of TRVs to soil concentrations based on the 95% UCL may be provided.

Summation of HQs will be added for COPECs that have a similar receptor-specific mode of toxicity. If the Tier 2 HI is less than one, adverse ecological effects are not expected and no further action will be taken.

For sites that have an HI equal to or greater than one, the site may require: 1) additional evaluation under a weight-of-evidence analysis; 2) a Tier 3 ERA; or 3) a corrective measures study.

Per US EPA (1997c), Tier 2 ecological risk characterization should include a discussion of the uncertainties since many assumptions may or may not accurately reflect site conditions. Therefore, a discussion of the uncertainties associated with the Tier 2 SLERA will be included in the report.

5.0 TIER 3: PHASE II - QUANTITATIVE ASSESSMENT

In the event that the SLERA does not show that levels of contamination in the impacted media are below the target level of 1.0, additional quantitative analyses may be warranted. This may include incorporation of biota studies to evaluate impact at the site. NMED should be consulted prior to conducting a Tier 3 assessment.

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ATTACHMENT A
SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT
SCOPING ASSESSMENT
SITE ASSESSMENT CHECKLIST

INTRODUCTION

This checklist has been developed as a tool for gathering information about the facility property and surrounding areas, as part of the scoping assessment. Specifically, the checklist assists in the compilation of information on the physical and biological aspects of the site including the site environmental setting, usage of the site, releases at the site, contaminant fate and transport mechanisms, and the area's habitats, receptors, and exposure pathways. The completed checklist can then be used to construct the preliminary conceptual site exposure model (PCSEM) for the site. In addition, the checklist and PCSEM will serve as the basis for the scoping assessment report. Section III of this document provides further information on using the completed checklist to develop the PCSEM.

In general, the checklist is designed for applicability to all sites; however, there may be unusual circumstances which require professional judgment in order to determine the need for further ecological evaluation (*e.g.,* cave-dwelling receptors). In addition, some of the questions in the checklist may not be relevant to all sites. Some facilities may have large amounts of data available regarding contaminant concentrations and hydrogeologic conditions at the site, while other may have only limited data. In either case, the questions on the checklist should be addressed as completely as possible with the information available.

Habitats and receptors, which may be present at the site, can be identified by direct or indirect[36] observations and by contacting local and regional natural resource agencies. Habitat types may be determined by reviewing land use and land cover maps (LULC), which are available via the Internet at http://www.nationalatlas.gov/mapit.html. With regard to receptors, it should be noted that receptors are often present at a site even when they are not observed. Therefore, for the purposes of this checklist, it should be assumed that receptors are present if viable habitat is present. The presence of receptors should be confirmed by contacting one or several of the organizations listed below.

Sources of general information available for the identification of ecological receptors and habitats include:

- U.S. Fish and Wildlife Service (http://www.fws.gov)
- Biota Information System of New Mexico (BISON-M) maintained by the New Mexico Department of Game and Fish (NMGF) (http://151.199.74.229/states/nm.htm)
- U.S. Forest Service (USFS) (http://www.fs.fed.us/)
- New Mexico Forestry Division (NMFD) of the Energy, Minerals and Natural Resources Department (http://www.emnrd.state.nm.us/forestry/index.htm)
- U.S. Bureau of Land Management (USBLM) (http://www.blm.gov/nhp/index.htm) or (http://www.nm.blm.gov/www/new_home_2.html)
- United States Geological Service (USGS) (http://www.usgs.gov)

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[36] Examples of indirect observations that indicate the presence of receptors include: tracks, feathers, burrows, scat

- National Wetland Inventory Maps (http://wetlands.fws.gov)
- National Audubon Society (http://www.audobon.com)
- National Biological Information Infrastructure (http://biology.usgs.gov)
- Sierra Club (http://www.sierraclub.org)
- National Geographic Society (http://www.nationalgeographic.com)
- New Mexico Natural Heritage Program (http://nmnhp.unm.edu/)
- State and National Parks System
- Local universities
- Tribal organizations

INSTRUCTIONS FOR COMPLETING THE CHECKLIST

The checklist consists of four sections: Site Location, Site Characterization, Habitat Evaluation, and Exposure Pathway Evaluation. Answers to the checklist should reflect existing conditions and should not consider future remedial actions at the site. Completion of the checklist should provide sufficient information for the preparation of a PCSEM and scoping report and allow for the identification of any data gaps.

Section I - Site Location, provides general site information, which identifies the facility being evaluated, and gives specific location information. Site maps and diagrams, which should be attached to the completed checklist, are an important part of this section. The following elements should be clearly illustrated: 1) the location and boundaries of the site relative to the surrounding area, 2) any buildings, structures or important features of the facility or site, and 3) all ecological areas or habitats identified during completion of the checklist. It is possible that several maps will be needed to clearly and adequately illustrate the required elements. Although topographical information should be illustrated on at least one map, it is not required for every map. Simplified diagrams (preferably to scale) of the site and surrounding areas will usually suffice.

Section II - Site Characterization, is intended to provide additional temporal and contextual information about the site, which may have an impact on determining whether a certain area should be characterized as ecologically viable habitat or contains receptors. Answers to the questions in Section II will help the reviewer develop a broader and more complete evaluation of the ecological aspects of a site.

Section III - Habitat Evaluation, provides information regarding the physical and biological characteristics of the different habitat types present at or in the locality of the site. Aquatic features such as lakes, ponds, streams, arroyos and ephemeral waters can be identified by reviewing aerial photographs, LULC and topographic maps and during site reconnaissance visits. In New Mexico, there are several well-defined terrestrial communities, which occur naturally. Typical communities include wetlands, forest (e.g., mixed conifer, ponderosa pine and pinyon juniper), scrub/shrub, grassland, and desert. Specific types of vegetation characterize each of these communities and can be used to identify them. Field guides are often useful for identifying vegetation types. A number of sites may be in areas that have been disturbed by human activities and may no longer match any of the naturally occurring communities typical of the southwest.

Particularly at heavily used areas at facilities, the two most common of these areas are usually described as “weed fields” and “lawn grass”. Vegetation at “weed fields” should be examined to determine whether the weeds consist primarily of species native to the southwest or introduced species such as Kochia. Fields of native weeds and lawn grass are best evaluated using the short grass prairie habitat guides.

The applicable portions of Section III of the checklist should be completed for each individual habitat identified. For example, the questions in Section III.A of the checklist should be answered for each wetland area identified at or in the locality of the site and the individual areas must be identified on a map or maps.

Section IV- Exposure Pathway Evaluation is used to determine if contaminants at the site have the potential to impact habitat identified in Section III. An exposure pathway is the course a chemical or physical agent takes from a source to an exposed organism. Each exposure pathway includes a source (or release from a source), an environmental transport mechanism, an exposure point, and an exposure route. A complete exposure pathway is one in which each of these components, as well as a receptor to be exposed, is present. Essentially, this section addresses the fate and transport of contaminants that are known or suspected to have been released at the site. In most cases, without a complete exposure pathway between contaminants and receptors, additional ecological evaluation is not warranted.

Potential transport pathways addressed in this checklist include migration of contaminants via air dispersion, leaching into groundwater, soil erosion/runoff, groundwater discharge to surface water, and irradiation. Due to New Mexico’s semi-arid climate, vegetation is generally sparse. The sparse vegetation, combined with the intense nature of summer storms in New Mexico, results in soil erosion that occurs sporadically over a very brief time frame. Soil erosion may be of particular concern for sites located in steeply sloped areas. Several questions within Section IV of this checklist have been developed to aid in the identification of those sites where soil erosion/runoff would be an important transport mechanism.

USING THE CHECKLIST TO DEVELOP THE PRELIMINARY CONCEPTUAL SITE EXPOSURE MODEL

The completed Site Assessment Checklist can be used to construct the PCSEM. An example PCSEM diagram is presented in Figure 1. The CSM illustrates actual and potential contaminant migration and exposure pathways to associated receptors. The components of a complete exposure pathway are simplified and grouped into three main categories: sources, release mechanisms, and potential receptors. As a contaminant migrates and/or is transformed in the environment, sources and release mechanisms may expand into primary, secondary, and tertiary levels. For example, Figure 1 illustrates releases from inactive lagoons (primary sources) through spills (primary release mechanism), which migrate to surface and subsurface soils (secondary sources), which are then leached (secondary release mechanism) to groundwater (tertiary source). Similarly, exposures of various trophic levels to the contaminant(s) and consequent exposures via the food chain may lead to multiple groups of receptors. For example, Figure 1 illustrates groups of both aquatic and terrestrial receptors which may be exposed and subsequently serve as tertiary release mechanisms to receptors which prey on them.

Although completing the checklist will not provide the user with a readymade PCSEM, a majority of the components of the PCSEM can be found in the answers to the checklist. It is then up to the user to put the pieces together into a comprehensive whole. The answers from Section II of the checklist, Site Characterization, can be used to identify sources of releases. The answers to Section IV, Exposure Pathway Evaluation, will assist users in tracing the migration pathways of releases in the environment, thus helping to identify release mechanisms and sources. The results of Section III, Habitat Evaluation, can be used to both identify secondary and tertiary sources and to identify the types of receptors which may be exposed. Appendix B of the NMED's *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Assessment* also contains sample food webs which may be used to develop the PCSEM.

Once all of the components have been identified, one can begin tracing the steps between the primary releases and the potential receptors. For each potential receptor, the user should consider all possible exposure points (e.g., prey items, direct contact with contaminated soil or water, etc.) then begin eliminating pathways, which are not expected to result in exposure to the contaminant at the site. Gradually, the links between the releases and receptors can be filled in, resulting in potential complete exposure pathways.

For further guidance on constructing a PCSEM, consult the NMED's *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Assessment* (2000), and EPA's Office of Solid Waste and Emergency *Response's Soil Screening Guidance: User's Guide* (1996).

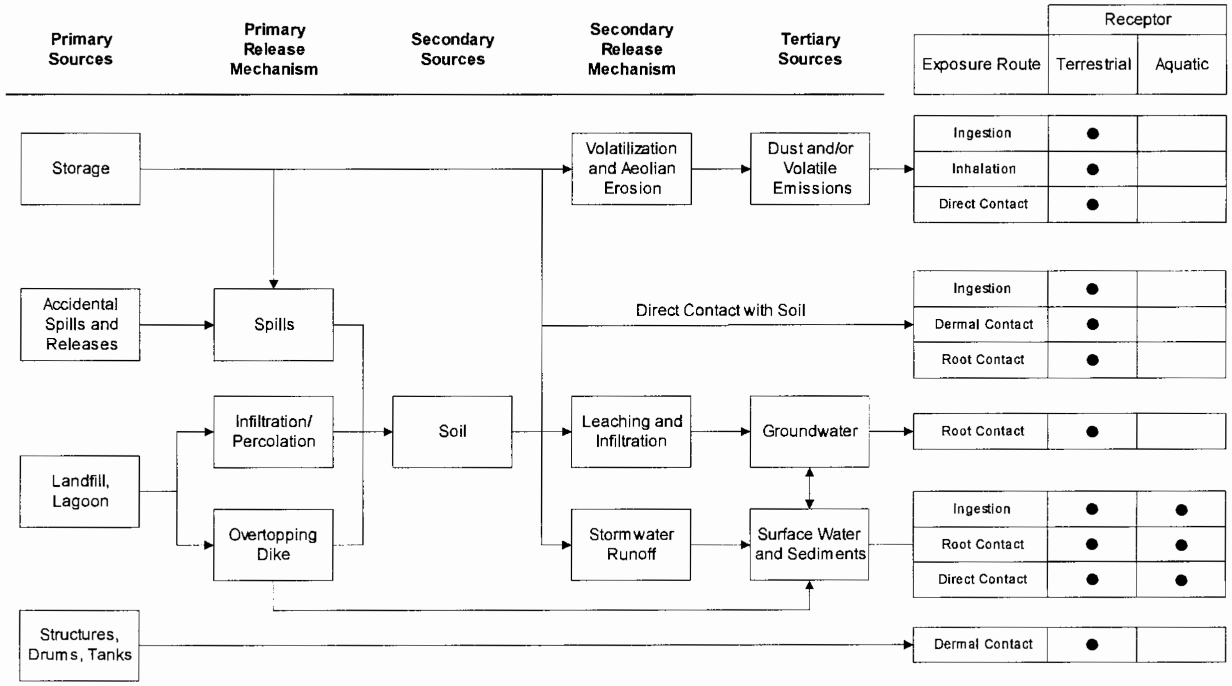

Figure 1. Example Preliminary Conceptual Site Exposure Model Diagram

NEW MEXICO ENVIRONMENT DEPARTMENT
SITE ASSESSMENT CHECKLIST

I. SITE LOCATION

1. Site
Name:____
US EPA I.D.
Number:____
Location:____
County:____________________
City:________________________State:__________

2. Latitude:______________________ Longitude:_________________________

3. Attach site maps, including a topographical map, a diagram which illustrates the layout of the facility (e.g., site boundaries, structures, etc.), and maps showing all habitat areas identified in Section III of the checklist. Also, include maps which illustrate known release areas, sampling locations, and any other important features, if available.

II. SITE CHARACTERIZATION

1. Indicate the approximate area of the site (i.e., acres or sq. ft)

____

2. Provide an approximate breakdown of the land uses on the site:

_____% Heavy Industrial	_____% Light Industrial	_____% Urban
_____% Residential	_____% Rural	_____% Agricultural[b]
_____% Recreational[a]	_____% Undisturbed	_____% Other[c]

[a]For recreational areas, please describe the usage of the area (e.g., park, playing field, etc.):

____

[b]For agricultural areas, please list the crops and/or livestock which are present:

____

[c]For areas designated as "other", please describe the usage of the area:

____

3. Provide an approximate breakdown of the land uses in the area surrounding the site. Indicate the radius (in miles) of the area described: ____________________

_____% Heavy Industrial
_____% Light Industrial
_____% Urban
_____% Residential
_____% Rural
_____% Agricultural[b]
_____% Recreational[a]
_____% Undisturbed
_____% Other [c]

[a]For recreational areas, please describe the usage of the area (e.g., park, playing field, golf course, etc.):

____

[b]For agricultural areas, please list the crops and/or livestock which are present:

____

[c]For areas designated as "other", please describe the usage of the area:

____

____

4. Describe reasonable and likely future land and/or water use(s) at the site.

____

____

____

____

____

____

5. Describe the historical uses of the site. Include information on chemical releases that may have occurred as a result of previous land uses. For each chemical release, provide information on the form of the chemical released (i.e., solid, liquid, vapor) and the known or suspected causes or mechanism of the release (i.e., spills, leaks, material disposal, dumping, explosion, etc.).

____

____

____

____

____

6. If any movement of soil has taken place at the site, describe the degree of the disturbance. Indicate the likely source of any disturbances (e.g., erosion, agricultural, mining, industrial activities, removals, etc.) and estimate when these events occurred.

____

____

____

7. Describe the current uses of the site. Include information on recent (previous 5 years) disturbances or chemical releases that have occurred. For each chemical release, provide information on the form of the chemical released and the causes or mechanism of the release.

____
____
____
____
____

8. Identify the location or suspected location of chemical releases at the site. Provide an estimate of the distance between these locations and the areas identified in Section III.

____
____
____
____
____

9. Identify the suspected contaminants of concern (COCs) at the site. If known, include the maximum contaminant levels. Please indicate the source of data cited (e.g., RFI, confirmatory sampling, etc.).

____
____
____
____
____
____
____

10. Identify the media (e.g., soil (surface or subsurface), surface water, air, groundwater) which are known or suspected to contain COCs._______________
____

11. Indicate the approximate depth to groundwater (in feet below ground surface [(bgs)].

____

12. Indicate the direction of groundwater flow (e.g., north, southeast, etc.)

____

III. HABITAT EVALUATION

III.A Wetland Habitats

Are any wetland[37] areas such as marshes or swamps on or adjacent to the site?

☐ Yes ☐ No

If yes, indicate the wetland area on the attached site map and answer the following questions regarding the wetland area. If more than one wetland area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual wetland area. Distinguish between wetland areas by using names or other designations (such as location), and clearly identify each area on the site map. Also, obtain and attach a National Wetlands Inventory Map (or maps) to illustrate each wetland area.

Identify the sources of the observations and information (e.g., National Wetland Inventory, Federal or State Agency, USGS topographic maps) used to make the determination that wetland areas are or are not present.

____

____

____

____

If no wetland areas are present, proceed to Section III.B.

Wetland Area Questions

☐ Onsite ☐ Offsite

Name or
Designation:____

1. Indicate the approximate area of the wetland (acres or ft^2)________________

2. Identify the type(s) of vegetation present in the wetland.

   ☐ Submergent (i.e., underwater) vegetation
   ☐ Emergent (i.e., rooted in the water, but rising above it) vegetation
   ☐ Floating vegetation
   ☐ Scrub/shrub

---

[37] Wetlands are defined in 40 CFR §232.2 as " Areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Examples of typical wetlands plants include: cattails, cordgrass, willows and cypress trees. National wetland inventory maps may be available at http:\\nwi.fws.gov. Additional information on wetland delineation criteria is also available from the Army Corps of Engineers.

☐ Wooded
☐ Other (Please describe):____

3. Estimate the vegetation density of the wetland area.

☐ Dense (i.e., greater than 75% vegetation)
☐ Moderate (i.e., 25% to 75% vegetation)
☐ Sparse (i.e., less than 25% vegetation)

4. Is standing water present? ☐ Yes ☐ No

If yes, is the water primarily: ☐ Fresh or ☐ Brackish
Indicate the approximate area of the standing water (ft^2):

____

Indicate the approximate depth of the standing water, if known (ft. or in.)_________

5. If known, indicate the source of the water in the wetland.

☐ Stream/River/Creek/Lake/Pond
☐ Flooding
☐ Groundwater
☐ Surface runoff

6. Is there a discharge from the facility to the wetland? ☐ Yes ☐ No

If yes, please describe:____
____
____
____
____

Wetland Area Questions (Continued)

7. Is there a discharge from the wetland? ☐ Yes ☐ No
If yes, indicate the type of aquatic feature the wetland discharges into:

- ☐ Surface stream/River (Name:_____________________________)
- ☐ Lake/Pond (Name:______________________________)
- ☐ Groundwater
- ☐ Not sure

8. Does the area show evidence of flooding? ☐ Yes ☐ No
If yes, indicate which of the following are present (mark all that apply):

- ☐ Standing water
- ☐ Water-saturated soils
- ☐ Water marks
- ☐ Buttressing
- ☐ Debris lines
- ☐ Mud cracks
- ☐ Other (Please describe):____

9. Animals observed in the wetland area or suspected to be present based on indirect evidence or file material:

- ☐ Birds
- ☐ Fish
- ☐ Mammals
- ☐ Reptiles (e.g., snakes, turtles)
- ☐ Amphibians (e.g., frogs, salamanders)
- ☐ Sediment-dwelling invertebrates (e.g., mussels, crayfish, insect nymphs)

Specify species, if known:

____
____
____
____

III.B Aquatic Habitats

III.B.1 Non-Flowing Aquatic Features

Are any non-flowing aquatic features (such as ponds or lakes) located at or adjacent to the site?

☐ Yes ☐ No

If yes, indicate the aquatic feature on the attached site map and answer the following questions regarding the non-flowing aquatic features. If more than one non-flowing aquatic feature is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual aquatic feature. Distinguish between aquatic features by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.B.2.

Non-Flowing Aquatic Feature Questions

☐ Onsite ☐ Offsite

Name or Designation:____

1. Indicate the type of aquatic feature present:

   ☐ Natural (e.g., pond or lake)
   ☐ Man-made (e.g., impoundment, lagoon, canal, etc.)

2. Estimate the approximate size of the water body (in acres or sq. ft.)_______________

3. If known, indicate the depth of the water body (in ft. or in.)._____________________

Non-Flowing Aquatic Feature Questions (Continued)

4. Indicate the general composition of the bottom substrate. Mark all sources that apply from the following list.

☐ Bedrock
☐ Boulder (>10 in.)
☐ Cobble (2.5 - 10 in.)
☐ Gravel (0.1 - 2.5 in.)
☐ Sand
☐ Silt
☐ Clay
☐ Muck (fine/black)
☐ Concrete
☐ Debris
☐ Detritus
☐ Other (please specify):____

5. Indicate the source(s) of the water in the aquatic feature. Mark all sources that apply from the following list.

☐ River/Stream/Creek
☐ Groundwater
☐ Industrial Discharge
☐ Surface Runoff
☐ Other (please specify):______________________________________

6. Is there a discharge from the facility to the aquatic feature? ☐ Yes ☐ No

If yes, describe the origin of each discharge and its migration path:

____
____
____
____

7. Does the aquatic feature discharge to the surrounding environment? ☐ Yes ☐ No

If yes, indicate the features from the following list into which the aquatic feature discharges, and indicate whether the discharge occurs onsite or offsite:

☐ River/Stream/Creek ☐ onsite ☐ offsite
☐ Groundwater ☐ onsite ☐ offsite
☐ Wetland ☐ onsite ☐ offsite
☐ Impoundment ☐ onsite ☐ offsite
☐ Other (please describe)____________________________________

Non-Flowing Aquatic Feature Questions (Continued)

8. Animals observed in the vicinity of the aquatic feature or suspected to be present based on indirect evidence or file material:

☐ Birds
☐ Fish
☐ Mammals
☐ Reptiles (e.g., snakes, turtles)
☐ Amphibians (e.g., frogs, salamanders)
☐ Sediment-dwelling invertebrates (e.g., mussels, crayfish, insect nymphs)

Specify species, if known:

____
____
____
____

III.B.2 Flowing Aquatic Features

Are any flowing aquatic features (such as streams or rivers) located at or adjacent to the site?

☐ Yes ☐ No

If yes, indicate the aquatic feature on the attached site map and answer the following questions regarding the flowing aquatic features. If more than one flowing aquatic feature is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual aquatic feature. Distinguish between aquatic features by using names or other designations, and clearly identify each area on the site map

If no, proceed to Section III.C.

Flowing Aquatic Feature Questions

☐ Onsite ☐ Offsite

Name or Designation:____

1. Indicate the type of flowing aquatic feature present.

   - ☐ River
   - ☐ Stream
   - ☐ Creek
   - ☐ Brook
   - ☐ Dry wash
   - ☐ Arroyo
   - ☐ Intermittent stream
   - ☐ Artificially created (ditch, etc.)
   - ☐ Other (specify)
   - ☐

2. Indicate the general composition of the bottom substrate.

   ☐ Bedrock
   ☐ Boulder (>10 in.)
   ☐ Cobble (2.5 - 10 in.)
   ☐ Gravel (0.1 - 2.5 in.)
   ☐ Sand
   ☐ Silt
   ☐ Clay
   ☐ Muck (fine/black)
   ☐ Concrete
   ☐ Debris
   ☐ Detritus
   ☐ Other (please specify):____

3. Describe the condition of the bank (e.g., height, slope, extent of vegetative cover) of the aquatic feature.

   ____
   ____
   ____
   ____

4. Is there a discharge from the facility to the aquatic feature? ☐ Yes ☐ No
   If yes, describe the origin of each discharge and its migration path:

   ____
   ____
   ____
   ____

5. Indicate the discharge point of the water body. Specify name, if known.

Flowing Aquatic Feature Questions (Continued)

6. If the flowing aquatic feature is a dry wash or arroyo, answer the following questions.
   ☐Check here if feature is not a dry wash or arroyo
   If known, specify the average number of days in a year in which flowing water is present in the feature: ______________________________
   Is standing water or mud present? Check all that apply.
   ☐Standing water
   ☐Mud
   ☐Neither standing water or mud
   Does the area show evidence of recent flow (e.g., flood debris clinging to vegetation)?
   ☐Yes
   ☐No
   ☐Not sure
7. Animals observed in the vicinity of the aquatic feature or suspected to be present based on indirect evidence or file material:

   ☐ Birds
   ☐ Fish
   ☐ Mammals
   ☐ Reptiles (e.g., snakes, turtles)
   ☐ Amphibians (e.g., frogs, salamanders)
   ☐ Sediment-dwelling invertebrates (e.g., mussels, crayfish, insect nymphs)

   Specify species, if known:
   ____
   ____
   ____
   ____

III.C Terrestrial Habitats

III.C.1 Wooded

Are any wooded areas on or adjacent to the site? ☐ Yes ☐ No

If yes, indicate the wooded area on the attached site map and answer the following questions. If more than one wooded area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual wooded area. Distinguish between wooded areas by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.2.

Wooded Area Questions

☐ On-site ☐ Off-site

Name or Designation:____

1. Estimate the approximate size of the wooded area (in acres or sq. ft.)_____________

2. Indicate the dominant type of vegetation in the wooded area.

   ☐ Evergreen
   ☐ Deciduous
   ☐ Mixed

   Dominant plant species, if known:__________________________________

3. Estimate the vegetation density of the wooded area.

   ☐Dense (i.e., greater than 75% vegetation)
   ☐Moderate (i.e., 25% to 75% vegetation)
   ☐Sparse (i.e., less than 25% vegetation)

4. Indicate the predominant size of the trees at the site. Use diameter at chest height.

   ☐ 0-6 inches
   ☐ 6-12 inches
   ☐ >12 inches
   ☐ No single size range is predominant

5. Animals observed in the wooded area or suspected to be present based on indirect evidence or file material:

   ☐ Birds
   ☐ Mammals
   ☐ Reptiles (e.g., snakes, lizards)
   ☐ Amphibians (e.g., toads, salamanders)

   Specify species, if known:

   ____
   ____
   ____
   ____

III.C.2 Shrub/Scrub

Are any shrub/scrub areas on or adjacent to the site? ☐ Yes ☐ No

> If yes, indicate the shrub/scrub area on the attached site map and answer the following questions. If more than one shrub/scrub area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual shrub/scrub area. Distinguish between shrub/scrub areas, using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.3.

Shrub/Scrub Area Questions

☐ Onsite ☐ Offsite

Name or Designation:____

1. Estimate the approximate size of the shrub/scrub area (in acres or sq. ft.).__________

2. Indicate the dominant type of shrub/scrub vegetation present, if known.

____
____
____
____

3. Estimate the vegetation density of the shrub/scrub area.

   ☐ Dense (i.e., greater than 75% vegetation)
   ☐ Moderate (i.e., 25% to 75% vegetation)
   ☐ Sparse (i.e., less than 25% vegetation)

4. Indicate the approximate average height of the scrub/shrub vegetation.

   ☐ 0-2 feet
   ☐ 2-5 feet
   ☐ >5 feet

5. Animals observed in the shrub/scrub area or suspected to be present based on indirect evidence or file material:
   ☐Birds
   ☐Mammals
   ☐Reptiles (e.g., snakes, lizards)
   ☐Amphibians (e.g., toads, salamanders)

   Specify species, if known:

____
____
____
____

III.C.3 Grassland

Are any grassland areas on or adjacent to the site? ☐ Yes ☐ No

If yes, indicate the grassland area on the attached site map and answer the following questions. If more than one grassland area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual grassland area. Distinguish between grassland areas by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.4.

Grassland Area Questions

☐ Onsite ☐ Offsite

Name or Designation:____

1. Estimate the approximate size of the grassland area (in acres or sq. ft.)._________

2. Indicate the dominant plant type, if known.

____
____
____
____

3. Estimate the vegetation density of the grassland area.

☐ Dense (i.e., greater than 75% vegetation)
☐ Moderate (i.e., 25% to 75% vegetation)
☐ Sparse (i.e., less than 25% vegetation)

4. Indicate the approximate average height of the dominant plant type (in ft. or in.)_

5. Animals observed in the grassland area or suspected to be present based on indirect evidence or file material:

☐Birds
☐Mammals
☐Reptiles (e.g., snakes, lizards)
☐Amphibians (e.g., toads, salamanders)

Specify species, if known:

III.C.4 Desert

Are any desert areas on or adjacent to the site? ☐ Yes ☐ No

If yes, indicate the desert area on the attached site map and answer the following questions. If more than one desert area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual desert area. Distinguish between desert areas by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.5.

Desert Area Questions

☐ Onsite ☐ Offsite

Name or Designation:____

1. Estimate the approximate size of the desert area (in acres or sq. ft.)._________

2. Describe the desert area (e.g., presence or absence of vegetation, vegetation types, presence/size of rocks, sand, etc.)

____
____
____
____
____
____
____
____
____

3. Animals observed in the desert area or suspected to be present based on indirect evidence or file material:

☐Birds
☐Mammals
☐Reptiles (e.g., snakes, lizards)
☐Amphibians (e.g., toads, salamanders)

Specify species, if known:

____

III.C.5 Other

1. Are there any other terrestrial communities or habitats on or adjacent to the site which were not previously described?

☐ Yes ☐ No

If yes, indicate the "other" area(s) on the attached site map and describe the area(s) below. Distinguish between onsite and offsite areas. If no, proceed to Section III.D.

III.D Sensitive Environments and Receptors

1. Do any other potentially sensitive environmental areas[38] exist adjacent to or within 0.5 miles of the site? If yes, list these areas and provide the source(s) of information used to identify sensitive areas. *Do not answer "no" without confirmation from the U.S. Fish and Wildlife Service and appropriate State of New Mexico division.*

---

3 Areas that provide unique and often protected habitat for wildlife species. These areas are typically used during critical life stages such as breeding, hatching, rearing of young and overwintering. Refer to **Table 1** at the end of this document for examples of sensitive environments.

2. Are any areas on or near (i.e., within 0.5 miles) the site which are owned or used by local tribes? If yes, describe. *Contact the Tribal Liaison in the Office of the Secretary (505)827-2855 to obtain this information.*

____
____
____
____
____

4. Does the site serve or potentially serve as a habitat, foraging area, or refuge by rare, threatened, endangered, candidate and/or proposed species (plants or animals), or any otherwise protected species? If yes, identify species. *This information should be obtained from the U.S. Fish and Wildlife Service and appropriate State of New Mexico division.*

____
____
____
____
____
____
____

5. Is the site potentially used as a breeding, roosting or feeding area by migratory bird species? If yes, identify which species.

____
____
____
____
____

6. Is the site used by any ecologically[39], recreationally, or commercially important

---

[39] Ecologically important species include populations of species which provide a critical (i.e., not replaceable) food resource for higher organisms and whose function as such would not be replaced by more tolerant species; or perform a critical ecological function (such as organic matter decomposition) and whose functions will not be replaced by other species. Ecologically important species include pest and opportunistic species that populate an area <u>if they serve as a food source for other species</u>, but do <u>not</u> include domesticated animals (e.g., pets and livestock) or plants/animals whose existence is maintained by continuous human interventions (e.g., fish hatcheries, agricultural crops, etc.,)

species? If yes, explain.

____
____
____
____
____

IV. EXPOSURE PATHWAY EVALUATION

1. Do existing data provide sufficient information on the nature, rate, and extent of contamination at the site?

☐ Yes
☐ No
☐ Uncertain

Please provide an explanation for your
answer:______________________
____
____
____
____

2. Do existing data provide sufficient information on the nature, rate, and extent of contamination in offsite affected areas?

☐ Yes
☐ No
☐ Uncertain
☐ No offsite contamination

Please provide an explanation for your
answer:______________________
____
____
____
____

3. Do existing data address potential migration pathways of contaminants at the site?

☐ Yes
☐ No
☐ Uncertain

Please provide an explanation for your
answer:____
_

____
____
____
____

4. Do existing data address potential migration pathways of contaminants in offsite affected areas?

☐ Yes
☐ No
☐ Uncertain
☐ No offsite contamination

Please provide an explanation for your answer:

5. Are there visible indications of stressed habitats or receptors on or near (i.e., within 0.5 miles) the site that may be the result of a chemical release? If yes, explain. Attach photographs if available.

6. Is the location of the contamination such that receptors might be reasonably expected to come into contact with it? For soil, this means contamination in the soil 0 to 5 feet below ground surface (bgs). If yes, explain.

7. Are receptors located in or using habitats where chemicals exist in air, soil, sediment or surface water? If yes, explain.

8. Could chemicals reach receptors via groundwater? Can chemicals leach or dissolve to groundwater? Are chemicals mobile in groundwater? Does groundwater discharge into receptor habitats? If yes, explain.

____
____
____
____
____
____
____

9. Could chemicals reach receptors through runoff or erosion? Answer the following questions:

What is the approximate distance from the contaminated area to the nearest watercourse or arroyo?

☐ 0 feet (i.e., contamination has reached a watercourse or arroyo)
☐ 1-10 feet
☐ 11-20 feet
☐ 21-50 feet
☐ 51-100 feet
☐ 101-200 feet
☐ > 200 feet
☐ > 500 feet
☐ > 1000 feet

What is the slope of the ground in the contaminated area?

☐ 0-10%
☐ 10-30%
☐ > 30%

What is the approximate amount of ground and canopy vegetative cover in the contaminated area?

☐ < 25%
☐ 25-75%
☐ > 75%

Is there visible evidence of erosion (e.g., a rill or gully) in or near the contaminated area?

☐ Yes
☐ No
☐ Do not know

Do any structures, pavement, or natural drainage features direct run-on flow (i.e., surface flows originating upstream or uphill from the area of concern) into the contaminated area?

☐ Yes
☐ No
☐ Do not know

10. Could chemicals reach receptors through the dispersion of contaminants in air (e.g., volatilization, vapors, fugitive dust)? If yes, explain.

____

____

____

____

____

____

11. Could chemicals reach receptors through migration of non-aqueous phase liquids (NAPLs)? Is a NAPL present at the site that might be migrating towards receptors or habitats? Could NAPL discharge contact receptors or their habitat?

____

____

____

____

____

____

____

12. Could receptors be impacted by external irradiation at the site? Are gamma emitting radionuclides present at the site? Is the radionuclide contamination buried or at the surface?

____

____

____

____

____

____

____

PHOTOGRAPHIC DOCUMENTATION

During the site visit(s), photographs should be taken to document the current conditions at the site and to support the information entered in the checklist. For example, photographs may be used to document the following:

- The nature, quality, and distribution of vegetation at the site
- Receptors or evidence of receptors
- Potentially important ecological features, such as ponds and drainage ditches
- Potential exposure pathways
- Any evidence of contamination or impact

The following space may be used to record photo subjects.

SUMMARY OF OBSERVATIONS AND SITE SETTING

Include information on significant source areas and migration pathways that are likely to constitute complete exposure pathways.

Checklist Completed by____

Affiliation____

Author Assisted by____

Date____

TABLE 1
EXAMPLES OF SENSITIVE ENVIRONMENTS

National Parks and National Monuments

Designated or Administratively Proposed Federal Wilderness Areas

National Preserves

National or State Wildlife Refuges

National Lakeshore Recreational Areas

Federal land designated for protection of natural ecosystems

State land designated for wildlife or game management

State designated Natural Areas

Federal or state designated Scenic or Wild River

All areas that provide or could potentially provide critical habitat[1] for state and federally listed Threatened or Endangered Species, those species that are currently petitioned for listing, and species designated by other agencies as sensitive or species of concern

All areas that provide or could potentially provide habitat for state protected species as defined in the Wildlife Code, Chapter 17 of the New Mexico Statutes

All areas that provide or could potentially provide habitat for migratory birds as protected by the Migratory Bird Treaty Act (16 U.S.C. §§ 703-712)

All areas that provide or could potentially provide habitat for bald eagles and golden eagles as protected by the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)

All areas that provide or could potentially provide habitat for song birds as protected by the State of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-13)

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[1] Critical habitats are defined by the Endangered Species Act (50 CFR §424.02(d)) as:

> 1) Specific areas within the geographical area currently occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (I) essential to the conservation of the species and (ii) that may require special management considerations or protection, and 2) Specific areas outside the geographical area occupied by a species at the time it is listed upon a determination by the Secretary [of Interior] that such areas are essential for the conservation of the species.

All areas that provide or could potentially provide habitat for hawks, vultures and owls as protected by the State of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-14)

All areas that provide or could potentially provide habitat for horned toads and Bullfrogs as protected by the State of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-15 and 16, resp.)

All perennial waters (e.g., rivers, lakes, playas, sloughs, ponds, etc)

All ephemeral drainage (e.g., arroyos, puddles/pools, intermittent streams, etc) that provide significant wildlife habitat or that could potentially transport contaminants off site to areas that provide wildlife habitat

All riparian habitats

All perennial and ephemeral wetlands (not limited to jurisdictional wetlands)

All areas that are potentially important breeding, staging, and overwintering habitats as well as other habitats important for the survival of animals during critical periods of their life cycle.

ATTACHMENT B
ECOLOGICAL SITE EXCLUSION CRITERIA CHECKLIST AND DECISION TREE

NEW MEXICO ECOLOGICAL EXCLUSION CRITERIA CHECKLIST

The following questions are designed to be used in conjunction with the Ecological Exclusion Criteria Decision Tree (Figure 1). After answering each question, refer to the Decision Tree to determine the appropriate next step. In some cases, questions will be omitted as the user is directed to another section as indicated by the flow diagram in the Decision Tree. For example, if the user answers "yes" to Question 1 of Section I, he or she is directed to proceed to Section II.

I. Habitat

In the following questions, "affected property" refers to all property on which a release has occurred or is believed to have occurred, including off-site areas where contamination may have occurred or migrated.

1. Are any of the below-listed sensitive environments at, adjacent to, or in the locality[1] of the affected property?

    - National Park or National Monument
    - Designated or administratively proposed Federal Wilderness Area
    - National Preserve
    - National or State Wildlife Refuge
    - Federal or State land designated for wildlife or game management
    - State designated Natural Areas
    - All areas that are owned or used by local tribes
    - All areas that are potentially important breeding, staging, and overwintering habitats as well as other habitats important for the survival of animals during critical periods of their life cycle
    - All areas that provide or could potentially provide habitat for state and federally listed Threatened or Endangered Species, those species that are currently petitioned for listing, and species designated by other agencies as sensitive or species of concern
    - All areas that provide or could potentially provide habitat for state protected species as defined in the Wildlife Code, Chapter 17 of the New Mexico Statutes
    - All areas that provide or could potentially provide habitat for migratory birds as protected by the Migratory Bird Treaty Act (16 U.S.C. §§ 703-712)
    - All areas that provide or could potentially provide habitat for bald eagles and golden eagles as protected by the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)
    - All areas that provide or could potentially provide habitat for song birds as protected by the state of New Mexico statute (New Mexico Statute, 1978, Chapter

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[1] *Locality* of the site refers to any area where an ecological receptor is likely to contact site-related chemicals. The locality of the site considers the likelihood of contamination migrating over time and places the site in the context of its general surrounding. Therefore, the locality is typically larger than the site and the areas adjacent to the site.

17, Game and Fish, 17-2-13)

- All areas that provide or could potentially provide habitat for hawks, vultures and owls as protected by the state of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-14)
- All areas that provide or could potentially provide habitat for horned toads and bullfrogs as protected by the state of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-15 and 16, respectively)

2. Does the affected property contain land areas which were not listed in Question 1, but could be considered viable ecological habitat? The following are examples (but not a complete listing) of viable ecological habitats:

- Wooded areas
- Shrub/scrub vegetated areas
- Open fields (prairie)
- Other grassy areas
- Desert areas
- Any other areas which support wildlife and/or vegetation, excluding areas which support only opportunistic species (such as house mice, Norway rats, pigeons, etc.) that do not serve as prey to species in adjacent habitats.

The following features are <u>not</u> considered ecologically viable:

- Pavement
- Buildings
- Paved areas of roadways
- Paved/concrete equipment storage pads
- Paved manufacturing or process areas
- Other non-natural surface cover or structure

3. Does the affected property contain any perennial or ephemeral aquatic features which were not listed in Question 1?

II. Receptors

1. Is any part of the affected property used for habitat, foraging area, or refuge by any rare, threatened, or endangered species (plant *or* animal), or otherwise protected species (e.g., raptors, migratory birds)?

2. Is any part of the affected property used for habitat, foraging area, or refuge by any species used as a recreational (e.g., game animals) and/or commercial resource?

3. Is any part of the affected property used for habitat, foraging area, or refuge by any plant or animal species? This includes plants considered "weeds" and opportunistic insect and animal species (such as cockroaches and rats) if they are used as a food source for other species in the area.

III. Exposure Pathways

1. Could receptors be impacted by contaminants via direct contact?
   Is a receptor located in or using an area where it could contact contaminated air, soil[3], or surface water?

For Questions 2 and 3, note that one must answer "yes" to all three bullets in order to be directed to the "exclusion denied" box of the decision tree. This is because answering "no" to one of the questions in the bullet list indicates that a complete exposure pathway is not present. For example, in Question 2, if the chemical cannot leach or dissolve to groundwater (bullet 1), there is no chance of ecological receptors being exposed to the chemical through contact with contaminated groundwater. Similarly, the responses to the questions in Question 4 determine whether a complete pathway exists for exposure to NAPL.

2. Could receptors contact contaminants via groundwater?
   - Can the chemical leach or dissolve to groundwater[4]?
   - Can groundwater mobilize the chemical?
   - Could (does) contaminated groundwater discharge into known or potential receptor habitats?

3. Could receptors contact contaminants via runoff (i.e., surface water and/or suspended sediment) or erosion by water or wind?
   - Are chemicals present in surface soils?
   - Can the chemical be leached from or eroded with surface soils?
   - Is there a receptor habitat located downgradient of the leached/eroded surface soil?

4. Could receptors contact contaminants via migration of non-aqueous phase liquids (NAPL)?
   - Is NAPL present at the site?
   - Is NAPL migrating toward potential receptors or habitats?
   - Could NAPL discharge impact receptors or habitats?

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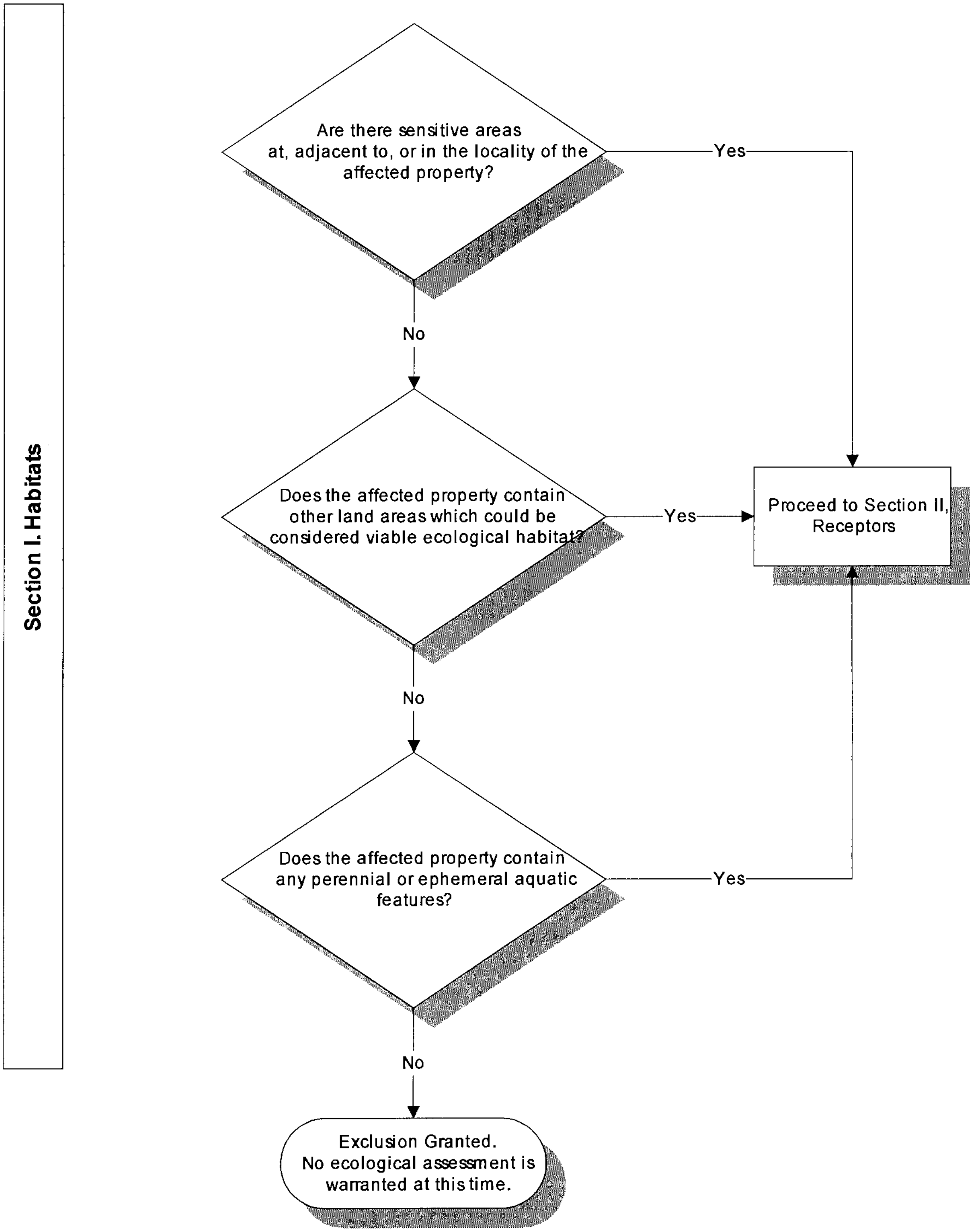
[3] For soil, this means contamination less than 5 feet below ground surface (bgs).

[4] Information on the environmental fate of specific chemicals can be found on the Internet at http://www.epa.gov/opptintr/chemfact/ or at a local library in published copies of the *Hazardous Substances Data Bank*.

Figure 1 -Ecological Exclusion Criteria Decision Tree
(Refer to corresponding checklist for the full text of each question)

Figure 1 - Exclusion Criteria Decision Tree (continued)



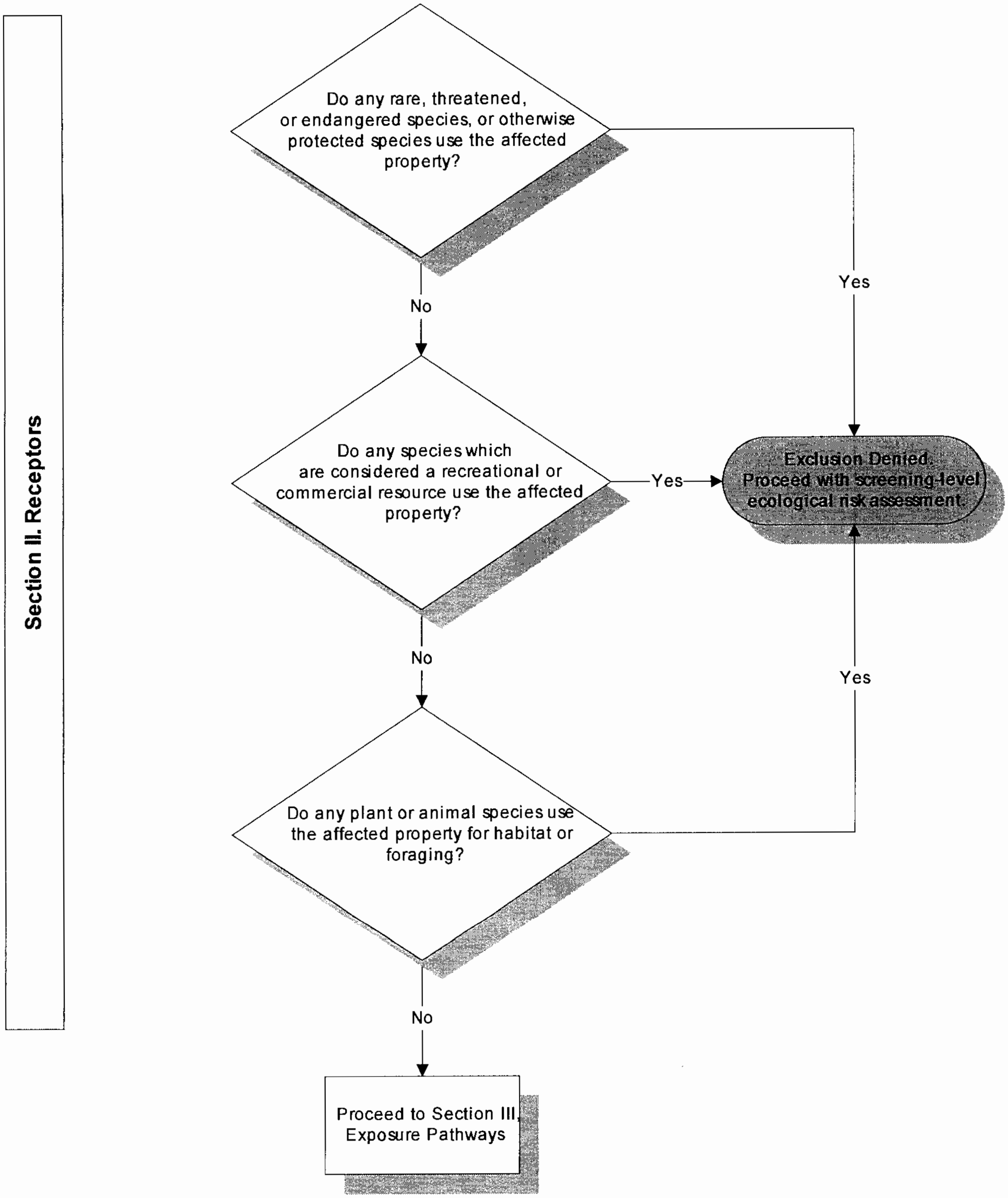
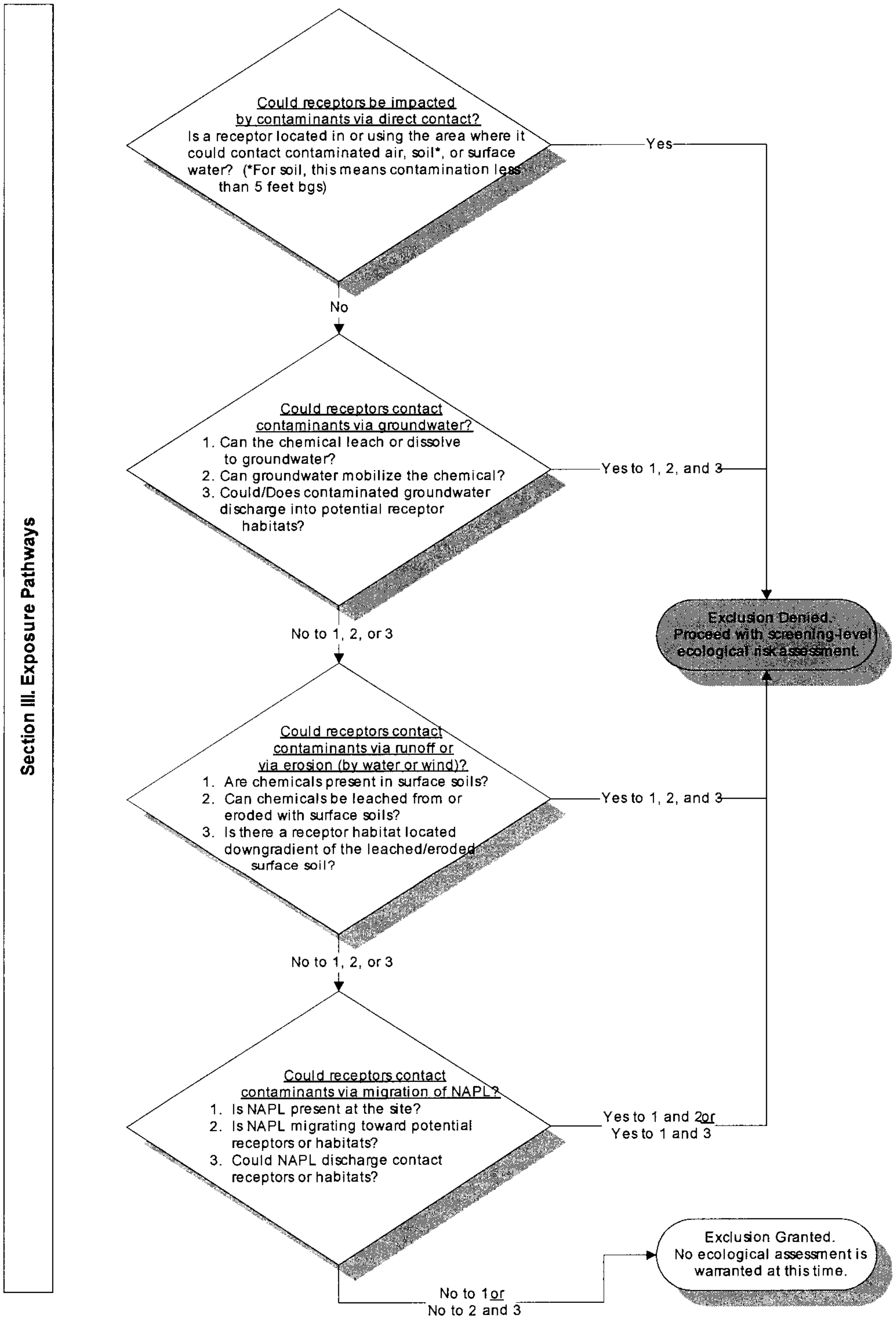


Figure 1 - Exclusion Criteria Decision Tree (continued)


Section III. Exposure Pathways
Could receptors be impacted by contaminants via direct contact?
Is a receptor located in or using the area where it could contact contaminated air, soil*, or surface water? (*For soil, this means contamination less than 5 feet bgs)
Yes
No
Could receptors contact contaminants via groundwater?
1. Can the chemical leach or dissolve to groundwater?
2. Can groundwater mobilize the chemical?
3. Could/Does contaminated groundwater discharge into potential receptor habitats?
Yes to 1, 2, and 3
No to 1, 2, or 3
Exclusion Denied. Proceed with screening-level ecological risk assessment.
Could receptors contact contaminants via runoff or via erosion (by water or wind)?
1. Are chemicals present in surface soils?
2. Can chemicals be leached from or eroded with surface soils?
3. Is there a receptor habitat located downgradient of the leached/eroded surface soil?
Yes to 1, 2, and 3
No to 1, 2, or 3
Could receptors contact contaminants via migration of NAPL?
1. Is NAPL present at the site?
2. Is NAPL migrating toward potential receptors or habitats?
3. Could NAPL discharge contact receptors or habitats?
Yes to 1 and 2 or Yes to 1 and 3
Exclusion Granted. No ecological assessment is warranted at this time.
No to 1 or No to 2 and 3

ATTACHMENT C

TIER 1 TOXICITY REFERENCE VALUES (TRVs) AND ECOLOGICAL SCREENING LEVELS (ESLs) AND TIER 2 TRVs

TABLE C-1: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE DEER MOUSE

Constituent	Tier 1				Tier 2		
	TRV NOAEL (mg/kg/day)	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
VOCs							
Acetone	1.00E+01	chronic cs	EcoRisk 3.2[b]	9.09E+01	5.00E+01	chronic cs	EcoRisk 3.2
Benzene	2.64E+01	chronic cs	EcoRisk 3.2	2.40E+02	2.64E+02	chronic cs	EcoRisk 3.2
2-Butanone (MEK)	1.77E+03	chronic cs	EcoRisk 3.2	1.61E+04	4.57E+03	chronic cs	EcoRisk 3.2
Carbon disulfide	2.50E-01	chronic cs	EcoRisk 3.2	2.27E+00	2.50E+00	chronic cs	EcoRisk 3.2
Chlorobenzene	6.00E+01	chronic cs	EcoRisk 3.2	5.45E+02	6.00E+02	chronic cs	EcoRisk 3.2
Chloroform	1.50E+01	chronic cs	EcoRisk 3.2	1.36E+02	4.10E+01	chronic cs	EcoRisk 3.2
1,2-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	2.27E+01	2.50E+01	chronic cs	EcoRisk 3.2
1,3-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	2.27E+01	2.50E+01	chronic cs	EcoRisk 3.2
1,4-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	2.27E+01	1.00E+01	chronic cs	EcoRisk 3.2
1,1-Dichloroethane	3.82E+02	chronic cs	EcoRisk 3.2	3.47E+03	3.82E+03	chronic cs	EcoRisk 3.2
1,2-Dichloroethane	4.97E+01	chronic cs	EcoRisk 3.2	4.52E+02	4.97E+02	chronic cs	EcoRisk 3.2
1,1-Dichloroethene	3.00E+01	chronic cs	EcoRisk 3.2	2.73E+02	3.00E+02	chronic cs	EcoRisk 3.2
cis-1,2-Dichloroethene	4.52E+01	chronic cs	EcoRisk 3.2	4.11E+02	4.52E+02	chronic cs	EcoRisk 3.2
trans-1,2-Dichloroethene	4.52E+01	chronic cs	EcoRisk 3.2	4.11E+02	4.52E+02	chronic cs	EcoRisk 3.2
2-Hexanone	8.27E+00	chronic GMM	EcoRisk 3.2	7.52E+01	3.15E+01	chronic GMM	EcoRisk 3.2
Methylene chloride	5.85E+00	chronic cs	EcoRisk 3.2	5.32E+01	5.00E+01	chronic cs	EcoRisk 3.2
4-Methyl-2-pentanone (MIBK)	2.50E+01	chronic cs	EcoRisk 3.2	2.27E+02	2.50E+02	chronic cs	EcoRisk 3.2
1,1,2,2-Tetrachloroethane	4.43E+01	chronic	ATSDR 1996	4.03E+02			
Tetrachloroethene	2.00E+00	chronic cs	EcoRisk 3.2	1.82E+01	1.00E+01	chronic cs	EcoRisk 3.2
Toluene	2.60E+01	chronic cs	EcoRisk 3.2	2.36E+02	2.60E+02	chronic cs	EcoRisk 3.2
1,2,4-Trichlorobenzene	1.48E+00	chronic cs	EcoRisk 3.2	1.35E+01	1.48E+01	chronic cs	EcoRisk 3.2
1,1,1-Trichloroethane	9.99E+02	chronic cs	EcoRisk 3.2	9.08E+03	9.99E+03	chronic cs	EcoRisk 3.2
1,1,2-Trichloroethane	3.90E+00	chronic	IRIS	3.55E+01			
Trichloroethene	1.00E+02	chronic cs	EcoRisk 3.2	9.09E+02	1.00E+03	chronic cs	EcoRisk 3.2
Trichlorofluoromethane	2.12E+02	chronic GMM	EcoRisk 3.2	1.93E+03	1.42E+03	chronic GMM	EcoRisk 3.2

TABLE C-1: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE DEER MOUSE

	Tier 1				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Vinyl chloride	1.70E-01	chronic cs	EcoRisk 3.2	1.55E+00	1.70E+00	chronic cs	EcoRisk 3.2
Xylene (total)	2.10E+00	chronic cs	EcoRisk 3.2	1.91E+01	2.60E+00	chronic cs	EcoRisk 3.2
SVOCs							
Benzyl alcohol	1.43E+02	chronic cs	EcoRisk 3.2	1.30E+03	1.43E+03	chronic cs	EcoRisk 3.2
Bis(2-ethylhexyl) phthalate	1.83E+01	chronic cs	EcoRisk 3.2	1.66E+02	1.83E+02	chronic cs	EcoRisk 3.2
Butyl benzyl phthalate	1.59E+02	chronic cs	EcoRisk 3.2	1.45E+03	1.59E+03	chronic cs	EcoRisk 3.2
Carbazole	2.28E+01	chronic cs	EcoRisk 3.2	2.07E+02	2.28E+02	chronic cs	EcoRisk 3.2
2-Chlorophenol	5.00E-01	chronic cs	EcoRisk 3.2	4.55E+00	5.00E+00	chronic cs	EcoRisk 3.2
Di-n-butyl phthalate	1.34E+03	chronic GMM	EcoRisk 3.2	1.22E+04	3.18E+03	chronic GMM	EcoRisk 3.2
Diethyl phthalate	4.60E+03	chronic cs	EcoRisk 3.2	4.18E+04	4.60E+04	chronic cs	EcoRisk 3.2
Dimethyl phthalate	6.80E+01	chronic cs	EcoRisk 3.2	6.18E+02	6.80E+02	chronic cs	EcoRisk 3.2
Di-n-octyl phthalate	6.51E+01	chronic cs	EcoRisk 3.2	5.92E+02	6.51E+02	chronic cs	EcoRisk 3.2
Hexachlorobenzene	7.10E+00	chronic cs	EcoRisk 3.2	6.45E+01	7.10E+01	chronic cs	EcoRisk 3.2
2-Methylphenol	2.20E+02	chronic cs	EcoRisk 3.2	2.00E+03	2.20E+03	chronic cs	EcoRisk 3.2
2-Nitroaniline	3.00E+00	chronic cs	EcoRisk 3.2	2.73E+01	6.00E+00	chronic cs	EcoRisk 3.2
Nitrobenzene	5.90E+00	chronic cs	EcoRisk 3.2	5.36E+01	5.90E+01	chronic cs	EcoRisk 3.2
Pentachlorophenol	8.42E+00	chronic GMM	EcoRisk 3.2	7.65E+01	8.42E+01	chronic GMM	EcoRisk 3.2
Phenol	6.00E+01	chronic cs	EcoRisk 3.2	5.45E+02	6.00E+02	chronic cs	EcoRisk 3.2
Pestcides/Herbicides							
4,4'-DDD	5.83E+00	chronic GMM	EcoRisk 3.2	5.30E+01	1.17E+01	chronic GMM	EcoRisk 3.2
4,4'-DDE	9.02E+00	chronic GMM	EcoRisk 3.2	8.20E+01	2.27E+01	chronic GMM	EcoRisk 3.2
4,4'-DDT	1.39E-01	chronic cs	EcoRisk 3.2	1.26E+00	6.94E-01	chronic cs	EcoRisk 3.2
Aldrin	2.00E-01	chronic cs	EcoRisk 3.2	1.82E+00	1.00E+00	chronic cs	EcoRisk 3.2
alpha-BHC	8.70E+01	chronic cs	EcoRisk 3.2	7.91E+02	8.70E+02	chronic cs	EcoRisk 3.2
alpha-Chlordane	1.18E+00	chronic cs	EcoRisk 3.2	1.07E+01	1.18E+01	chronic cs	EcoRisk 3.2
beta-BHC	4.00E-01	chronic cs	EcoRisk 3.2	3.64E+00	2.00E+00	chronic cs	EcoRisk 3.2

TABLE C-1: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE DEER MOUSE							
Constituent	**Tier 1**				**Tier 2**		
	TRV NOAEL (mg/kg/day)	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
delta-BHC	1.40E-02	chronic cs	EcoRisk 3.2	1.27E-01	1.40E-01	chronic cs	EcoRisk 3.2
Dieldrin	1.50E-02	chronic cs	EcoRisk 3.2	1.36E-01	3.00E-02	chronic cs	EcoRisk 3.2
Endosulfan I	1.50E-01	chronic cs	EcoRisk 3.2	1.36E+00	1.50E+00	chronic cs	EcoRisk 3.2
Endosulfan II	1.50E-01	chronic cs	EcoRisk 3.2	1.36E+00	1.50E+00	chronic cs	EcoRisk 3.2
Endrin	9.20E-02	chronic cs	EcoRisk 3.2	8.36E-01	9.20E-01	chronic cs	EcoRisk 3.2
gamma-BHC (Lindane)	1.40E-02	chronic cs	EcoRisk 3.2	1.27E-01	1.40E-01	chronic cs	EcoRisk 3.2
gamma-Chlordane	1.18E+00	chronic cs	EcoRisk 3.2	1.07E+01	1.18E+01	chronic cs	EcoRisk 3.2
Heptachlor	1.00E-01	chronic cs	EcoRisk 3.2	9.09E-01	1.00E+00	chronic cs	EcoRisk 3.2
Methoxychlor	4.00E+00	chronic cs	EcoRisk 3.2	3.64E+01	8.00E+00	chronic cs	EcoRisk 3.2
Aroclors							
Aroclor 1016	1.49E+00	chronic GMM	EcoRisk 3.2	1.35E+01	4.26E+00	chronic GMM	EcoRisk 3.2
Aroclor 1260	1.38E+01	chronic GMM	EcoRisk 3.2	1.25E+02	3.33E+01	chronic GMM	EcoRisk 3.2
Aroclor 1254	6.11E-01	chronic GMM	EcoRisk 3.2	5.55E+00	3.37E+00	chronic GMM	EcoRisk 3.2
PAHs							
Acenaphthene	7.00E+01	chronic cs	EcoRisk 3.2	6.36E+02	7.00E+02	chronic cs	EcoRisk 3.2
Acenaphthylene	7.00E+01	chronic cs	EcoRisk 3.2	6.36E+02	7.00E+02	chronic cs	EcoRisk 3.2
Anthracene	1.00E+02	chronic cs	EcoRisk 3.2	9.09E+02	1.00E+03	chronic cs	EcoRisk 3.2
Benzo(a)anthracene	1.70E-01	chronic cs	EcoRisk 3.2	1.55E+00	1.70E+00	chronic cs	EcoRisk 3.2
Benzo(a)pyrene	5.58E+00	chronic GMM	EcoRisk 3.2	5.07E+01	1.77E+01	chronic GMM	EcoRisk 3.2
Benzo(b)fluoranthene	4.00E+00	chronic cs	EcoRisk 3.2	3.64E+01	4.00E+01	chronic cs	EcoRisk 3.2
Benzo(ghi)perylene	7.20E+00	chronic cs	EcoRisk 3.2	6.54E+01	7.20E+01	chronic cs	EcoRisk 3.2
Benzo(k)fluoranthene	7.20E+00	chronic cs	EcoRisk 3.2	6.54E+01	7.20E+01	chronic cs	EcoRisk 3.2
Chrysene	1.70E-01	chronic cs	EcoRisk 3.2	1.55E+00	1.70E+01	chronic cs	EcoRisk 3.2
Dibenzo(a,h)anthracene	1.33E+00	chronic cs	EcoRisk 3.2	1.21E+01	1.33E+01	chronic cs	EcoRisk 3.2
Fluoranthene	1.25E+01	chronic cs	EcoRisk 3.2	1.14E+02	1.25E+02	chronic cs	EcoRisk 3.2
Fluorene	1.25E+02	chronic cs	EcoRisk 3.2	1.14E+03	2.50E+02	chronic cs	EcoRisk 3.2

TABLE C-1: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE DEER MOUSE							
	Tier 1				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Indeno(1,2,3-cd)pyrene	7.20E+00	chronic cs	EcoRisk 3.2	6.54E+01	7.20E+01	chronic cs	EcoRisk 3.2
Naphthalene	1.43E+01	chronic GMM	EcoRisk 3.2	1.30E+02	4.02E+01	chronic GMM	EcoRisk 3.2
Phenanthrene	5.14E+00	chronic cs	EcoRisk 3.2	4.67E+01	5.14E+01	chronic cs	EcoRisk 3.2
Pyrene	7.50E+00	chronic cs	EcoRisk 3.2	6.82E+01	7.50E+01	chronic cs	EcoRisk 3.2
Dioxin/Furans							
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	5.62E-07	chronic GMM	EcoRisk 3.2	5.11E-06	3.76E-06	chronic GMM	EcoRisk 3.2
Metals							
Aluminum (note: pH dependent)	6.20E+01	chronic	ATSDR 1999	5.64E+02	1.30E+02	chronic	ATSDR 1999
Antimony	5.90E-02	chronic cs	EcoRisk 3.2	5.36E-01	5.90E-01	chronic cs	EcoRisk 3.2
Arsenic	1.04E+00	chronic cs	EcoRisk 3.2	9.45E+00	1.66E+00	chronic cs	EcoRisk 3.2
Barium	5.18E+01	chronic GMM	EcoRisk 3.2	4.71E+02	5.18E+02	chronic GMM	EcoRisk 3.2
Beryllium	5.32E-01	chronic cs	EcoRisk 3.2	4.84E+00	5.32E+00	chronic cs	EcoRisk 3.2
Boron	2.80E+01	chromic cs	EcoRisk 3.2	2.55E+02	2.80E+02	chronic cs	EcoRisk 3.2
Cadmium	7.70E-01	chronic cs	EcoRisk 3.2	7.00E+00	7.70E+00	chronic cs	EcoRisk 3.2
Chromium (total)	2.40E+00	chronic GMM	EcoRisk 3.2	2.18E+01	2.40E+01	chronic GMM	EcoRisk 3.2
Chromium (hexavalent)	9.24E+00	chronic GMM	EcoRisk 3.2	8.40E+01	9.24E+01	chronic GMM	EcoRisk 3.2
Cobalt	7.33E+00	chronic GMM	EcoRisk 3.2	6.66E+01	7.33E+01	chronic GMM	EcoRisk 3.2
Copper	5.60E+00	chronic cs	EcoRisk 3.2	5.09E+01	9.34E+00	chronic cs	EcoRisk 3.2
Lead	4.70E+00	chronic cs	EcoRisk 3.2	4.27E+01	8.90E+00	chronic cs	EcoRisk 3.2
Manganese	5.15E+01	chronic GMM	EcoRisk 3.2	4.68E+02	5.15E+02	chronic GMM	EcoRisk 3.2
Mercury (inorganic)	1.41E+00	chronic cs	EcoRisk 3.2	1.28E+01	1.41E+01	chronic cs	EcoRisk 3.2
Nickel	1.70E+00	chronic cs	EcoRisk 3.2	1.55E+01	3.40E+00	chronic cs	EcoRisk 3.2
Selenium	1.43E-01	chronic cs	EcoRisk 3.2	1.30E+00	2.15E-01	chronic cs	EcoRisk 3.2
Silver	6.02E+00	chronic cs	EcoRisk 3.2	5.47E+01	6.02E+01	chronic cs	EcoRisk 3.2
Thallium	7.10E-03	chronic cs	EcoRisk 3.2	6.45E-02	7.10E-02	chronic cs	EcoRisk 3.2
Vanadium	4.16E+00	chronic cs	EcoRisk 3.2	3.78E+01	8.31E+00	chronic cs	EcoRisk 3.2

TABLE C-1: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE DEER MOUSE

	Tier 1				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Zinc	7.54E+01	chronic GMM	EcoRisk 3.2	6.85E+02	7.54E+02	chronic GMM	EcoRisk 3.2
Miscellaneous							
Cyanide (CN-)	6.87E+01	chronic cs	EcoRisk 3.2	6.24E+02	6.87E+02	chronic cs	EcoRisk 3.2
Nitrite	5.07E+02	chonic cs	Sample 1996	4.61E+03			
Explosives							
Dinitrobenzene, 1,3-	1.13E-01	chronic cs	EcoRisk 3.2	1.03E+00	2.64E-01	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,4-	2.68E+00	chronic cs	EcoRisk 3.2	2.44E+01	2.68E+01	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,6-	1.77E+00	chronic cs	EcoRisk 3.2	1.61E+01	1.77E+01	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2-Amino-4,6-	1.39E+01	chronic cs	EcoRisk 3.2	1.26E+02	1.39E+02	chronic cs	EcoRisk 3.2
Dinitrotoluene, 4-Amino-2,6-	9.59E+00	chronic cs	EcoRisk 3.2	8.72E+01	9.59E+01	chronic cs	EcoRisk 3.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	8.94E+00	chronic GMM	EcoRisk 3.2	8.13E+01	2.83E+01	chronic GMM	EcoRisk 3.2
Nitroglycerin	9.64E+01	chronic cs	EcoRisk 3.2	8.76E+02	1.02E+03	chronic cs	EcoRisk 3.2
Nitrotoluene, m-	1.07E+01	chronic cs	EcoRisk 3.2	9.73E+01	1.07E+02	chronic cs	EcoRisk 3.2
Nitrotoluene, o-	8.91E+00	chronic cs	EcoRisk 3.2	8.10E+01	8.91E+01	chronic cs	EcoRisk 3.2
Nitrotoluene, p-	1.96E+01	chronic cs	EcoRisk 3.2	1.78E+02	1.96E+02	chronic cs	EcoRisk 3.2
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	7.50E+01	chronic cs	EcoRisk 3.2	6.82E+02	2.00E+02	chronic cs	EcoRisk 3.2
PETN	7.00E+01	chronic cs	EcoRisk 3.2	6.36E+02	7.00E+02	chronic cs	EcoRisk 3.2
Tetryl (Trinitrophenylmethylnitramine)	1.30E+00	chronic cs	EcoRisk 3.2	1.18E+01	6.20E+00	chronic cs	EcoRisk 3.2
Trinitrobenzene, 1,3,5-	1.34E+01	chronic cs	EcoRisk 3.2	1.22E+02	1.34E+02	chronic cs	EcoRisk 3.2
Trinitrotoluene, 2,4,6-	3.47E+01	chronic cs	EcoRisk 3.2	3.15E+02	1.60E+02	chronic cs	EcoRisk 3.2
Agent Breakdown Products							
DIMP	3.00E+02	chronic	ATSDR 1988	2.73E+03	3.75E+02	chronic	IRIS
IMPA	2.79E+02	chronic	IRIS	2.54E+03	1.16E+02	chronic	IRIS
MPA	2.79E+02	chronic	IRIS	2.54E+03	1.16E+02	chronic	IRIS
Thiodiglycol	5.00E+02	chronic	USACHPPM 1999	4.55E+03			

[a] chronic cs - TRV based on a critical study (two or less data), chronic GMM - TRV based on geometric mean (three or more relevent data), [b] EcoRisk 3.2 - includes uncertainty factors for extrapolation to chronic NOAEL and LOAEL (see Uncertanty Factor's tab

TABLE C-2: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE HORNED LARK

Surrogate: American Robin (Avian Omnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
VOCs							
Acetone	2.01E+02	chronic	EcoRisk 3.2	9.51E+02	2.01E+03	chronic	EcoRisk 3.2
Chlorobenzene	6.00E+01	chronic	EcoRisk 3.2	2.84E+02	6.00E+02	chronic	EcoRisk 3.2
1,2-Dichloroethane	4.60E+00	chronic cs	EcoRisk 3.2	2.18E+01	9.10E+00	chronic cs	EcoRisk 3.2
Hexachlorobenzene	5.00E+00	chronic cs	EcoRisk 3.2	2.37E+01	5.00E+01	chronic cs	EcoRisk 3.2
2-Hexanone	1.00E+00	chronic cs	EcoRisk 3.2	4.73E+00	1.00E+01	chronic cs	EcoRisk 3.2
Xylene (total)	1.07E+02	chronic cs	EcoRisk 3.2	5.06E+02	1.07E+03	chronic cs	EcoRisk 3.2
SVOCs							
Bis(2-ethylhexyl) phthalate	1.10E+00	chronic cs	EcoRisk 3.2	5.20E+00	1.10E+01	chronic cs	EcoRisk 3.2
2-Chlorophenol	1.13E+00	chronic cs	EcoRisk 3.2	5.34E+00	1.13E+01	chronic cs	EcoRisk 3.2
Di-n-butyl phthalate	1.40E-01	chronic cs	EcoRisk 3.2	6.62E-01	1.40E+00	chronic cs	EcoRisk 3.2
Pentachlorophenol	6.73E+00	chronic cs	EcoRisk 3.2	3.18E+01	6.73E+01	chronic cs	EcoRisk 3.2
Pestcides/Herbicides							
4,4'-DDD	1.60E-02	chronic GMM	EcoRisk 3.2	7.57E-02	8.30E-02	chronic GMM	EcoRisk 3.2
4,4'-DDE	4.80E-01	chronic GMM	EcoRisk 3.2	2.27E+00	2.40E+00	chronic GMM	EcoRisk 3.2
4,4'-DDT	2.01E+00	chronic GMM	EcoRisk 3.2	9.51E+00	5.96E+00	chronic GMM	EcoRisk 3.2
alpha-Chlordane	2.14E+00	chronic cs	EcoRisk 3.2	1.01E+01	1.07E+01	chronic cs	EcoRisk 3.2
beta-BHC	3.83E+01	chronic cs	EcoRisk 3.2	1.81E+02	3.83E+02	chronic cs	EcoRisk 3.2
Dieldrin	7.09E-02	chronic cs	EcoRisk 3.2	3.35E-01	3.78E+00	chronic cs	EcoRisk 3.2
Endosulfan I	1.00E+01	chronic cs	EcoRisk 3.2	4.73E+01	1.00E+02	chronic cs	EcoRisk 3.2
Endosulfan II	1.00E+01	chronic cs	EcoRisk 3.2	4.73E+01	1.00E+02	chronic cs	EcoRisk 3.2
Endrin	1.00E-02	chronic cs	EcoRisk 3.2	4.73E-02	1.00E-01	chronic cs	EcoRisk 3.2
gamma-BHC (Lindane)	5.60E-01	chronic cs	EcoRisk 3.2	2.65E+00	2.25E+00	chronic cs	EcoRisk 3.2
gamma-Chlordane	2.14E+00	chronic cs	EcoRisk 3.2	1.01E+01	1.07E+01	chronic cs	EcoRisk 3.2
Heptachlor	9.20E-01	chronic cs	EcoRisk 3.2	4.35E+00	9.20E+00	chronic cs	EcoRisk 3.2
Methoxychlor	2.58E+01	chronic cs	EcoRisk 3.2	1.22E+02	2.58E+02	chronic cs	EcoRisk 3.2

TABLE C-2: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE HORNED LARK							
Surrogate: American Robin (Avian Omnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Aroclors							
Aroclor 1260	2.15E+00	chronic GMM	EcoRisk 3.2	1.02E+01	3.04E+00	chronic GMM	EcoRisk 3.2
Aroclor 1254	1.00E-01	chronic cs	EcoRisk 3.2	4.73E-01	1.00E+00	chronic cs	EcoRisk 3.2
PAHs							
Benzo(a)anthracene	1.07E-01	chronic cs	EcoRisk 3.2	5.06E-01	1.07E+00	chronic cs	EcoRisk 3.2
Naphthalene	1.50E+01	chronic cs	EcoRisk 3.2	7.10E+01	1.50E+02	chronic cs	EcoRisk 3.2
Pyrene	2.05E+01	chronic cs	EcoRisk 3.2	9.70E+01	2.05E+02	chronic cs	EcoRisk 3.2
Metals							
Aluminum (Note: pH dependent)	1.10E+02	chronic	Sample 1996	5.20E+02			
Arsenic	2.24E+00	chronic GMM	EcoRisk 3.2	1.06E+01	2.24E+01	chronic GMM	EcoRisk 3.2
Barium	7.35E+01	chronic GMM	EcoRisk 3.2	3.48E+02	1.31E+02	chronic GMM	EcoRisk 3.2
Boron	2.92E+00	chronic GMM	EcoRisk 3.2		1.45E+01	chronic GMM	EcoRisk 3.2
Cadmium	1.47E+00	chronic GMM	EcoRisk 3.2	6.95E+00	1.47E+01	chronic GMM	EcoRisk 3.2
Chromium (total)	2.66E+00	chronic GMM	EcoRisk 3.2	1.26E+01	2.66E+01	chronic GMM	EcoRisk 3.2
Chromium (hexavalent)	1.10E+01	chronic cs	EcoRisk 3.2	5.20E+01	1.10E+02	chronic cs	EcoRisk 3.2
Cobalt	7.61E+00	chronic GMM	EcoRisk 3.2	3.60E+01	7.61E+01	chronic GMM	EcoRisk 3.2
Copper	4.05E+00	chronic cs	EcoRisk 3.2	1.92E+01	1.21E+01	chronic cs	EcoRisk 3.2
Lead	1.63E+00	chronic cs	EcoRisk 3.2	7.71E+00	3.26E+00	chronic cs	EcoRisk 3.2
Manganese	1.79E+02	chronic GMM	EcoRisk 3.2	8.47E+02	1.79E+03	chronic GMM	EcoRisk 3.2
Mercury (inorganic)	1.90E-02	chronic cs	EcoRisk 3.2	8.99E-02	1.90E-01	chronic cs	EcoRisk 3.2
Molybdenum	3.50E+00	chronic cs	EcoRisk 3.2	1.66E+01	3.50E+01	chronic cs	EcoRisk 3.2
Nickel	6.71E+00	chronic cs	EcoRisk 3.2	3.17E+01	6.71E+01	chronic cs	EcoRisk 3.2
Selenium	2.90E-01	chronic cs	EcoRisk 3.2	1.37E+00	5.79E-01	chronic cs	EcoRisk 3.2
Silver	2.20E+00	chronic cs	EcoRisk 3.2	1.04E+01	2.02E+01	chronic cs	EcoRisk 3.2
Thallium	3.50E-01	chronic cs	EcoRisk 3.2	1.66E+00	3.50E+00	chronic cs	EcoRisk 3.2
Vanadium	3.44E-01	chronic cs	EcoRisk 3.2	1.63E+00	6.88E-01	chronic cs	EcoRisk 3.2
Zinc	6.61E+01	chronic	EcoRisk	3.13E+02	6.61E+02	chronic	EcoRisk

TABLE C-2: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE HORNED LARK							
Surrogate: American Robin (Avian Omnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
		GMM	3.2			GMM	3.2
Miscellaneous							
Cyanide (CN-)	4.00E-02	chronic cs	EcoRisk 3.2	1.89E-01	4.00E-01	chronic cs	EcoRisk 3.2
Explosives							
Dinitrobenzene, 1,3-	4.22E-01	chronic cs	EcoRisk 3.2	2.00E+00	4.22E+00	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,6-	6.00E+01	chronic cs	EcoRisk 3.2	2.84E+02	6.00E+02	chronic cs	EcoRisk 3.2
Trinitrotoluene, 2,4,6-	9.75E+00	chronic cs	EcoRisk 3.2	4.61E+01	1.78E+01	chronic cs	EcoRisk 3.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	2.36E+00	chronic GMM	EcoRisk 3.2	1.12E+01	4.49E+00	chronic GMM	EcoRisk 3.2

[a] chronic cs - TRV based on a critical study (two or less data), chronic GMM - TRV based on geometric mean (three or more relevent data)

[b] EcoRisk 3.2 - includes uncertainty factors for extrapolation to chronic NOAEL and LOAEL (see Uncertanty Factor's tab)

TABLE C-3: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE KIT FOX

Surrogate: Red Fox (Mammalian to Carnivore)	Tier 1				Tier 2		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
VOCs							
Acetone	1.00E+01	chronic cs	EcoRisk 3.2	4.04E+02	5.00E+01	chronic cs	EcoRisk 3.2
Benzene	2.64E+01	chronic cs	EcoRisk 3.2	1.07E+03	2.64E+02	chronic cs	EcoRisk 3.2
2-Butanone (MEK)	1.77E+03	chronic cs	EcoRisk 3.2	7.15E+04	4.57E+03	chronic cs	EcoRisk 3.2
Carbon disulfide	2.50E-01	chronic cs	EcoRisk 3.2	1.01E+01	2.50E+00	chronic cs	EcoRisk 3.2
Chlorobenzene	6.00E+01	chronic cs	EcoRisk 3.2	2.42E+03	6.00E+02	chronic cs	EcoRisk 3.2
Chloroform	1.50E+01	chronic cs	EcoRisk 3.2	6.06E+02	4.10E+01	chronic cs	EcoRisk 3.2
1,2-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	1.01E+02	2.50E+01	chronic cs	EcoRisk 3.2
1,3-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	1.01E+02	2.50E+01	chronic cs	EcoRisk 3.2
1,4-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	1.01E+02	1.00E+01	chronic cs	EcoRisk 3.2
1,1-Dichloroethane	3.82E+02	chronic cs	EcoRisk 3.2	1.54E+04	3.82E+03	chronic cs	EcoRisk 3.2
1,2-Dichloroethane	4.97E+01	chronic cs	EcoRisk 3.2	2.01E+03	4.97E+02	chronic cs	EcoRisk 3.2
1,1-Dichloroethene	3.00E+01	chronic cs	EcoRisk 3.2	1.21E+03	3.00E+02	chronic cs	EcoRisk 3.2
cis-1,2-Dichloroethene	4.52E+01	chronic cs	EcoRisk 3.2	1.83E+03	4.52E+02	chronic cs	EcoRisk 3.2
trans-1,2-Dichloroethene	4.52E+01	chronic cs	EcoRisk 3.2	1.83E+03	4.52E+02	chronic cs	EcoRisk 3.2
2-Hexanone	8.27E+00	chronic GMM	EcoRisk 3.2	3.34E+02	3.15E+01	chronic GMM	EcoRisk 3.2
Hexachlorobenzene	7.10E+00	chronic cs	EcoRisk 3.2	2.87E+02	7.10E+01	chronic cs	EcoRisk 3.2
Methylene chloride	5.85E+00	chronic cs	EcoRisk 3.2	2.36E+02	5.00E+01	chronic cs	EcoRisk 3.2
4-Methyl-2-pentanone (MIBK)	2.50E+01	chronic cs	EcoRisk 3.2	1.01E+03	2.50E+02	chronic cs	EcoRisk 3.2
Tetrachloroethene	2.00E+00	chronic cs	EcoRisk 3.2	8.08E+01	1.00E+01	chronic cs	EcoRisk 3.2
Toluene	2.60E+01	chronic cs	EcoRisk 3.2	1.05E+03	2.60E+02	chronic cs	EcoRisk 3.2
1,2,4-Trichlorobenzene	1.48E+00	chronic cs	EcoRisk 3.2	5.98E+01	1.48E+01	chronic cs	EcoRisk 3.2
1,1,1-Trichloroethane	9.99E+02	chronic cs	EcoRisk 3.2	4.04E+04	9.99E+03	chronic cs	EcoRisk 3.2
Trichloroethene	1.00E+02	chronic cs	EcoRisk 3.2	4.04E+03	1.00E+03	chronic cs	EcoRisk 3.2
Trichlorofluoromethane	2.12E+02	chronic GMM	EcoRisk 3.2	8.56E+03	1.42E+03	chronic GMM	EcoRisk 3.2
Vinyl chloride	1.70E-01	chronic cs	EcoRisk 3.2	6.87E+00	1.70E+00	chronic cs	EcoRisk 3.2

TABLE C-3: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE KIT FOX

Surrogate: Red Fox (Mammalian to Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Xylene (total)	2.10E+00	chronic cs	EcoRisk 3.2	8.48E+01	2.60E+00	chronic cs	EcoRisk 3.2
SVOCs							
Benzyl alcohol	1.43E+02	chronic cs	EcoRisk 3.2	5.78E+03	1.43E+03	chronic cs	EcoRisk 3.2
Bis(2-ethylhexyl) phthalate	1.83E+01	chronic cs	EcoRisk 3.2	7.39E+02	1.83E+02	chronic cs	EcoRisk 3.2
Butyl benzyl phthalate	1.59E+02	chronic cs	EcoRisk 3.2	6.42E+03	1.59E+03	chronic cs	EcoRisk 3.2
Carbazole	2.28E+01	chronic cs	EcoRisk 3.2	9.21E+02	2.28E+02	chronic cs	EcoRisk 3.2
2-Chlorophenol	5.00E-01	chronic cs	EcoRisk 3.2	2.02E+01	5.00E+00	chronic cs	EcoRisk 3.2
Di-n-butyl phthalate	1.34E+03	chronic GMM	EcoRisk 3.2	5.41E+04	3.18E+03	chronic GMM	EcoRisk 3.2
Diethyl phthalate	4.60E+03	chronic cs	EcoRisk 3.2	1.86E+05	4.60E+04	chronic cs	EcoRisk 3.2
Dimethyl phthalate	6.80E+01	chronic cs	EcoRisk 3.2	2.75E+03	6.80E+02	chronic cs	EcoRisk 3.2
Di-n-octyl phthalate	6.51E+01	chronic cs	EcoRisk 3.2	2.63E+03	6.51E+02	chronic cs	EcoRisk 3.2
Hexachlorobenzene	7.10E+00	chronic cs	EcoRisk 3.2	2.87E+02	7.10E+01	chronic cs	EcoRisk 3.2
2-Methylphenol	2.20E+02	chronic cs	EcoRisk 3.2	8.89E+03	2.20E+03	chronic cs	EcoRisk 3.2
2-Nitroaniline	3.00E+00	chronic cs	EcoRisk 3.2	1.21E+02	6.00E+00	chronic cs	EcoRisk 3.2
Nitrobenzene	5.90E+00	chronic cs	EcoRisk 3.2	2.38E+02	5.90E+01	chronic cs	EcoRisk 3.2
Pentachlorophenol	8.42E+00	chronic GMM	EcoRisk 3.2	3.40E+02	8.42E+01	chronic GMM	EcoRisk 3.2
Phenol	6.00E+01	chronic cs	EcoRisk 3.2	2.42E+03	6.00E+02	chronic cs	EcoRisk 3.2
Pestcides/Herbicides							
4,4'-DDD	5.83E+00	chronic GMM	EcoRisk 3.2	2.36E+02	1.17E+01	chronic GMM	EcoRisk 3.2
4,4'-DDE	9.02E+00	chronic GMM	EcoRisk 3.2	3.64E+02	2.27E+01	chronic GMM	EcoRisk 3.2
4,4'-DDT	1.39E-01	chronic cs	EcoRisk 3.2	5.62E+00	6.94E-01	chronic cs	EcoRisk 3.2
Aldrin	2.00E-01	chronic cs	EcoRisk 3.2	8.08E+00	1.00E+00	chronic cs	EcoRisk 3.2
alpha-BHC	8.70E+01	chronic cs	EcoRisk 3.2	3.51E+03	8.70E+02	chronic cs	EcoRisk 3.2
alpha-Chlordane	1.18E+00	chronic cs	EcoRisk 3.2	4.77E+01	1.18E+01	chronic cs	EcoRisk 3.2
beta-BHC	4.00E-01	chronic cs	EcoRisk 3.2	1.62E+01	2.00E+00	chronic cs	EcoRisk 3.2
delta-BHC	1.40E-02	chronic cs	EcoRisk 3.2	5.66E-01	1.40E-01	chronic cs	EcoRisk 3.2

TABLE C-3: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE KIT FOX							
Surrogate: Red Fox (Mammalian to Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Dieldrin	1.50E-02	chronic cs	EcoRisk 3.2	6.06E-01	3.00E-02	chronic cs	EcoRisk 3.2
Endosulfan I	1.50E-01	chronic cs	EcoRisk 3.2	6.06E+00	1.50E+00	chronic cs	EcoRisk 3.2
Endosulfan II	1.50E-01	chronic cs	EcoRisk 3.2	6.06E+00	1.50E+00	chronic cs	EcoRisk 3.2
Endrin	9.20E-02	chronic cs	EcoRisk 3.2	3.72E+00	9.20E-01	chronic cs	EcoRisk 3.2
gamma-BHC (Lindane)	1.40E-02	chronic cs	EcoRisk 3.2	5.66E-01	1.40E-01	chronic cs	EcoRisk 3.2
gamma-Chlordane	1.18E+00	chronic cs	EcoRisk 3.2	4.77E+01	1.18E+01	chronic cs	EcoRisk 3.2
Heptachlor	1.00E-01	chronic cs	EcoRisk 3.2	4.04E+00	1.00E+00	chronic cs	EcoRisk 3.2
Methoxychlor	4.00E+00	chronic cs	EcoRisk 3.2	1.62E+02	8.00E+00	chronic cs	EcoRisk 3.2
Aroclors							
Aroclor 1016	1.49E+00	chronic GMM	EcoRisk 3.2	6.02E+01	4.26E+00	chronic GMM	EcoRisk 3.2
Aroclor 1260	3.10E-02	chronic cs	EcoRisk 3.2	1.25E+00	3.10E-01	chronic cs	EcoRisk 3.2
Aroclor 1254	6.11E-01	chronic GMM	EcoRisk 3.2	2.47E+01	3.37E+00	chronic GMM	EcoRisk 3.2
PAHs							
Acenaphthene	7.00E+01	chronic cs	EcoRisk 3.2	2.83E+03	7.00E+02	chronic cs	EcoRisk 3.2
Acenaphthylene	7.00E+01	chronic cs	EcoRisk 3.2	2.83E+03	7.00E+02	chronic cs	EcoRisk 3.2
Anthracene	1.00E+02	chronic cs	EcoRisk 3.2	4.04E+03	1.00E+03	chronic cs	EcoRisk 3.2
Benzo(a)anthracene	1.70E-01	chronic cs	EcoRisk 3.2	6.87E+00	1.70E+00	chronic cs	EcoRisk 3.2
Benzo(a)pyrene	5.58E+00	chronic GMM	EcoRisk 3.2	2.25E+02	1.77E+01	chronic GMM	EcoRisk 3.2
Benzo(b)fluoranthene	4.00E+00	chronic cs	EcoRisk 3.2	1.62E+02	4.00E+01	chronic cs	EcoRisk 3.2
Benzo(ghi)perylene	7.20E+00	chronic cs	EcoRisk 3.2	2.91E+02	7.20E+01	chronic cs	EcoRisk 3.2
Benzo(k)fluoranthene	7.20E+00	chronic cs	EcoRisk 3.2	2.91E+02	7.20E+01	chronic cs	EcoRisk 3.2
Chrysene	1.70E-01	chronic cs	EcoRisk 3.2	6.87E+00	1.70E+01	chronic cs	EcoRisk 3.2
Dibenzo(a,h)anthracene	1.33E+00	chronic cs	EcoRisk 3.2	5.37E+01	1.33E+01	chronic cs	EcoRisk 3.2
Fluoranthene	1.25E+01	chronic cs	EcoRisk 3.2	5.05E+02	1.25E+02	chronic cs	EcoRisk 3.2
Fluorene	1.25E+02	chronic cs	EcoRisk 3.2	5.05E+03	2.50E+02	chronic cs	EcoRisk 3.2
Indeno(1,2,3-cd)pyrene	7.20E+00	chronic cs	EcoRisk 3.2	2.91E+02	7.20E+01	chronic cs	EcoRisk 3.2

TABLE C-3: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE KIT FOX

Surrogate: Red Fox (Mammalian to Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Naphthalene	1.43E+01	chronic GMM	EcoRisk 3.2	5.78E+02	4.02E+01	chronic GMM	EcoRisk 3.2
Phenanthrene	5.14E+00	chronic cs	EcoRisk 3.2	2.08E+02	5.14E+01	chronic cs	EcoRisk 3.2
Pyrene	7.50E+00	chronic cs	EcoRisk 3.2	3.03E+02	7.50E+01	chronic cs	EcoRisk 3.2
Dioxin/Furans							
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	5.62E-07	chronic GMM	EcoRisk 3.2	2.27E-05	3.76E-06	chronic GMM	EcoRisk 3.2
Metals							
Aluminum (note: pH dependent)	6.20E+01	chronic	ATSDR 1999	2.50E+03	1.30E+02	chronic	ATSDR 1999
Antimony	5.90E-02	chronic cs	EcoRisk 3.2	2.38E+00	5.90E-01	chronic cs	EcoRisk 3.2
Arsenic	1.04E+00	chronic cs	EcoRisk 3.2	4.20E+01	1.66E+00	chronic cs	EcoRisk 3.2
Barium	5.18E+01	chronic GMM	EcoRisk 3.2	2.09E+03	5.18E+02	chronic GMM	EcoRisk 3.2
Beryllium	5.32E-01	chronic cs	EcoRisk 3.2	2.15E+01	5.32E+00	chronic cs	EcoRisk 3.2
Boron	2.80E+01	chronic cs	EcoRisk 3.2	1.13E+03	2.80E+02	chronic cs	EcoRisk 3.2
Cadmium	7.70E-01	chronic cs	EcoRisk 3.2	3.11E+01	7.70E+00	chronic cs	EcoRisk 3.2
Chromium (total)	2.40E+00	chronic GMM	EcoRisk 3.2	9.70E+01	2.40E+01	chronic GMM	EcoRisk 3.2
Chromium (hexavalent)	9.24E+00	chronic GMM	EcoRisk 3.2	3.73E+02	9.24E+01	chronic GMM	EcoRisk 3.2
Cobalt	7.33E+00	chronic GMM	EcoRisk 3.2	2.96E+02	7.33E+01	chronic GMM	EcoRisk 3.2
Copper	5.60E+00	chronic cs	EcoRisk 3.2	2.26E+02	9.34E+00	chronic cs	EcoRisk 3.2
Lead	4.70E+00	chronic cs	EcoRisk 3.2	1.90E+02	8.90E+00	chronic cs	EcoRisk 3.2
Manganese	5.15E+01	chronic GMM	EcoRisk 3.2	2.08E+03	5.15E+02	chronic GMM	EcoRisk 3.2
Mercury (inorganic)	1.41E+00	chronic cs	EcoRisk 3.2	5.70E+01	1.41E+01	chronic cs	EcoRisk 3.2
Nickel	1.70E+00	chronic cs	EcoRisk 3.2	6.87E+01	3.40E+00	chronic cs	EcoRisk 3.2
Selenium	1.43E-01	chronic cs	EcoRisk 3.2	5.78E+00	2.15E-01	chronic cs	EcoRisk 3.2
Silver	6.02E+00	chronic cs	EcoRisk 3.2	2.43E+02	6.02E+01	chronic cs	EcoRisk 3.2
Thallium	7.10E-03	chronic cs	EcoRisk 3.2	2.87E-01	7.10E-02	chronic cs	EcoRisk 3.2
Vanadium	4.16E+00	chronic cs	EcoRisk 3.2	1.68E+02	8.31E+00	chronic cs	EcoRisk 3.2
Zinc	7.54E+01	chronic GMM	EcoRisk 3.2	3.05E+03	7.54E+02	chronic GMM	EcoRisk 3.2

TABLE C-3: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE KIT FOX

Surrogate: Red Fox (Mammalian to Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Miscellaneous							
Nitrite	5.07E+02	chonic cs	Sample 1996	2.05E+04			
Cyanide (CN-)	6.87E+01	chronic cs	EcoRisk 3.2	2.78E+03	6.87E+02	chronic cs	EcoRisk 3.2
Explosives							
Trinitrobenzene, 1,3,5-	1.34E+01	chronic cs	EcoRisk 3.2	5.41E+02	1.34E+02	chronic cs	EcoRisk 3.2
Dinitrobenzene, 1,3-	1.13E-01	chronic cs	EcoRisk 3.2	4.57E+00	2.64E-01	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,4-	2.68E+00	chronic cs	EcoRisk 3.2	1.08E+02	2.68E+01	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,6-	1.77E+00	chronic cs	EcoRisk 3.2	7.15E+01	1.77E+01	chronic cs	EcoRisk 3.2
Trinitrotoluene, 2,4,6-	3.47E+01	chronic cs	EcoRisk 3.2	1.40E+03	1.60E+02	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2-Amino-4,6-	1.39E+01	chronic cs	EcoRisk 3.2	5.62E+02	1.39E+02	chronic cs	EcoRisk 3.2
Nitrotoluene, o-	8.91E+00	chronic cs	EcoRisk 3.2	3.60E+02	8.91E+01	chronic cs	EcoRisk 3.2
Nitrotoluene, m-	1.07E+01	chronic cs	EcoRisk 3.2	4.32E+02	1.07E+02	chronic cs	EcoRisk 3.2
Dinitrotoluene, 4-Amino-2,6-	9.59E+00	chronic cs	EcoRisk 3.2	3.87E+02	9.59E+01	chronic cs	EcoRisk 3.2
Nitrotoluene, p-	1.96E+01	chronic cs	EcoRisk 3.2	7.92E+02	1.96E+02	chronic cs	EcoRisk 3.2
PETN	7.00E+01	chronic cs	EcoRisk 3.2	2.83E+03	7.00E+02	chronic cs	EcoRisk 3.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	8.94E+00	chronic GMM	EcoRisk 3.2	3.61E+02	2.83E+01	chronic GMM	EcoRisk 3.2
Tetryl (Trinitrophenylmethylnitramine)	1.30E+00	chronic cs	EcoRisk 3.2	5.25E+01	6.20E+00	chronic cs	EcoRisk 3.2
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	7.50E+01	chronic cs	EcoRisk 3.2	3.03E+03	2.00E+02	chronic cs	EcoRisk 3.2
Nitroglycerin	9.64E+01	chronic cs	EcoRisk 3.2	3.89E+03	1.02E+03	chronic cs	EcoRisk 3.2

[a] chronic cs - TRV based on a critical study (two or less data), chronic GMM - TRV based on geometric mean (three or more relevent data)
[b] EcoRisk 3.2 - includes uncertainty factors for extrapolation to chronic NOAEL and
LOAEL (see Uncertanty Factor's tab)

TABLE C-4: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE RED-TAILED HAWK							
Surrogate: American Kestral (Avian Top Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
VOCs							
Acetone	2.01E+02	chronic cs	EcoRisk 3.2	7.32E+03	2.01E+03	chronic cs	EcoRisk 3.2
1,2-Dichloroethane	4.60E+00	chronic cs	EcoRisk 3.2	1.67E+02	9.10E+00	chronic cs	EcoRisk 3.2
Hexachlorobenzene	5.00E+00	chronic cs	EcoRisk 3.2	1.82E+02	5.00E+01	chronic cs	EcoRisk 3.2
2-Hexanone	1.00E+00	chronic cs	EcoRisk 3.2	3.64E+01	1.00E+01	chronic cs	EcoRisk 3.2
Xylene (total)	1.07E+02	chronic cs	EcoRisk 3.2	3.89E+03	1.07E+03	chronic cs	EcoRisk 3.2
SVOCs							
Bis(2-ethylhexyl) phthalate	1.10E+00	chronic cs	EcoRisk 3.2	4.00E+01	1.10E+01	chronic cs	EcoRisk 3.2
2-Chlorophenol	1.13E+00	chronic cs	EcoRisk 3.2	4.11E+01	1.13E+01	chronic cs	EcoRisk 3.2
Di-n-butyl phthalate	1.40E-01	chronic cs	EcoRisk 3.2	5.10E+00	1.40E+00	chronic cs	EcoRisk 3.2
Pentachlorophenol	6.73E+00	chronic cs	EcoRisk 3.2	2.45E+02	6.73E+01	chronic cs	EcoRisk 3.2
Pestcides/Herbicides							
4,4'-DDD	1.60E-02	chronic GMM	EcoRisk 3.2	5.82E-01	8.30E-02	chronic GMM	EcoRisk 3.2
4,4'-DDE	4.80E-01	chronic GMM	EcoRisk 3.2	1.75E+01	2.40E+00	chronic GMM	EcoRisk 3.2
4,4'-DDT	2.01E+00	chronic GMM	EcoRisk 3.2	7.32E+01	5.96E+00	chronic GMM	EcoRisk 3.2
alpha-Chlordane	2.14E+00	chronic cs	EcoRisk 3.2	7.79E+01	1.07E+01	chronic cs	EcoRisk 3.2
beta-BHC	3.83E+01	chronic cs	EcoRisk 3.2	1.39E+03	3.83E+02	chronic cs	EcoRisk 3.2
Dieldrin	7.09E-02	chronic cs	EcoRisk 3.2	2.58E+00	3.78E+00	chronic cs	EcoRisk 3.2
Endosulfan I	1.00E+01	chronic cs	EcoRisk 3.2	3.64E+02	1.00E+02	chronic cs	EcoRisk 3.2
Endosulfan II	1.00E+01	chronic cs	EcoRisk 3.2	3.64E+02	1.00E+02	chronic cs	EcoRisk 3.2
Endrin	1.00E-02	chronic cs	EcoRisk 3.2	3.64E-01	1.00E-01	chronic cs	EcoRisk 3.2
gamma-BHC (Lindane)	5.60E-01	chronic cs	EcoRisk 3.2	2.04E+01	2.25E+00	chronic cs	EcoRisk 3.2
gamma-Chlordane	2.14E+00	chronic cs	EcoRisk 3.2	7.79E+01	1.07E+01	chronic cs	EcoRisk 3.2
Heptachlor	9.20E-01	chronic cs	EcoRisk 3.2	3.35E+01	9.20E+00	chronic cs	EcoRisk 3.2
Methoxychlor	2.58E+01	chronic cs	EcoRisk 3.2	9.39E+02	2.58E+02	chronic cs	EcoRisk 3.2
Aroclors							
Aroclor 1260	2.15E+00	chronic GMM	EcoRisk 3.2	7.83E+01	3.04E+00	chronic cs	EcoRisk 3.2

TABLE C-4: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE RED-TAILED HAWK							
Surrogate: American Kestral (Avian Top Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Aroclor 1254	1.00E-01	chronic cs	EcoRisk 3.2	3.64E+00	1.00E+00	chronic cs	EcoRisk 3.2
PAHs							
Benzo(a)anthracene	1.07E-01	chronic cs	EcoRisk 3.2	3.89E+00	1.07E+00	chronic cs	EcoRisk 3.2
Naphthalene	1.50E+01	chronic cs	EcoRisk 3.2	5.46E+02	1.50E+02	chronic cs	EcoRisk 3.2
Pyrene	2.05E+01	chronic cs	EcoRisk 3.2	7.46E+02	2.05E+02	chronic cs	EcoRisk 3.2
Metals							
Aluminum (Note: pH dependent)	1.10E+02	chronic	Sample 1996	4.00E+03			
Arsenic	2.24E+00	chronic GMM	EcoRisk 3.2	8.15E+01	2.24E+01	chronic GMM	EcoRisk 3.2
Barium	7.35E+01	chronic GMM	EcoRisk 3.2	2.68E+03	1.31E+02	chronic GMM	EcoRisk 3.2
Boron	2.92E+00	chronic GMM	EcoRisk 3.2	1.06E+02	1.45E+01	chronic GMM	EcoRisk 3.2
Cadmium	1.47E+00	chronic GMM	EcoRisk 3.2	5.35E+01	1.47E+01	chronic GMM	EcoRisk 3.2
Chromium (total)	2.66E+00	chronic GMM	EcoRisk 3.2	9.68E+01	2.66E+01	chronic GMM	EcoRisk 3.2
Chromium (hexavalent)	1.10E+01	chronic cs	EcoRisk 3.2	4.00E+02	1.10E+02	chronic cs	EcoRisk 3.2
Cobalt	7.61E+00	chronic GMM	EcoRisk 3.2	2.77E+02	7.61E+01	chronic GMM	EcoRisk 3.2
Copper	4.05E+00	chronic cs	EcoRisk 3.2	1.47E+02	1.21E+01	chronic cs	EcoRisk 3.2
Lead	1.63E+00	chronic cs	EcoRisk 3.2	5.93E+01	3.26E+00	chronic cs	EcoRisk 3.2
Manganese	1.79E+02	chronic GMM	EcoRisk 3.2	6.52E+03	1.79E+03	chronic GMM	EcoRisk 3.2
Mercury (inorganic)	1.90E-02	chronic cs	EcoRisk 3.2	6.92E-01	1.90E-01	chronic cs	EcoRisk 3.2
Molybdenum	3.50E+00	chronic cs	EcoRisk 3.2	1.27E+02	3.50E+01	chronic cs	EcoRisk 3.2
Nickel	6.71E+00	chronic cs	EcoRisk 3.2	2.44E+02	6.71E+01	chronic cs	EcoRisk 3.2
Selenium	2.90E-01	chronic cs	EcoRisk 3.2	1.06E+01	5.79E-01	chronic cs	EcoRisk 3.2
Silver	2.02E+00	chronic cs	EcoRisk 3.2	7.35E+01	2.02E+01	chronic cs	EcoRisk 3.2
Thallium	3.50E-01	chronic cs	EcoRisk 3.2	1.27E+01	3.50E+00	chronic cs	EcoRisk 3.2
Vanadium	3.44E-01	chronic cs	EcoRisk 3.2	1.25E+01	6.88E-01	chronic cs	EcoRisk 3.2
Zinc	6.61E+01	chronic GMM	EcoRisk 3.2	2.41E+03	6.61E+02	chronic GMM	EcoRisk 3.2
Miscellaneous							
Cyanide (CN-)	4.00E-02	chronic cs	EcoRisk	1.46E+00	4.00E-01	chronic cs	EcoRisk

TABLE C-4: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE RED-TAILED HAWK							
Surrogate: American Kestral (Avian Top Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
			3.2				3.2
Explosives							
Dinitrobenzene, 1,3-	4.22E-01	chronic cs	EcoRisk 3.2	1.54E+01	4.22E+00	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,6-	6.00E+01	chronic cs	EcoRisk 3.2	2.18E+03	6.00E+02	chronic cs	EcoRisk 3.2
Trinitrotoluene, 2,4,6-	9.75E+00	chronic cs	EcoRisk 3.2	3.55E+02	1.78E+01	chronic cs	EcoRisk 3.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	2.36E+00	chronic GMM	EcoRisk 3.2	8.59E+01	4.49E+00	chronic GMM	EcoRisk 3.2

[a] chronic cs - TRV based on a critical study (two or less data), chronic GMM - TRV based on geometric mean (three or more relevent data)

[b] EcoRisk 3.2 - includes uncertainty factors for extrapolation to chronic NOAEL and LOAEL (see Uncertanty Factor's tab)

TABLE C-5: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE PRONGHORN ANTELOPE							
	Tier 1				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type**	**Source**
Metals							
Arsenic	1.25E-01	subchronic	NAS, 1972	3.61E+01	1.56E-01	subchronic	NAS, 1972
Cobalt	2.00E-01	chronic	NAS, 1980	5.77E+01	2.50E-01	chronic	NAS, 1980
Lead	6.00E-01	chronic	NAS, 1980	1.73E+02	7.50E-01	chronic	NAS, 1980
Manganese	2.00E+01	chronic	NAS, 1980	5.77E+03	2.50E+01	chronic	NAS, 1980
Molybdenum	4.00E+00	chronic	NAS, 1972	1.15E+03	5.00E+00	chronic	NAS, 1972
Nickel	1.00E+00	chronic	NAS, 1980	2.89E+02	1.25E+00	chronic	NAS, 1980
Silver	1.00E-02	acute	Gough, 1979	2.89E+00			
Vanadium	1.00E+00	chronic	NAS, 1980	2.89E+02	1.25E+00	chronic	NAS, 1980
Zinc	1.00E+01	chronic	NAS, 1980	2.89E+03	1.25E+01	chronic	NAS, 1980

TABLE C-6: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR PLANTS						
	Tier 1			**Tier 2**		
Constituent	**Effect Concentration NOAEL (mg/kg)**	**Type[a]**	**Source**	**Effect Concentration LOAEL (mg/kg)**	**Type[a]**	**Source**
VOCs						
Hexachlorobenzene	1.00E+01	chronic cs	EcoRisk 3.2	1.00E+02	chronic cs	EcoRisk 3.2
Methylene chloride	1.67E+03	chronic cs	EcoRisk 3.2	1.67E+04	chronic cs	EcoRisk 3.2
Styrene	3.20E+00	chronic cs	EcoRisk 3.2	3.20E+01	chronic cs	EcoRisk 3.2
Tetrachloroethene	1.00E+01	chronic cs	EcoRisk 3.2	1.00E+02	chronic cs	EcoRisk 3.2
Toluene	2.00E+02	chronic cs	EcoRisk 3.2	2.00E+03	chronic cs	EcoRisk 3.2
Xylene (total)	1.00E+02	chronic cs	EcoRisk 3.2	1.00E+03	chronic cs	EcoRisk 3.2
SVOCs						
Dibenzofuran	6.17E+00	chronic cs	EcoRisk 3.2	6.17E+01	chronic cs	EcoRisk 3.2
Di-n-butyl phthalate	1.67E+02	chronic GMM	EcoRisk 3.2	6.01E+02	chronic GMM	EcoRisk 3.2
Diethyl phthalate	1.00E+02	chronic cs	EcoRisk 3.2	1.00E+03	chronic cs	EcoRisk 3.2
Hexachlorobenzene	1.00E+01	chronic cs	EcoRisk 3.2	1.00E+02	chronic cs	EcoRisk 3.2
2-Methylphenol	6.70E-01	chronic cs	EcoRisk 3.2	6.70E+00	chronic cs	EcoRisk 3.2
3-Methylphenol	6.90E-01	chronic cs	EcoRisk 3.2	6.90E+00	chronic cs	EcoRisk 3.2
Pentachlorophenol	5.00E+00	chronic GMM	EcoRisk 3.2	5.00E+01	chronic GMM	EcoRisk 3.2
Phenol	7.90E-01	chronic cs	EcoRisk 3.2	7.90E+00	chronic cs	EcoRisk 3.2
Pestcides/Herbicides						
gamma-BHC (Lindane)	1.00E-01	chronic cs	EcoRisk 3.2	1.00E+00	chronic cs	EcoRisk 3.2
alpha-Chlordane	2.24E+00	chronic cs	EcoRisk 3.2	2.24E+01	chronic cs	EcoRisk 3.2
gamma-Chlordane	2.24E+00	chronic cs	EcoRisk 3.2	2.24E+01	chronic cs	EcoRisk 3.2
4,4'-DDT	4.10E+00	chronic GMM	EcoRisk 3.2	6.10E+00	chronic GMM	EcoRisk 3.2
Dieldrin	1.00E+01	chronic cs	EcoRisk 3.2	1.00E+02	chronic cs	EcoRisk 3.2
Endrin	3.40E-03	chronic cs	EcoRisk 3.2	3.40E-02	chronic cs	EcoRisk 3.2
Heptachlor	4.08E-01	chronic cs	EcoRisk 3.2	4.08E+00	chronic cs	EcoRisk 3.2
Aroclors						
Aroclor 1254	1.63E+02	chronic GMM	EcoRisk 3.2	6.20E+02	chronic GMM	EcoRisk 3.2
PAHs						
Acenaphthene	2.50E-01	chronic cs	EcoRisk 3.2	2.50E+00	chronic cs	EcoRisk 3.2
Anthracene	6.88E+00	chronic GMM	EcoRisk 3.2	8.95E+00	chronic GMM	EcoRisk 3.2
Benzo(a)anthracene	1.80E+01	chronic cs	EcoRisk 3.2	1.80E+02	chronic cs	EcoRisk 3.2
Benzo(b)fluoranthene	1.80E+01	chronic cs	EcoRisk 3.2	1.80E+02	chronic cs	EcoRisk 3.2
Naphthalene	1.00E+00	chronic cs	EcoRisk 3.2	1.00E+01	chronic cs	EcoRisk 3.2
Metals						

TABLE C-6: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR PLANTS						
	Tier 1			**Tier 2**		
Constituent	**Effect Concentration NOAEL (mg/kg)**	**Type[a]**	**Source**	**Effect Concentration LOAEL (mg/kg)**	**Type[a]**	**Source**
Antimony	1.14E+01	chronic GMM	EcoRisk 3.2	5.80E+01	chronic GMM	EcoRisk 3.2
Arsenic	1.80E+01	chronic GMM	EcoRisk 3.2	9.10E+01	chronic GMM	EcoRisk 3.2
Barium	1.18E+02	chronic GMM	EcoRisk 3.2	2.61E+02	chronic GMM	EcoRisk 3.2
Beryllium	2.50E+00	chronic cs	EcoRisk 3.2	2.50E+01	chronic cs	EcoRisk 3.2
Boron	3.68E+01	chronic GMM	EcoRisk 3.2	8.66E+01	chronic GMM	EcoRisk 3.2
Cadmium	3.20E+01	chronic GMM	EcoRisk 3.2	1.60E+02	chronic GMM	EcoRisk 3.2
Chromium (hexavalent)	3.50E-01	chronic cs	EcoRisk 3.2	3.50E+00	chronic cs	EcoRisk 3.2
Cobalt	1.30E+01	chronic GMM	EcoRisk 3.2	1.34E+02	chronic GMM	EcoRisk 3.2
Copper	7.00E+01	chronic GMM	EcoRisk 3.2	4.97E+02	chronic GMM	EcoRisk 3.2
Lead	1.20E+02	chronic GMM	EcoRisk 3.2	5.76E+02	chronic GMM	EcoRisk 3.2
Manganese	2.20E+02	chronic GMM	EcoRisk 3.2	1.10E+03	chronic GMM	EcoRisk 3.2
Mercury (inorganic)	3.49E+01	chronic cs	EcoRisk 3.2	6.40E+01	chronic cs	EcoRisk 3.2
Nickel	3.80E+01	chronic GMM	EcoRisk 3.2	2.76E+02	chronic GMM	EcoRisk 3.2
Selenium	5.20E-01	chronic GMM	EcoRisk 3.2	3.40E+00	chronic GMM	EcoRisk 3.2
Silver	5.60E+02	chronic GMM	EcoRisk 3.2	2.81E+03	chronic GMM	EcoRisk 3.2
Thallium	5.00E-02	chronic cs	EcoRisk 3.2	5.00E-01	chronic cs	EcoRisk 3.2
Vanadium	6.00E+01	chronic cs	EcoRisk 3.2	8.00E+01	chronic cs	EcoRisk 3.2
Zinc	1.60E+02	chronic GMM	EcoRisk 3.2	8.12E+02	chronic GMM	EcoRisk 3.2
Explosives						
Dinitrotoluene, 2,4-	6.00E+00	EPA Eco SSL	EcoRisk 3.2	6.00E+01	EPA Eco SSL	EcoRisk 3.2
Trinitrotoluene, 2,4,6-	6.21E+01	chronic GMM	EcoRisk 3.2	1.26E+02	chronic GMM	EcoRisk 3.2
Dinitrotoluene, 2-Amino-4,6-	1.40E+01	EPA Eco SSL	EcoRisk 3.2	1.40E+02	EPA Eco SSL	EcoRisk 3.2
Dinitrotoluene, 4-Amino-2,6-	3.30E+01	EPA Eco SSL	EcoRisk 3.2	3.30E+02	EPA Eco SSL	EcoRisk 3.2
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2.74E+03	chronic GMM	EcoRisk 3.2	3.56E+03	chronic GMM	EcoRisk 3.2
Nitroglycerin	2.10E+01	EPA Eco SSL	EcoRisk 3.2	2.10E+02	EPA Eco SSL	EcoRisk 3.2

[a] chronic cs - TRV based on a critical study (two or less data), chronic GMM - TRV based on geometric mean (three or more relevent data)

[b] EcoRisk 3.2 - includes uncertainty factors for extrapolation to chronic NOAEL and LOAEL (see Uncertanty Factor's tab)

Appendix B

Field Methods

Soil Gas Sampling

Sampling Procedure

Injection pressure and injection flow rates are collected from bioventing wells in which air is being injected. Soil gas samples are collected before groundwater purging and sampling.

Each well is equipped with an air-tight well cap for sample extraction through a sample port at the top of the well casing. Each well has dedicated flexible Teflon Food Grade tubing which extends through both sides of the sample port with one side continuing down into the well casing to approximately 1 foot above the water table. The other end (topside) protrudes from the cap and is available as a connector. Before purging, pressure is measured by attaching a hand-held Magnahelic Pressure Gauge to the topside tubing.

A portable vacuum pump is used for purging and sample collection. The topside tubing is connected to the suction of the vacuum pump and at least three purge volumes are withdrawn from the well prior to sample collection. After sufficient purging, a Tedlar bag is attached to the tubing at the discharge end of the pump for sample collection. All samples are properly labeled and placed in a cooler for delivery to the analytical laboratory or for field measurements of vapor-phase organics

Well Purging Technique

A vacuum pump is used to remove stagnant air from the soil gas sampling assembly. No less than three well volumes are purged from the well before sampling. Purged volumes are based on the following equation:

(Conversion Factor) x (depth-to-water) x (28 liters/ft3) x 3

The conversion factor is determined by the diameter of the well casing.

Casing	Conversion Factor
6”	0.196L/ft
4”	0.0873L/ft
2”	0.0218L/ft
1”	0.005545L/ft

Soil Gas Sampling and Sample Handling Procedure

Equipment and supplies needed for collecting representative soil gas samples include:

- Interface Probe
- Vacuum Pump
- 1 Liter Tedlar Bags
- PID Meter
- RKI Eagle Meter
- Cooler to store Tedlar Bags
- Sharpie Permanent Marker
- Field Paper work/Log sheet
- Trash container (plastic garbage bag)

Tedlar bags and tubing dedicated for each well are used for field measurements. New Tedlar bags are used for BTEX and GRO collection and analysis.

After sufficient purging, samples are collected using the vacuum pump. Field measurements of vapor-phase organics, oxygen, and carbon dioxide concentrations are recorded using portable field instruments. BTEX and GRO samples are labeled immediately with location, date, time, analysis, and sampler and then put in a trash bag and placed in a cooler. The field logsheet is reviewed to verify all entries. Samples are then shipped to the laboratory.

To prevent cross-contamination, procedures include dedicated tubing for each of the wells sampled as well as a five minute purge time of the vacuum pump in ambient air.

Instrument Calibration

Multi-Gas Meter

The RKI Eagle is a portable gas detection system with sensors for oxygen, carbon dioxide, and methane. Calibration of the instrument is conducted at the beginning of each day of sampling.

The meter is turned on and allowed to warm up. Fill the dedicated Tedlar bags with known calibration gas. One bag is used for the carbon dioxide calibration and the other bag contains the oxygen and methane calibration gasses. Press and hold the AIR/▲ button until a tone sounds. The Eagle automatically sets the toxics circuits to zero and the oxygen circuit to 20.9%.

Press and hold the SHIFT /▼ button, then press the DISP/ADJ button. The calibration menu is displayed. Use the AIR/▲ and SHIFT/▼ buttons to place the prompt next to the SINGLE CALIBRATION menu option. Press the POWER/ENTER button to display the Single Calibration menu. Use the AIR/▲ or SHIFT/▼ button to place the prompt next to the channel to calibrate. Press the POWER/ENTER button. Connect the tubing from the Tedlar bag to the Eagle's probe. If necessary, use the AIR/▲ (increase) and SHIFT/▼ (decrease) buttons to adjust the reading to match the concentration listed on the calibration cylinder. Press the POWER/ENTER button to set the span value. Repeat the steps for any other channels you want to calibrate.

Photoionization Detector

The MiniRae 2000 Portable VOC Monitor (PID) is calibrated at the beginning of each day of sampling. Turn on the monitor and wait for the Ready message display. Press and hold both (N/-) and (MODE) keys for three seconds to enter programming mode. The first menu item "Calibrate/select Gas?" will be displayed. Press (N/-) to scroll to Fresh Air Cal? And press (Y/-) to select that menu item. Clean ambient air can be used for the "fresh air" calibration. Press (Y/-) to begin the zeroing process.

After zeroing is complete, press (N/-) to scroll to the next menu item. When Span Cal? is displayed press (Y/-) to select that menu item. Connect the monitor to a known calibration gas cylinder (isobutylene) after the display shows Apply gas now! The monitor will then perform the calibration. When calibration is completed, turn off the flow of gas, disconnect the cylinder, and exit the programming mode by pressing the (MODE) key once.

Groundwater Sampling

Groundwater Elevation

All water/product levels are determined to an accuracy of 0.01 foot using a Geotech Interface Meter. The technician records separate phase hydrocarbon, depth to water, and total well depth using this probe.

Water Quality/Groundwater Sampling

Water quality parameters are measured using an YSI Professional Plus instrument. Electrical conductance, oxidation-reduction potential (ORP), pH, temperature, and dissolved oxygen are monitored during purging.

Well Purging Technique

At least three well volumes are purged from the well. Purge volumes are determined using the following equation:

(Well depth) – (Casing height) – (Depth to Liquid) x (Conversion Factor) x 3

The conversion factor is determined by the diameter of the well casing.

Casing	Conversion Factor
6"	1.50 gal/ft
5"	1.02 gal/ft
4"	0.74 gal/ft
3"	0.367 gal/ft
2"	0.163 gal/ft

Well Sampling and Sample Handling Procedure

Equipment and supplies needed for collecting representative groundwater samples include:

- Interface Probe
- YSI Professional Plus
- Distilled Water
- Disposable Nitrile Gloves
- Disposable Bailers
- String/Twine
- Cooler with Ice
- Bottle kits with Preservatives (provided by the contract laboratory)
- Sharpie Permanent Marker
- Field Paperwork/Log sheet
- Two 5-gallon buckets
- Trash container (plastic garbage bag)
- Ziploc Bags
- Paper towels

Typically disposable bailers are used for purging and sampling. Each bailer holds one liter of liquid. Three well volumes can be calculated by counting the number of times a well is bailed. All purged water is poured into a 55-gallon drum designated for sampling events.

After sufficient purging, samples are collected with the bailer and poured into the appropriate sample containers. Two people are usually utilized for sampling. Sampling takes place over a bucket to insure that spills are contained

Samples are labeled immediately with location, date, time, analysis, preservative, and sampler. Then they are put in a Ziploc bag and placed in a cooler holding sufficient ice to keep them cool. The field log sheet is reviewed to verify all entries.

Purge and Decontamination Water Disposal

The YSI Professional Plus and the interface probe are rinsed with distilled water after every well. The rinse procedure takes place over a bucket to insure that spills are contained. All rinse and purge water is contained and then disposed of through the refinery wastewater system.

Instrument Calibration

Calibration of the YSI Professional Plus occurs at the beginning of each day of sampling. The probe is powered on and allowed to stabilize, which usually takes 15 minutes. The calibration menu is selected. The LCD screen runs through a list of selections to specify units, calibration solutions, etc. The calibrations procedures outlined in the YSI Professional Plus instruction manual are followed.

Appendix C

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory

QUALITY ASSURANCE PLAN

Effective Date: August 13th, 2014

Revision 9.9

www.hallenvironmental.com

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3.0 Introduction

Purpose of Document

The purpose of this Quality Assurance Plan is to formally document the quality assurance policies and procedures of Hall Environmental Analysis Laboratory, Inc. (HEAL), for the benefit of its employees, clients, and accrediting organizations. HEAL continually implements all aspects of this plan as an essential and integral part of laboratory operations in order to ensure that high quality data is produced in an efficient and effective manner.

Objectives

The objective of HEAL is to achieve and maintain excellence in environmental testing. This is accomplished by developing, incorporating and documenting the procedures and policies specified by each of our accrediting authorities and outlined in this plan. These activities are carried out by a laboratory staff that is analytically competent, well-qualified, and highly trained. An experienced management team, knowledgeable in their area of expertise, monitors them. Finally, a comprehensive quality assurance program governs laboratory practices and ensures that the analytical results are valid, defensible, reproducible, reconstructable and of the highest quality.

HEAL establishes and thoroughly documents its activities to ensure that all data generated and processed will be scientifically valid and of known and documented quality. Routine laboratory activities are detailed in method specific standard operating procedures (SOP). All data reported meets the applicable requirements for the specific method or methods that are referenced, ORELAP, TCEQ, EPA, client specific requirements and/or State Bureaus. In the event that these requirements are ever in contention with each other, it is HEAL's policy to always follow the most prudent requirement available. For specific method requirements refer to HEAL's Standard Operating Procedures (SOP's), EPA methods, Standard Methods 20th edition, ASTM methods or state specific methods.

HEAL management ensures that this document is correct in terms of required accuracy and data reproducibility, and that the procedures contain proper quality control measures. HEAL management additionally ensures that all equipment is reliable, well-maintained and appropriately calibrated. The procedures and practices of the laboratory are geared towards not only strictly following our regulatory requirements but also allowing the flexibility to conform to client specific specifications. Meticulous records are maintained for all samples and their respective analyses so that results are well-documented and defensible in a court of law.

The HEAL Quality Assurance/Quality Control Officer (QA/QCO) and upper management are responsible for supervising and administering this quality assurance program, and ensuring each individual is responsible for its proper implementation. All HEAL management remains committed to the encouragement of excellence in analytical testing and will continue to provide the necessary resources and environment conducive to its achievement.

Policies

Understanding that quality cannot be mandated, it is the policy of this laboratory to provide an environment that encourages all staff members to take pride in the quality of their work. In addition to furnishing proper equipment and supplies, HEAL stresses the importance of continued training and professional development. Further, HEAL recognizes the time required for data interpretation. Therefore, no analyst should feel pressure to sacrifice data quality for data quantity. Each staff member must perform with the highest level of integrity and professional competence, always being alert to problems that could compromise the quality of their technical work.

Management and senior personnel supervise analysts closely in all operations. Under no circumstance is the willful act or fraudulent manipulation of analytical data condoned. Such acts must be reported immediately to HEAL management. Reported acts will be assessed on an individual basis and resulting actions could result in dismissal. The laboratory staff is encouraged to speak with lab managers or senior management if they feel that there are any undo commercial, financial, or other pressures, which might adversely affect the quality of their work; or in the event that they suspect that data quality has been compromised in any way. HEAL's Quality Assurance/Quality Control Officer is available if any analyst and/or manager wishes to anonymously report any suspected or known breaches in data integrity.

Understanding the importance of meeting customer requirements in addition to the requirements set forth in statutory and regulatory requirements, HEAL shall periodically seek feedback from customers and evaluate the feedback in order to initiate improvements.

All proprietary rights and client information at HEAL (including national security concerns) are considered confidential. No information will be given out without the express verbal or written permission of the client. All reports generated will be held in the strictest of confidence.

HEAL shall continually improve the effectiveness of its management system through the use of the policies and procedures outlined in this Quality Assurance Plan. Quality control results, internal and external audit findings, management reviews, new and continual training and corrective and preventive actions are continually evaluated to identify possible improvements and to ensure that appropriate communication processes are taking place regarding the effectiveness of the management system. HEAL shall ensure that the integrity of the quality system is maintained when changes to the system are planned and implemented.

This is a controlled document. Each copy is assigned a unique tracking number and when released to a client or accrediting agency the QA/QCO keeps the tracking number on file. This document is reviewed on an annual basis to ensure that it is valid and representative of current practices at HEAL.

4.0 Organization and Responsibility

Company

HEAL is accredited in accordance with the 2009 TNI standard (see NELAC accredited analysis list in the QA Department or on the company website), through ORELAP and TCEQ and by the Arizona Department of Health Services. Additionally, HEAL is qualified as defined under the State of New Mexico Water Quality Control Commission regulations and the New Mexico State Drinking Water Bureau. HEAL is a locally owned small business that was established in 1991. HEAL is a full service environmental analysis laboratory with analytical capabilities that include both organic and inorganic methodologies and has performed analyses of soil, water, and air as well as various other matrices for many sites in the region. HEAL's client base includes local, state and federal agencies, private consultants, commercial industries as well as individual homeowners. HEAL has performed as a subcontractor to the state of New Mexico and to the New Mexico Department of Transportation. HEAL has been acclaimed by its customers as producing quality results and as being adaptive to client-specific needs.

The laboratory is divided into an organic section, an inorganic section and a microbiology section. Each section has a designated manager/technical director. The technical directors report directly to the laboratory manager, who oversees all operations.

Certifications

ORELAP – NELAC Oregon Primary accrediting authority.

TCEQ – NELAC Texas Secondary accrediting authority.

The Arizona Department of Health Services

The New Mexico Drinking Water Bureau

See our website at www.hallenvironmental.com or the QA Office for copies of current licenses and licensed parameters.

In the event of a certification being revoked or suspended, HEAL will notify, in writing, those clients that require the affected certification.

Personnel

HEAL management ensures the competence of all who operate equipment, perform environmental tests, evaluate results, and sign test reports. Personnel performing specific tasks shall be qualified on the basis of appropriate education, training, experience and /or demonstrated skills.

HEAL ensures that all personnel are aware of the relevance and importance of their activities and how each employee contributes to the achievement of the objectives defined throughout this document.

All personnel shall be responsible for complying with HEAL's quality assurance/quality control requirements that pertain to their technical function. Each technical staff member must have a combination of experience and education to adequately demonstrate specific knowledge of their particular function and a general knowledge of laboratory operations, test methods, quality assurance/quality control procedures, and records management.

All employees' training certificates and diplomas are kept on file with demonstrations of capability for each method they perform. An Organizational Chart can be found at the end of this section and a personnel list is available in the current Controlled Document Logbook.

Laboratory Director

The Laboratory Director is responsible for overall technical direction and business leadership of HEAL. The Laboratory Manager, the Project Manager and Quality Assurance/Quality Control Officer report directly to the Laboratory Director. Someone with a minimum of 7 years of directly related experience and a bachelor's degree in a scientific or engineering discipline should fill this position.

Laboratory Manager/Lead Technical Director

The Laboratory Manager shall exercise day–to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results. The Laboratory Manager shall be experienced in the fields of accreditation for which the laboratory is approved or seeking accreditation. The Laboratory Manager shall certify that personnel with appropriate educational and/or technical background perform all tests for which HEAL is accredited. Such certification shall be documented.

The Laboratory Manager shall monitor standards of performance in quality control and quality assurance and monitor the validity of the analyses performed and data generated at HEAL to assure reliable data.

The Laboratory Manager is responsible for the daily operations of the laboratory. The Laboratory Manager is the lead technical director of the laboratory and, in conjunction with the section technical directors, is responsible for coordinating activities within the laboratory with the overall goal of efficiently producing high quality data within a reasonable time frame.

In events where employee scheduling or current workload is such that new work cannot be incorporated, without missing hold times, the Laboratory Manager has authority to modify employee scheduling, re-schedule projects or, when appropriate, allocate the work to approved subcontracting laboratories.

Additionally, the laboratory manager reviews and approves new analytical procedures and methods, and performs a final review of most analytical results. The Laboratory Manager provides technical support to both customers and HEAL staff.

The Laboratory Manager also observes the performance of supervisors to ensure that good laboratory practices and proper techniques are being taught and utilized, and to assist in overall quality control implementation and strategic planning for the future of the company. Other duties include assisting in establishing laboratory policies that lead to the fulfillment of requirements for various certification programs, assuring that all Quality Assurance and Quality Control documents are reviewed and approved, and assisting in conducting Quality Assurance Audits.

The laboratory manager addresses questions or complaints that cannot be answered by the section managers.

The Laboratory Manager shall have a bachelor's degree in a chemical, environmental, biological sciences, physical sciences, or engineering field, and at least five years of experience in the environmental analysis of representative inorganic and organic analytes for which the laboratory seeks or maintains accreditation.

Assistant Laboratory Manager

The Assistant Laboratory Manager shall aid the Laboratory Manager in exercising day–to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results. The Assistant Laboratory Manager shall be experienced in the fields of accreditation for which the laboratory is approved or seeking accreditation.

The Assistant Laboratory Manager is responsible for helping the Laboratory Manager in the daily operations of the laboratory. In conjunction with the section Technical Directors, the Assistant Laboratory Manager is responsible for coordinating activities within the laboratory with the overall goal of efficiently producing high quality data within a reasonable time frame.

The Assistant Laboratory Manager shall have at least ten years of experience in environmental analysis of representative inorganic and/or organic analytes for which the laboratory seeks or maintains accreditation.

Quality Assurance Quality Control Officer

The Quality Assurance/Quality Control Officer (QA/QCO) serves as the focal point for QA/QC and shall be responsible for the oversight and/or review of quality control data. The QA/QCO functions independently from laboratory operations and shall be empowered to halt unsatisfactory work and/or prevent the reporting of results generated from an out-of-control measurement system. The QA/QCO shall objectively evaluate data and perform assessments without any outside/managerial influence. The QA/QCO shall have direct access to the highest level of management at which decisions are made on laboratory policy and/or resources. The QA/QCO shall notify laboratory management of deficiencies in the quality system in periodic, independent reports.

The QA/QCO shall have general knowledge of the analytical test methods for which data review is performed and have documented training and/or experience in QA/QC procedures and in the laboratory's quality system. The QA/QCO will have a minimum of a BS in a scientific or related field and a minimum of three years of related experience.

The QA/QCO shall schedule and conduct internal audits as per the Internal Audit SOP at least annually, monitor and trend Corrective Action Reports as per the Data Validation SOP, periodically review control charts for out of control conditions, and initiate any appropriate corrective actions.

The QA/QCO shall oversee the analysis of proficiency testing in accordance with our standards and monitor any corrective actions issued as a result of this testing.

The QA/QCO reviews all standard operating procedures and statements of work in order to assure their accuracy and compliance to method and regulatory requirements.

The QA/QCO shall be responsible for maintaining and updating this quality manual.

Project Managers

The role of the project manager is to act as a liaison between HEAL and our clients. The Project Manager updates clients on the status of projects in-house, prepares quotations for new work, and is responsible for HEAL's marketing effort.

All new work is assessed by the Project Manager and reviewed with the other managers so as to not exceed the laboratory's capacity. In events where employee scheduling or current workload is such that new work cannot be incorporated without missing hold times, the Project Manager has authority to re-schedule projects.

It is also the duty of the project manager to work with the Laboratory Manager and QA/QCO to insure that before new work is undertaken, the resources required and accreditations requested are available to meet the client's specific needs.

Additionally, the Project Manager can initiate the review of the need for new analytical procedures and methods, and perform a final review of some analytical results. The Project Manager provides technical support to customers. Someone with a minimum of 2 years of directly related experience and a bachelor's degree in a scientific or engineering discipline should fill this position.

Technical Directors

Technical Directors are full-time members of the staff at HEAL who exercise day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results for their department within HEAL. A Technical Director's duties shall include, but not be limited to, monitoring standards of performance in quality control and quality assurance, monitoring the validity of the analyses performed and the data generated in their sections to ensure reliable data, overseeing training and supervising departmental staff, scheduling incoming work for their sections, and monitoring laboratory personnel to ensure that proper procedures and techniques are being utilized. They supervise and implement new Quality Control procedures as directed by the QA/QCO, update and maintain quality control records including, but not limited to, training forms, IDOCs, ADOCPs, and MDLs, and evaluate laboratory personnel in their Quality Control activities. In addition, technical directors are responsible for upholding the spirit and intent of HEAL's data integrity procedures.

As Technical Directors of their associated section, they review analytical data to acknowledge that data meets all criteria set forth for good Quality Assurance practices. Someone with a minimum of 2 years of experience in the environmental analysis of representative analytes for which HEAL seeks or maintains accreditation and a bachelor's degree in a scientific or related discipline should fill this position.

The education requirements for a Technical Director may be waived at the discretion of HEAL's accrediting agencies.

Health and Safety / Chemical Hygiene Officer

Refer to the most recent version of the Health and Safety and Chemical Hygiene Plans for the roles, responsibilities, and basic requirements of the Health and Safety Officer (H&SO) and the Chemical Hygiene Officer (CHO). These jobs can be executed by the same employee.

Analyst I, II and III

Analysts are responsible for the analysis of various sample matrices including, but not limited to, solid, aqueous, and air, as well as the generation of high quality data in accordance with the HEAL SOPs and QA/QC guidelines in a reasonable time as prescribed by standard turnaround schedules or as directed by the Section Manager or Laboratory Manager.

Analysts are responsible for making sure all data generated is entered in the database in the correct manner and the raw data is reviewed, signed and delivered to the appropriate peer for review. An analyst reports daily to the section manager and will inform them as to material needs of the section specifically pertaining to the analyses performed by the analyst. Additional duties may include preparation of samples for analysis, maintenance of lab instruments or equipment, and cleaning and providing technical assistance to lower level laboratory staff.

The senior analyst in the section may be asked to perform supervisory duties as related to operational aspects of the section. The analyst may perform all duties of a lab technician.

The position of Analyst is a full or part time hourly position and is divided into three levels, Analyst I, II, and III. All employees hired into an Analyst position at HEAL must begin as an Analyst I and remain there at a minimum of three months regardless of their education and experience. Analyst I must have a minimum of an AA in a related field or equivalent experience (equivalent experience means years of related experience can be substituted for the education requirement). An Analyst I is responsible for analysis, instrument operation, including calibration and data reduction. Analyst II must have a minimum of an AA in a related field or equivalent experience and must have documented and demonstrated aptitude to perform all functions of an Analyst II. An Analyst II is responsible for the full analysis of their test methods, routine instrument maintenance, purchase of consumables as dictated by their Technical Director, advanced data reduction, and basic data review. Analyst II may also assist Analyst III in method development and, as dictated by their Technical Director, may be responsible for the review and/or revision of their method specific SOPs. Analyst III must have Bachelor's degree or equivalent experience and must have documented and demonstrated aptitude to perform all functions of an Analyst III. An Analyst III is responsible for all tasks completed by an Analyst I and II as well as advanced data review, non-routine instrument maintenance, assisting their technical director in basic supervisory duties and method development.

Laboratory Technician

A laboratory technician is responsible for providing support to analysts in the organics, inorganics and disposal departments. Laboratory Technicians can assist analysts in basic sample preparation, general laboratory maintenance, glassware washing, chemical inventories, sample disposal and sample kit preparation. This position can be filled by someone without the education and experience necessary to obtain a position as an analyst.

Sample Control Manager

The sample control manager is responsible for receiving samples and reviewing the sample login information after it has been entered into the computer. The sample control manager also checks the samples against the chain-of-custody for any sample and/or labeling discrepancies prior to distribution.

The sample control manager is responsible for sending out samples to the sub-contractors along with the review and shipping of field sampling bottle kits. The sample control manager acts as a liaison between the laboratory and field sampling crew to ensure that the appropriate analytical test is assigned. If a discrepancy is noted, the sample control manager or sample custodian will contact the customer to resolve any questions or problems. The sample control manager is an integral part of the customer service team.

This position should be filled by someone with a high school diploma and a minimum of 2 years of related experience and can also be filled by a senior manager.

Sample Custodians

Sample Custodians work directly under the Sample Control Manager. They are responsible for sample intake into the laboratory and into the LIMS. Sample Custodians take orders from our clients and prepare appropriate bottle kits to meet the clients' needs. Sample Custodians work directly with the clients in properly labeling and identifying samples as well as properly filling out legal COCs. When necessary, Sample Custodians contact clients to resolve any questions or problems associated with their samples. Sample Custodians are responsible for distributing samples throughout the laboratory and are responsible for notifying analysts of special circumstances such as short holding times or improper sample preservation upon receipt.

Sample Disposal Custodian

The sample disposal custodian is responsible for characterizing and disposing of samples in accordance to the most recent version of the sample disposal SOP. The sample disposal custodian collects waste from the laboratory and transports it to the disposal warehouse for storage and eventual disposal. The sample disposal custodian is responsible for maintaining the disposal warehouse and following the requirements for documentation, integrity, chemical hygiene and health and safety as set forth in the various HEAL administrative SOPs. The sample disposal custodian is responsible for overseeing any laboratory technicians employed at the disposal warehouse.

This position should be filled by someone with a high school diploma and a minimum of 1 year of related experience.

Bookkeeper

The Bookkeeper is responsible for the preparation of quarterly financials and quarterly payroll reports. The bookkeeper monitors payables, receivables, deposits, pays all bills and maintains an inventory of administrative supplies. The Bookkeeper completes final data package assembly and oversees the consignment of final reports. The Bookkeeper assists in the project management of drinking water compliance samples for NMED and NMEFC and any other tasks as assigned by the Laboratory Manager. This position should be filled by someone with a degree in accounting or a minimum of a high school diploma and at least 4 years of directly related experience.

Administrative Assistant

The Administrative Assistant is responsible for aiding administrative staff in tasks that include but are not limited to: the processing and consignment of final reports, and the generation of client specific spreadsheets. This position should be filled by someone with a minimum of a high school diploma.

IT Specialist

The IT Specialist is responsible for the induction and maintenance of all hard and software technology not maintained through a service agreement. The IT Specialist follows the requirements of this document, all regulatory documents and the EPAs Good Automated Laboratory Practices. This position should be filled by someone with a degree in a computer related field, or at least two years of directly related experience.

Delegations in the Absence of Key Personnel

Planned absences shall be preceded by notification to the Laboratory Manager. The appropriate staff members shall be informed of the absence. In the case of unplanned absences, the superior shall either assume the responsibilities and duties or delegate the responsibilities and duties to another appropriately qualified employee.

In the event that the Laboratory Manager is absent for a period of time exceeding fifteen consecutive calendar days, another full-time staff member meeting the basic qualifications and competent to temporarily perform this function will be designated. If this absence exceeds thirty-five consecutive calendar days, HEAL will notify ORELAP in writing of the absence and the pertinent qualifications of the temporary laboratory manager.

Laboratory Personnel Qualification and Training

All personnel joining HEAL shall undergo orientation and training. During this period the new personnel shall be introduced to the organization and their responsibilities, as well as the policies and procedures of the company. They shall also undergo on-the-job training and shall work with trained staff. They will be shown required tasks and be observed while performing them.

When utilizing staff undergoing training, appropriate supervision shall be dictated and overseen by the appropriate section technical director. Prior to analyzing client samples, a new employee, or an employee new to a procedure, must meet the following basic requirements. The SOP and Method(s) for the analysis must be read and signed by the employee indicating that they read, understand, and intend to comply with the requirements of the documents. The employee must undergo documented training. Training is conducted by a senior analyst familiar with the procedure and overseen by the section Technical Director. This training is documented by any means deemed appropriate by the trainer and section Technical Director, and kept on file in the employees file located in the QA/QCO's office. The employee must perform a successful Initial Demonstration of Capability (IDOC). See the current Document Control Logbook for the training documents and checklists utilized at HEAL to ensure that all of these requirements are met. Once all of the above requirements are met it is incumbent upon the section Technical Director to determine at which point the employee can begin to perform the test unsupervised. A Certification to Complete Work Unsupervised (see the current Document Control Logbook) is then filled out by the employee and technical director.

IDOCs are required for all new analysts and methods prior to sample analysis. IDOCs are also required any time there is a change in the instrument, analyte list or method. If more than twelve months have passed since an analyst performed an IDOC and they have not performed the method and/or have not met the continuing DOC requirements, the analyst must perform an IDOC prior to resuming the test.

All IDOCs shall be documented through the use of the certification form which can be found in the current Document Control Logbook. IDOCs are performed by analyzing four Laboratory Control Spikes (LCSs). Using the results of the LCSs the mean recovery is calculated in the appropriate reporting units and the standard deviations of the population sample (n-1) (in the same units) as well as the relative percent difference for each parameter of interest. When it is not possible or pertinent to determine mean and standard deviations HEAL assesses performance against establish and documented criteria dictated in the method SOP. The mean and standard deviation are compared to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory-generated acceptance criteria. In the event that the HEAL SOP or test method(s) fail to establish the pass/fail criteria the default limits of +/- 20% for calculated recovery and <20% relative percent difference based on the standard deviation will be utilized. If all parameters meet the acceptance criteria, the IDOC is successfully completed. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter and the analyst must either locate and correct the source of the problem and repeat the test for all parameters of interest or repeat the test for all parameters that failed to meet criteria. Repeat failure, however, confirms a general problem with the measurement system. If this occurs the source of the problem must be identified and the test repeated for all parameters of interest.

New employees that do not have prior analysis experience will not be allowed to perform analysis until they have demonstrated attention to detail with minimal errors in the assigned tasks. To ensure a sustained level of quality performance among staff members, continuing demonstration of capability shall be performed at least once a year. These are as an Annual Documentation of Continued Proficiency (ADOCP).

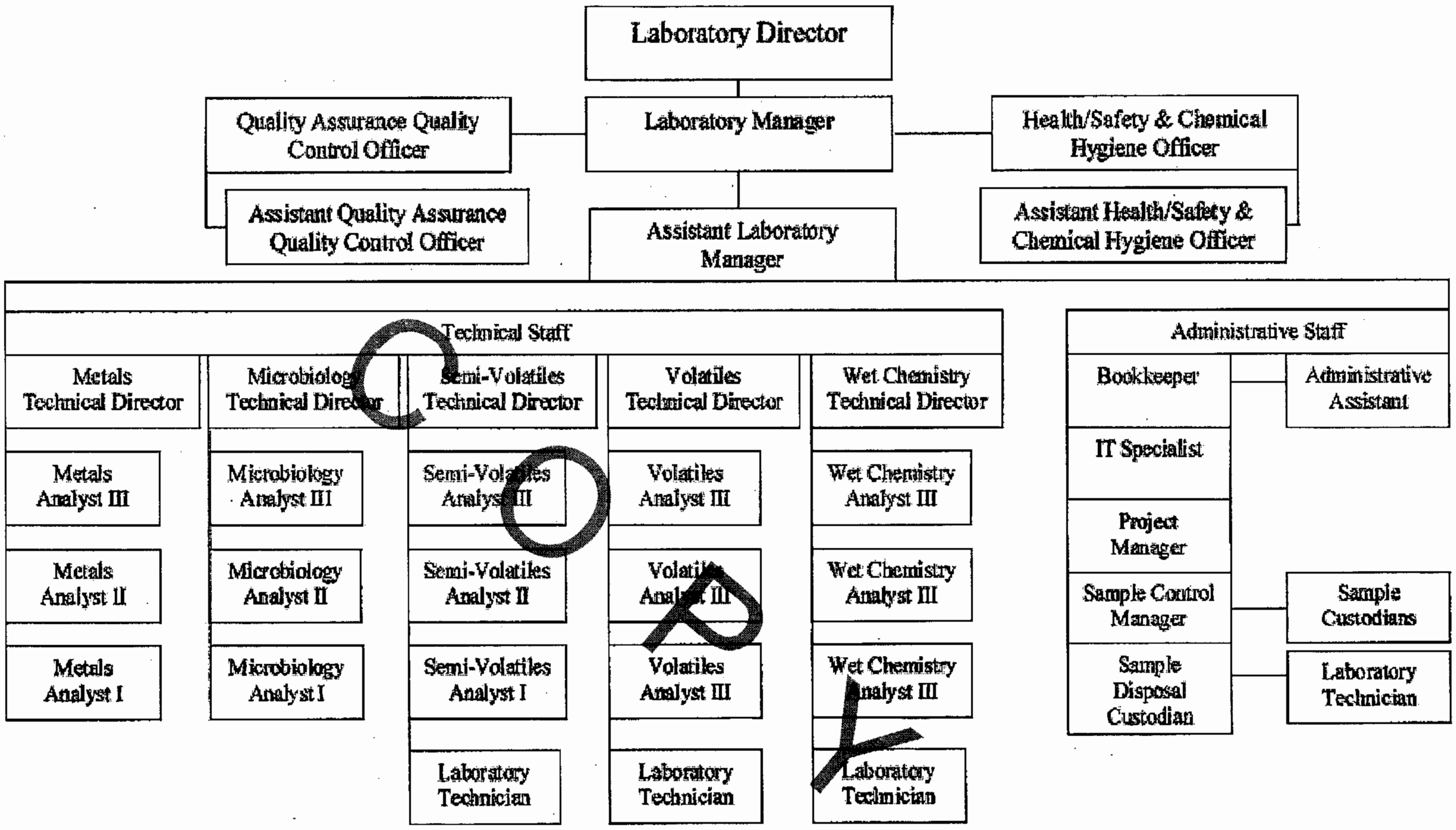
At least once per year an ADOCP must be completed. This is achieved by the acceptable performance of a blind sample (typically by using a PT sample, but can be a single blind (to the analyst) sample), by performing another IDOC, or by summarizing the data of four consecutive laboratory control samples with acceptable levels of precision and accuracy (these limits are those currently listed in the LIMS for an LCS using the indicated test method(s).) ADOCPs are documented using a standard form and are kept on file in each analyst's employee folder. ADOCPs may be demonstrated as an analyst group utilizing LIMS control charting, so long as all listed analysts participated, the results are consecutive and pass the requirements for precision and accuracy.

Each new employee shall be provided with data integrity training as a formal part of their new employee orientation. Each new employee will sign an ethics and data integrity agreement to ensure that they understand that data quality is our main objective. Every HEAL employee recognizes that although turnaround time is important, quality is put above any pressure to complete the task expediently. Analysts are not compensated for passing QC parameters nor are incentives given for the quantity of work produced. Data Integrity and Ethics training are performed on an annual basis in order to remind all employees of HEAL's policy on data quality. Employees are required to understand that any infractions of the laboratory data integrity procedures will result in a detailed investigation that could lead to very serious consequences including immediate termination, debarment, or civil/criminal prosecution.

Training for each member of HEAL's technical staff is further established and maintained through documentation that each employee has read, understood, and is using the latest version of this Quality Assurance Manual. Training courses or workshops on specific equipment, analytical techniques, or laboratory procedures are documented through attendance sheets, certificates of attendance, training forms,. or quizzes. This training documentation is located in analyst specific employee folders in the QA/QCO Office. On the front of all methods, SOPs, and procedures for HEAL, there is a signoff sheet that is signed by all pertinent employees, indicating that they have read, understand, and agree to perform the most recent version of the document.

The effectiveness of training will be evaluated during routine data review, annual employee reviews, and internal and external audits. Repetitive errors, complaints and audit findings serve as indicators that training has been ineffective. When training is deemed to have been ineffective a brief review of the training process will be completed and a re-training conducted as soon as possible.

HEAL Personnel Chart



5.0 Receipt and Handling of Samples

Reviewing Requests, Tenders and Contracts

All contracts and written requests by clients are closely reviewed to ensure that the client's data quality objectives can be met to their specifications. This review includes making sure that HEAL has the resources necessary to perform the tests to the clients specifications.

When HEAL is unable to meet the clients specifications their samples will be subcontracted to an approved laboratory capable of meeting the client's data quality objectives.

Sampling

Procedures

HEAL does not provide field sampling for any projects. Sample kits are prepared and provided for clients upon request. The sample kits contain the appropriate sampling containers (with a preservative when necessary), labels, blue ice (The use of "blue ice" by anyone except HEAL personnel is discouraged because it generally does not maintain the appropriate temperature of the sample. If blue ice is used, it should be completely frozen at the time of use, the sample should be chilled before packing, and special notice taken at sample receipt to be certain the required temperature has been maintained.), a cooler, chain-of-custody forms, plastic bags, bubble wrap, and any special sampling instructions. Sample kits are reviewed prior to shipment for accuracy and completeness.

Containers

Containers which are sent out for sampling are purchased by HEAL from a commercial source. Glass containers are certified "EPA Cleaned" QA level 1. Plastic containers are certified clean when required. These containers are received with a Certificate of Analysis verifying that the containers have been cleaned according to the EPA wash procedure. Containers are used once and discarded. If the samples are collected and stored in inappropriate containers the laboratory may not be able to accurately quantify the amount of the desired components. In this case, re-sampling may be required.

Preservation

If sampling for analyte(s) requires preservation, the sample custodians fortify the containers prior to shipment to the field, or provide the preservative for the sampler to add in the field. The required preservative is introduced into the vials in uniform amounts and done so rapidly to minimize the risk of contamination. Vials that contain a preservative are labeled appropriately. If the samples are stored with inappropriate preservatives, the laboratory may not be able to accurately quantify the amount of the desired components. In this case re-sampling may be required.

Refer to the current Login SOP and/or the current price book for detailed sample receipt and handling procedures, appropriate preservation and holding time requirements.

Sample Custody

Chain-of-Custody Form

A Chain-of-Custody (COC) form is used to provide a record of sample chronology from the field to receipt at the laboratory. HEAL's COC contains the client's name, address, phone and fax numbers, the project name and number, the project manager's name, and the field sampler's name. It also identifies the date and time of sample collection, sample matrix, field sample ID number, number/volume of sample containers, sample temperature upon receipt, and any sample preservative information.

There is also a space to record the HEAL ID number assigned to samples after they are received. Next to the sample information is a space for the client to indicate the desired analyses to be performed. There is a section for the client to indicate the data package level as well as any accreditation requirements. Finally, there is a section to track the actual custody of the samples. The custody section contains lines for signatures, dates and times when samples are relinquished and received. The COC form also includes a space to record special sample related instructions, sampling anomalies, time constraints, and any sample disposal considerations.

It is paramount that all COCs arrive at HEAL complete and accurate so that the samples can be processed and allocated for testing in a timely and efficient manner. A sample chain-of-custody form can be found in the current Document Control Logbook or on line at www.hallenvironmental.com.

Should a specific project or client require the use of an internal COC, advanced notification and approval must be obtained. The use of internal COCs are not part of our standard operating procedure.

Receiving Samples

Samples are received by authorized HEAL personnel. Upon arrival, the COC is compared to the respective samples. After the samples and COC have been determined to be complete and accurate, the sampler signs over the COC. The HEAL staff member in turn signs the chain-of-custody, also noting the current date, time, and sample temperature. This relinquishes custody of the samples from the sampler and delegates sample custody to HEAL. The first (white) copy of the COC form is filed in the appropriate sample folder. The second (yellow) copy of the COC form is filed in the COC file in the sample control manager's office. The third (pink) copy of the COC form is given to the person who has relinquished custody of the samples.

Logging in Samples and Storage

Standard Operating Procedures have been established for the receiving and tracking of all samples (refer to the current HEAL Login SOP). These procedures ensure that samples are received and properly logged into the laboratory and that all associated documentation, including chain of custody forms, is complete and consistent with the samples received. Each sample set is given a unique HEAL tracking ID number. Individual sample locations within a defined sample set are given a unique sample ID suffix-number. Labels with the HEAL numbers, and tests requested, are generated and placed on their respective containers. The pH of preserved, non-volatile samples is checked and noted if out of compliance. Due to the nature of the samples, the pHs of volatiles samples are checked after analysis. Samples are reviewed prior to being distributed for analysis.

All samples received that are requested for compliance, whether on the COC or by contract, will be identified as compliance samples in the LIMS so as to properly notify the analytical staff that they are to be analyzed in accordance with the test method(s) as well as the compliance requirements.

Samples are distributed for analysis based upon the requested tests. In the event that sample volume is limited and different departments at HEAL are required to share the sample, volatile work takes precedence and will always be analyzed first before the sample is sent to any other department for analysis.

Care will be taken to store samples isolated from laboratory contaminants, standards and highly contaminated samples.

All samples that require thermal preservation shall be acceptably stored at a temperature range just above freezing to 6 °C unless specified at another range by the SOP and Method.

Each project (sample set) is entered into the Laboratory Information Management System (LIMS) with a unique ID that will be identified on every container. The ID tag includes the Lab ID, Client ID, date and time of collection, and the analysis/analyses to be performed. The LIMS continually updates throughout the lab. Therefore, at any time, an analyst or manager may inquire about a project and/or samples status. For more information about the login procedures, refer to the Sample Login SOP.

Disposal of Samples

Samples are held at HEAL for a minimum of thirty days and then transferred to the HEAL warehouse for disposal. Analytical results are used to characterize their respective sample contamination level(s) so that the proper disposal can be performed. These wastes will be disposed of according to their hazard as well as their type and level of contamination. Refer to the Hall Environmental Analysis Laboratory Chemical Hygiene Plan and current Sample Disposal SOP for details regarding waste disposal.

Waste drums are provided by an outside agency. These drums are removed by the outside agency and disposed of in a proper manner.

The wastes that are determined to be non-hazardous are disposed of as non-hazardous waste in accordance with the Chemical Hygiene Plan and Sample Disposal SOP.

6.0 Analytical Procedures

All analytical methods used at HEAL incorporate necessary and sufficient Quality Assurance and Quality Control practices. A Standard Operating Procedure (SOP) is used to provide the necessary criteria to yield acceptable results. These procedures are reviewed at least annually and revised as necessary and are attached as a pdf file in the Laboratory Information Management System (LIMS) for easy access by each analyst. The sample is often consumed or altered during the analytical process. Therefore, it is important that each step in the analytical process be correctly followed in order to yield valid data.

When unforeseen problems arise, the analyst, technical director, and, when necessary, laboratory manager meet to discuss the factors involved. The analytical requirements are evaluated and a suitable corrective action or resolution is established. The client is notified in the case narrative with the final report or before, if the validity of their result is in question.

List of Procedures Used

Typically, the procedures used by HEAL are EPA approved methodologies or 20th edition Standard Methods. However, proprietary methods for client specific samples are sometimes used. On occasion, multiple methods or multiple method revisions are used, in this event the SOP is written to include the requirements of all referenced methods. The following tables list EPA and Standard Methods Method numbers with their corresponding analytes and/or instrument classification.

Methods Utilized at HEAL

Drinking Water(DW) Non-Potable Water (NPW) Solids (S)

Methodology	Matrix	Title of Method
180.1.	DW NPW	"Turbidity (Nephelometric)"
200.2	DW NPW	"Sample Preparation Procedure For Spectrochemical Determination of Total Recoverable Elements"
200.7	DW NPW	"Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry"
200.8	DW NPW	"Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry."
245.1	DW NPW	"Mercury (Manual Cold Vapor Technique)"

300.0	DW NPW S	"Determination of Inorganic Anions by Ion Chromatography"
413.2	NPW S	"Oil and Grease"
418.1	NPW S	"Petroleum Hydrocarbons (Spectrophotometric, Infrared)"
504.1	DW	"EDB, DBCP and 123TCP in Water by Microextraction and Gas Chromatography"
524.2	DW	"Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry"
552.3	DW	"Determination of Haloacetic Acids and Dalapon in Drinking Water by Ion-Exchange Liquid-Solid Extraction and Gas Chromatography with an Electron Capture Detector"
624	NPW	Appendix A to Part 136 Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater Method 624-Purgeables"
1311	S	"Toxicity Characteristic Leaching Procedure"
1311ZHE	S	"Toxicity Characteristic Leaching Procedure"
1664A	NPW	"N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material) by Extraction and Gravimetry"
3005A	NPW	"Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by FLAA or ICP Spectroscopy"
3010A	NPW	"Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by FLAA or ICP Spectroscopy"
3050B	S	"Acid Digestion of Sediment, Sludge, and Soils"
3510C	DW NPW	"Separatory Funnel Liquid-Liquid Extraction"
3540	S	"Soxhlet Extraction"
3545	S	"Pressurized Fluid Extraction(PFE)"
3665	NPW S	"Sulfuric Acid/Permanganate Cleanup"
5030B	NPW	"Purge-and-Trap for Aqueous Samples"
5035	S	"Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples"
6010B	NPW S	"Inductively Coupled Plasma-Atomic Emission Spectrometry"

7470A	NPW	“Mercury in Liquid Waste (Manual Cold-Vapor Technique)”
7471A	S	“Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique)”
8021B	NPW S	“Aromatic and Halogenated Volatiles By Gas Chromatography Using Photoionization and/or Electrolytic Conductivity Detectors”
8015D	NPW	“Nonhalogenated Volatile Organics by Gas Chromatography”
	S	(Gasoline Range and Diesel Range Organics)
8081A	NPW S	“Organochlorine Pesticides by Gas Chromatography”
8082	NPW S	“Polychlorinated Biphenyls (PCBs) by Gas Chromatography”
8260B	NPW S	“Volatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS)”
8270C	NPW S	“Semivolatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS)”
8310	NPW S	“Polynuclear Aromatic Hydrocarbons”
9060	NPW	“Total Organic Carbon”
9067	NPW S	“Phenolics (Spectrophotometric, MBTH With Distillation)”
9095A	S	“Paint Filter Liquids Test”
H-8167	DW NPW	“Method 8167 Chlorine, Total”
Walkley/Black	S	FOC/TOC WB
SM2320 B	DW NPW	“Alkalinity”
SM2340B	NPW	“2340 Hardness”
SM2510B	DW NPW	“2510 Conductivity”
SM2540 B	NPW	“Total Solids Dried at 103-105° C”
SM2540 C	DW NPW	“Total Dissolved Solids Dried at 180° C”
SM2540 D	NPW	“Total Suspended Solids Dried at 103-105° C”
SM4500-H+B	DW NPW	“pH Value”
SM4500-NH3 C	NPW S	“4500-NH3” Ammonia
SM4500-Norg	NPW	“4500-Norg” Total Kjeldahl Nitrogen (TKN)

C	S	
SM5210 B	NPW	"5210 B. 5-day BOD Test"
SM5310 B	DW	"5310" Total Organic Carbon (TOC)
SM9223B	NPW DW	"9223 Enzyme Substrate Coliform Test"
8000B	NPW S	"Determinative Chromatographic Separations"
8000C	NPW S	"Determinative Chromatographic Separations"

Criteria for Standard Operating Procedures

HEAL has Standard Operating Procedures (SOPs) for each of the test methods listed above. These SOPs are based upon the listed methods and detail the specific procedure and equipment utilized as well as the quality requirements necessary to prove the integrity of the data. SOPs are reviewed or revised every twelve months or sooner if necessary. The review/revision is documented in the Master SOP Logbook filed in the QA/QC Office. All SOPs are available in the LIMS under the Documents and SOPs menu.
Hand written corrections or alterations to SOPs are not permitted. In the event that a correction is needed and a revision is not immediately possible, a corrective action report will be generated documenting the correction or alteration, signed by the section Technical Director and the QA/QC Officer and will be scanned into the current SOP and will document the change until a new revision is possible.

Controlled documents such as calibration summary forms, analysis bench sheets, etc. are tracked as appendices in SOPs, through the Controlled Document Logbook with copies available through the LIMS or through the MOAL as bound logbooks.

Each HEAL test method SOP shall include or reference the following topics where applicable:

Identification of the test method;
Applicable matrix or matrices;
Limits of detection and quantitation;
Scope and application, including parameters to be analyzed;
Summary of the test method;
Definitions;
Interferences;
Safety;
Equipment and supplies;
Reagents and standards;

Sample collection, preservation, shipment and storage;
Quality control parameters;
Calibration and standardization;
Procedure;
Data analysis and calculations;
Method performance;
Pollution prevention;
Data assessment and acceptance criteria for quality control measures;
Corrective actions for out-of-control data;
Contingencies for handling out-of-control or unacceptable data;
Waste management;
References; and
Any tables, diagrams, flowcharts and validation data.

7.0 Calibration

All equipment and instrumentation used at HEAL are operated, maintained and calibrated according to manufacturers' guidelines, as well as criteria set forth in applicable analytical methodology. Personnel who have been properly trained in their procedures perform the operation and calibration. Brief descriptions of the calibration processes for our major laboratory equipment and instruments are found below.

Thermometers

The thermometers in the laboratory are used to measure the temperatures of the refrigerators, freezers, ovens, water baths, incubators, hot blocks, ambient laboratory conditions, TCLP Extractions, digestion blocks, and samples at the time of log-in. All NIST traceable thermometers are either removed from use upon their documented expiration date or they are checked annually with a NIST-certified thermometer and a correction factor is noted on each thermometer log. See the most current Login SOP for detailed procedures on this calibration procedure.

Data Loggers are used to record refrigerator temperatures. These data loggers are calibrated quarterly with NIST-certified thermometers.

The NIST thermometer should be recalibrated at least every five years or whenever the thermometer has been exposed to temperature extremes.

Refrigerators/Freezers

Each laboratory refrigerator or freezer contains a thermometer capable of measuring to a minimum precision of 0.1°C. The thermometers are kept with the bulb immersed in liquid. Each day of use, the temperatures of the refrigerators are recorded to insure that the refrigerators are within the required designated range. Samples are stored separately from the standards to reduce the risk of contamination.

See the current Catastrophic Failure SOP for the procedure regarding how to handle failed refrigerators or freezers.

Ovens

The ovens contain thermometers graduated by 1° C. The ovens are calibrated quarterly against NIST thermometers and checked each day of use as required and in whatever way is dictated by or appropriate for the method in use.

Analytical and Table Top Balances

The table top balances are capable of weighing to a minimum precision of 0.01 grams. The analytical balances are capable of weighing to a minimum precision of 0.0001 grams. Records are kept of daily calibration checks for the balances in use. Working weights are used in these checks. The balances are annually certified by an outside source and the certifications are on file with the QA/QCO.

Balances, unless otherwise indicated by method specific SOPs, will be checked each day of use with at least two weights that will bracket the working range of the balance for the day. Daily balance checks will be done using working weights that are calibrated annually against Class S weights. Class S weights are calibrated by an external provider as required. The Class S weights are used once a year, or more frequently if required, to assign values to the Working Weights. During the daily balance checks, the working weights are compared to their assigned values and must pass in order to validate the calibration of the balance. The assigned values, as well as the daily checks, for the working weights are recorded in the balance logbook for each balance.

Instrument Calibration

An instrument calibration is the relationship between the known concentrations of a set of calibration standards introduced into an analytical instrument and the measured response they produce. Calibration curve standards are a prepared series of aliquots at various known concentration levels from a primary source reference standard. Specific mathematical types of calibration techniques are outlined in SW-846 8000B and/or 8000C. The entire initial calibration must be performed prior to sample analyses.

The lowest standard in the calibration curve must be at or below the required reporting limit.

Refer to the current SOP to determine the minimum requirement for calibration points.

Most compounds tend to be linear and a linear approach should be favored when linearity is suggested by the calibration data. Non-linear calibration should be considered only when a linear approach cannot be applied. It is not acceptable to use an alternate calibration procedure when a compound fails to perform in the usual manner. When this occurs, it is indicative of instrument issues or operator error.

If a non-linear calibration curve fit is employed, a minimum of six calibration levels must be used for second-order (quadratic) curves.

When more than 5 levels of standards are analyzed in anticipation of using second-order calibration curves, all calibration points MUST be used regardless of the calibration option employed. The highest or lowest calibration point may be excluded for the purpose of narrowing the calibration range and meeting the requirements for a specific calibration option. Otherwise, unjustified exclusion of calibration data is expressly forbidden.

Analytical methods vary in QC acceptance criteria. HEAL follows the method specific guidelines for QC acceptance. The specific acceptance criteria are outlined in the analytical methods and their corresponding SOPs.

pH Meter

The pH meter measures to a precision of 0.01 pH units. The pH calibration logbook contains the calibration before each use, or each day of use, if used more than once per day. It is calibrated using a minimum of 3 certified buffers. Also available with the pH meter is a magnetic stirrer with a temperature sensor. See the current pH SOP (SM4500 H+ B) for specific details regarding calibration of the pH probe.

Other Analytical Instrumentation and Equipment

The conductivity probe is calibrated as needed and checked daily when in use.

Eppendorf (or equivalent brands) pipettes are checked gravimetrically prior to use.

Standards

All of the source reference standards used are ordered from a reliable commercial vendor. A Certificate of Analysis (CoA), which verifies the quality of the standard, accompanies the standards from the vendor. The Certificates of Analysis are dated and stored on file by the Technical Directors or their designee. These standards are traceable to the National Institute of Standards (NIST). When salts are purchased and used as standards the certificate of purity must be obtained from the vendor and filed with the CoAs.

All standard solutions, calibration curve preparations, and all other quality control solutions are labeled in a manner that can be traced back to the original source reference standard. All source reference standards are entered into the LIMS with an appropriate description of the standard. Dilutions of the source reference standard (or any mixes of the source standards) are fully tracked in the LIMS. Standards are labeled with the date opened for use and with an expiration date.

As part of the quality assurance procedures at HEAL, analysts strictly adhere to manufacturer recommendations for storage times/expiration dates and policies of analytical standards and quality control solutions.

Reagents

HEAL ensures that the reagents used are of acceptable quality for their intended purpose. This is accomplished by ordering high quality reagents and adhering to good laboratory practices so as to minimize contamination or chemical degradation. All reagents must meet any specifications noted in the analytical method. Refer to the current Purchase of Consumables SOP for details on how this is accomplished and documented.

Upon receipt, all reagents are assigned a separate ID number, and logged into the LIMS. All reagents shall be labeled with the date received into the laboratory and again with the date opened for use. Recommended shelf life, as defined by the manufacturer, shall be documented and controlled. Dilutions or solutions prepared shall be clearly labeled, dated, and initialed. These solutions are traceable back to their primary reagents and do not extend beyond the expiration date listed for the primary reagent.

All gases used with an instrument shall meet specifications of the manufacturer. All safety requirements that relate to maximum and/or minimum allowed pressure, fitting types, and leak test frequency, shall be followed. When a new tank of gas is placed in use, it shall be checked for leaks and the date put in use will be written in the instrument maintenance logbook.

HEAL continuously monitors the quality of the reagent water and provides the necessary indicators for maintenance of the purification systems in order to assure that the quality of laboratory reagent water meets established criteria for all analytical methods. The majority of HEAL methods utilize medium quality deionized reagent water maintained at a resistivity greater than 1MΩ in accordance with SM1080.

Reagent blank samples are also analyzed to ensure that no contamination is present at detectable levels. The frequency of reagent blank analysis is typically the same as calibration verification samples. Refrigerator storage blanks are stored in the volatiles refrigerator for a period of one week and analyzed and replaced once a week.

8.0 Maintenance

Maintenance logbooks are kept for each major instrument and all support equipment in order to document all repair and maintenance. In the front of the logbook, the following information is included:

Unique Name of the Item or Equipment
Manufacturer
Type of Instrument
Model Number
Serial Number
Date Received and Date Placed into Service
Location of Instrument
Condition of Instrument Upon Receipt

For routine maintenance, the following information shall be included in the log:

Maintenance Date
Maintenance Description
Maintenance Performed by Initials

A manufacturer service agreement (or equivalent) covers most major instrumentation to assure prompt and reliable response to maintenance needs beyond HEAL instrument operator capabilities.

Refer to the current Maintenance and Troubleshooting SOP for each section in the laboratory for further information.

9.0 Data Integrity

For HEAL's policy on ethics and data integrity, see section 3.0 of this document. Upon being hired, and annually thereafter, all employees at HEAL undergo documented data integrity training. All new employees sign an Ethics and Data Integrity Agreement, documenting their understanding of the high standards of integrity required at HEAL and outlining their responsibilities in regards to ethics and data integrity. See the current Document Control Logbook for a copy of this agreement.

In instances of ethical concern, analysts are required to report the known or suspected concern to their Technical Director, the Laboratory Manager, or the QA/QCO. This will be done in a confidential and receptive environment, allowing all employees to privately discuss ethical issues or report items of ethical concern.

Once reported and documented, the ethical concern will be immediately elevated to the Laboratory Manager and the need for an investigation, analyst remediation, or termination will be determined on a case-by-case basis.

All reported instances of ethical concern will be thoroughly documented and handled in a manner sufficient to rectify any breaches in data integrity with an emphasis on preventing similar incidences from happening in the future.

10.0 Quality Control

Internal Quality Control Checks

HEAL utilizes various internal quality control checks, including duplicates, matrix spikes, matrix spike duplicates, method blanks, laboratory control spikes, laboratory control spike duplicates, surrogates, internal standards, calibration standards, quality control charts, proficiency tests and calculated measurement uncertainty.

Refer to the current method SOP to determine the frequency and requirements of all quality controls. In the event that the frequency of analysis is not indicated in the method specific SOP, duplicate samples, laboratory control spikes (LCS), Method Blanks (MB), and matrix spikes and matrix spike duplicates (MS/MSD) are analyzed for every batch of twenty samples.

When sample volume is limited on a test that requires an MS/MSD an LCSD shall be analyzed to demonstrate precision and accuracy and when possible a sample duplicate will be analyzed.

Duplicates are identical tests repeated for the same sample or matrix spike in order to determine the precision of the test method. A Relative Percent Difference (RPD) is calculated as a measure of this precision. Unless indicated in the SOP, the default acceptance limit is </= 20%.

Matrix Spikes and Matrix Spike Duplicates are spiked samples (MS/MSD) that are evaluated with a known added quantity of a target compound. This is to help determine the accuracy of the analyses and to determine the matrix effects on analyte recovery. A percent recovery is calculated to assess the quality of the accuracy. In the event that the acceptance criteria is not outlined in the SOP, a default limit of 70-130% will be utilized. When an MSD is employed an RPD is calculated and when not indicated in the SOP shall be acceptable at </= 20%.

> In an effort to evaluate all received matricies, MS/MSD samples are chosen randomly. Notable exceptions to this policy are when a client requests the MS/MSD be analyzed utilizing their sample or in the event the matrix requires such a significant dilution that utilizing it as an MS/MSD is impractical.

When appropriate for the method, a Method Blank should be analyzed with each batch of samples processed to assess contamination levels in the laboratory. MBs consist of all the reagents measured and treated as they are with samples, except without the samples. This enables the laboratory to ensure clean reagents and procedures. Guidelines should be in place for accepting or rejecting data based on the level of contamination in the blank. In the event that these guidelines are not dictated by the SOP or in client specific work plans, the MB should be less than the MDL reported for the analyte being reported.

It is important to note that the LIMS qualifies samples for Method Blank failures when the amount in the blank is greater than the sample's listed PQL.

A Laboratory Control Spike and Laboratory Control Spike Duplicate (LCS/LCSD) are reagent blanks, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system. Guidelines are outlined in each SOP for the frequency and pass fail requirements for LCS and LCSDs. These limits can be set utilizing control charts as discussed below.

Surrogates are utilized when dictated by method and are substances with properties that mimic the analytes of interest. The surrogate is an analyte that is unlikely to be found in environmental samples. Refer to the appropriate Method and SOP for guidelines on pass/fail requirements for surrogates.

Internal Standards are utilized when dictated by the method and are known amounts of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method. Refer to the appropriate Method and SOP for guidelines on pass/fail requirements for Internal Standards.

Proficiency Test (PT) Samples are samples provided by an unbiased third party. They are typically analyzed twice a year, between five and seven months apart, or at any other interval as defined in the method SOP. They contain a pre-determined concentration of the target compound, which is unknown to HEAL. HEAL's management and all analysts shall ensure that all PT samples are handled in the same manner as real environmental samples utilizing the same staff, methods, procedures, equipment, facilities and frequency of analysis as used for routine analysis of that analyte. When analyzing a PT, HEAL shall employ the same calibration, laboratory quality control and acceptance criteria, sequence of analytical steps, number of replicates and other procedures as used when analyzing routine samples. PT results are reported as normal samples, within the working range of the associated calibration curve. In the event an analyte concentration is less than the PQL, the result shall be reported as less than the PQL.

With regards to analyzing PT Samples HEAL shall not send any PT sample, or portion of a PT sample, to another laboratory for any analysis for which we seek accreditation, or are accredited. HEAL shall not knowingly receive any PT sample or portion of a PT sample from another laboratory for any analysis for which the sending laboratory seeks accreditation, or is accredited. Laboratory management or staff will not communicate with any individual at another laboratory concerning the PT sample. Laboratory management or staff shall not attempt to obtain the assigned value of any PT sample from the PT Provider.

Upon receiving a Not Acceptable PT result for any analyte, a root cause analysis is conducted and the cause of the failure determined and corrected. As defined by TNI, two out of the past three PTs must be acceptable to maintain accreditation for any given analyte. If this requirement is not met, a successful history will be reestablished by the analysis of an additional PT sample. For accredited tests, the PT provider will be notified, when the PT is for corrective action purposes. The analysis dates of successive PT samples for the same TNI accredited analyte shall be at least fifteen days apart.

Calibration standards are standards run to calibrate. Once the calibration is established the same standards can be analyzed as Continuing Calibration Verifications (CCV), used to confirm the consistency of the instrumentation. Calibration standards can be utilized at the beginning and end of each batch, or more frequently as required. Typically Continuing Calibration Blanks (CCB) are run in conjunction with CCVs. Refer to the current method SOP for frequency and pass/fail requirements of CCVs and CCBs.

Control Limits are limits of acceptable ranges of the values of quality control checks. The control limits approximate a 99% confidence interval around the mean recovery. Any matrix spike, surrogate, or LCS results outside of the control limits require further evaluation and assessment. This should begin with the comparison of the results from the samples or matrix spike with the LCS results. If the recoveries of the analytes in the LCS are outside of the control limits, then the problem may lie with the application of the extraction, with cleanup procedures, or with the chromatographic procedure. Once the problem has been identified and addressed, corrective action may include reanalysis of samples or re-extraction followed by reanalysis. When the LCS results are within the control limits, the issue may be related to the sample matrix or to the use of an inappropriate extraction, cleanup, and/or determinative method for the matrix. If the results are to be used for regulatory compliance monitoring, then steps must be taken to demonstrate that the analytes of concern can be determined in the sample matrix at the levels of interest. Data generated with laboratory control samples that fall outside of the established control limits are judged to be generated during an "out-of-control" situation. These data are considered suspect and shall be repeated or reported with qualifiers.

Control limits are to be updated only by Technical Directors, Section Supervisors or the Quality Assurance Officer. Control limits should be established and updated according to the requirements of the method being utilized. When the method does not specify, and control limits are to be generated or updated for a test, the following guidelines shall be utilized.

Limits should typically be generated utilizing the most recent 20-40 data values. In order to obtain an even distribution across multiple instruments and to include more than a single day's worth of data, surrogate limits should be generated using around 100 data values. The data values used shall not reuse values that were included in the previous Control Limit update. The data values shall also be reviewed by the LIMS for any Grubbs Outliers, and if identified, the outliers must be removed prior to generating new limits. The results used to update control limits should meet all other QC criteria associated with the determinative method. For example, MS/MSD recoveries from a GC/MS procedure should be generated from samples analyzed after a valid tune and a valid initial calibration that includes all analytes of interest. Additionally, no analyte should be reported when it is beyond the working range of the calibration currently in use. MS/MSD and surrogate limits should be generated using the same set of extraction, cleanup, and analysis procedures.

All generated limits should be evaluated for appropriateness. Where limits have been established for MS/MSD samples, the LCS/LCSD limits should fall within those limits, as the LCS/LCSD are prepared in a clean matrix. Surrogate limits should be updated using all sample types and should be evaluated to ensure that all instruments as well as a reasonable dispersion across days are represented by the data. LCS/LCSD recovery limits should be evaluated to verify that they are neither inappropriately wide nor unreasonably tight. The default LCS/LCSD acceptance limits of 70-130% and RPD of 20% (or those limits specified by the method for LCS/LCSD and/or CCV acceptability), should be used to help make this evaluation. Technical directors may choose to use warning limits when they feel their generated limits are too wide, or default LCS limits when they feel their limits have become arbitrarily tight.

Once new Control Limits have been established and updated in the LIMS, the Control Charts shall be printed and reviewed by the appropriate section supervisor and primary analyst performing the analysis for possible trends and compared to the previous Control Charts. The technical director initials the control charts, indicating that they have been reviewed and that the updated Limits have been determined to be accurate and appropriate. Any manual alterations to the limits will be documented and justified on the printed control chart. These initialed charts are then filed in the QA/QCO office.

Once established, control limits should be reviewed after every 20-30 data values and updated at least every six months, provided that there are sufficient points to do so. The limits used to evaluate results shall be those in place at the time that the sample was analyzed. Once limits are updated, those limits apply to all subsequent analyses.

When updating surrogate control limits, all data, regardless of sample/QC type, shall be updated together and assigned one set of limits for the same method/matrix.

In the event that there are insufficient data points to update limits that are over a year old, the default limits, as established in the method or SOP, shall be re-instated. Refer to the requirements in SW-846 method 8000B and 8000C for further guidance on generating control limits.

Calculated Measurement Uncertainty is calculated annually using LCSs in order to determine the laboratory specific uncertainty associated with each test method. These uncertainty values are available to our clients upon request and are utilized as a trending tool internally to determine the effectiveness of new variables introduced into the procedure over time.

Client Requested QC

Occasionally certain clients will require QC that is not defined by or covered in the SOPs. These special requests will be issued to all analysts and data reviewers in writing and the analysts and data reviewers will be provided with guidance on how to properly document the client requested deviation/QC in their preparation and analytical batches.

Precision, Accuracy, Detection Levels

Precision

The laboratory uses sample duplicates, laboratory control spike duplicates, and matrix spike duplicates to assess precision in terms of relative percent difference (RPD). HEAL requires the RPD to fall within the 99% confidence interval of established control charts or an RPD of less than 20% if control charts are not available. RPD's greater than these limits are considered out-of-control and require an appropriate response.

$$\text{RPD} = 2 \text{ x } \frac{(\text{Sample Result} - \text{Duplicate Result})}{(\text{Sample Result} + \text{Duplicate Result})} \text{ X } 100$$

Accuracy

The accuracy of an analysis refers to the difference between the calculated value and the actual value of a measurement. The accuracy of a laboratory result is evaluated by comparing the measured amount of QC reference material recovered from a sample and the known amount added. Control limits can be established for each analytical method and sample matrix. Recoveries are assessed to determine the method efficiency and/or the matrix effect.

Analytical accuracy is expressed as the Percent Recovery (%R) of an analyte or parameter. A known amount of analyte is added to an environmental sample before the sample is prepared and subsequently analyzed. The equation used to calculate percent recovery is:

$$\%\text{Recovery} = \{(\text{concentration* recovered})/(\text{concentration* added})\} \text{ X } 100$$

*or amount

HEAL requires that the Percent Recovery to fall within the 99 % confidence interval of established control limits. A value that falls outside of the confidence interval requires a warning and process evaluation. The confidence intervals are calculated by determining the mean and sample standard deviation. If control limits are not available, the range of 80 to 120% is used unless the specific method dictates otherwise. Percent Recoveries outside of this range mandate additional action such as analyses by Method of Standard Additions, additional sample preparation(s) where applicable, method changes, and out-of-control action or data qualification.

Detection Limit

Current practices at HEAL define the Detection Limit (DL) as the smallest amount that can be detected above the baseline noise in a procedure within a stated confidence level.

HEAL presently utilizes an Instrument Detection Limit (IDL), a Method Detection Limit (MDL), and a Practical Quantitation Limit (PQL). The relationship between these levels is approximately
IDL: MDL: PQL = 1:5:5.

The IDL is a measure of the sensitivity of an analytical instrument. The IDL is the amount which, when injected, produces a detectable signal in 99% of the analyses at that concentration. An IDL can be considered the minimum level of analyte concentration that is detectable above random baseline noise.

The MDL is a measure of the sensitivity of an analytical method. MDL studies are required annually for each quality system matrix, technology and analyte, unless indicated otherwise in the referenced method. An MDL determination (as required in 40CFR part 136 Appendix B) consists of replicate spiked samples carried through all necessary preparation steps. The spike concentration is three times the standard deviation of three replicates of spikes. At least seven replicates are spiked and analyzed and their standard deviation(s) calculated. Routine variability is critical in passing the 10 times rule and is best achieved by running the MDLs over different days and when possible over several calibration events. Standard Methods and those methods used for drinking water analysis must have MDL studies that are performed over a period of at least three days in order to include day to day variations. The method detection limit (MDL) can be calculated using the standard deviation according to the formula:

$$MDL = s * t\,(99\%),$$

where t (99%) is the Student's t-value for the 99% confidence interval. The t-value depends on the number of trials used in calculating the sample standard deviation, so choose the appropriate value according to the number of trials.

Number of Trials	t(99%)
6	3.36
7	3.14
8	3.00
9	2.90

The calculated MDL must not be less than 10 times the spiked amount or the study must be performed again with a lower concentration.

Where there are multiple MDL values for the same test method in the LIMS the highest MDL value is utilized.

The PQL is significant because different laboratories can produce different MDLs although they may employ the same analytical procedures, instruments and sample matrices. The PQL is about two to five times the MDL and represents a practical, and routinely achievable, reporting level with a good certainty that the reported value is reliable. It is often determined by regulatory limits. The reported PQL for a sample is dependent on the dilution factor utilized during sample analysis.

In the event that an analyte will not be reported less than the PQL, an MDL study is not required and a PQL check shall be done, at least annually, in place of the MDL study. The PQL check shall consist of a QC sample spiked at or below the PQL. All sample-processing and analysis steps of the analytical method shall be included in the PQL check and shall be done for each quality system matrix, technology, and analyte. A successful check is one where the recovery of each analyte is within the established method acceptance criteria. When this criterion is not defined by the method or SOP, a default limit of +/-50% shall be utilized.

Quality Control Parameter Calculations

Mean

The sample mean is also known as the arithmetic average. It can be calculated by adding all of the appropriate values together, and dividing this sum by the number of values.

$$\text{Average} = (\Sigma x_I) / n$$

x_I = the value x in the I^{th} trial
n = the number of trials

Standard Deviation

The sample standard deviation, represented by s, is a measure of dispersion. The dispersion is considered to be the difference between the average and each of the values x_i. The variance, s^2, can be calculated by summing the squares of the differences and dividing by the number of differences. The sample standard deviation, s, can be found by taking the square root of the variance.

$$\text{Standard deviation} = s = [\underline{\Sigma (x_I - \text{average})}^2 /(n - 1)]^{½}$$

Percent Recovery (LCS and LCSD)

$$\text{Percent Recovery} = \frac{(\text{Spike Sample Result})}{(\text{Spike Added})} \text{X100}$$

Percent Recovery (MS, MSD)

$$\text{Percent Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{(\text{Spike Added})} \text{X100}$$

Control Limits

Control Limits are calculated by the LIMS using the average percent recovery (x), and the standard deviation (s).

$$\text{Upper Control Limit} = x + 3s$$
$$\text{Lower Control Limit} = x - 3s$$

These control limits approximate a 99% confidence interval around the mean recovery.

Grubbs Outliers

Grubbs Outliers are calculated by the LIMS during the generation of control limits and uncertainties. An outlier is an observation that appears to deviate markedly from other observations in the sample set and are removed, unless documented otherwise.

Identify both the lowest and highest values in the sample set. Use the following equations to determine the T values.

$$T = \frac{x_{max} - x_{mean}}{sd} \quad \text{(for the largest value)}$$

$$T = \frac{x_{mean} - x_{min}}{sd} \quad \text{(for the smallest value)}$$

Compare the T values to the Grubbs' critical value table. If either value of T is greater than the critical value (assuming a 5% risk) for the sample size, the point(s) must be dropped then the calculation repeated for both the lowest and highest value using the new mean and standard deviation.
The Grubbs test is repeated until there are no longer any outliers detected. Keep in mind you must have at least 20 data points available to generate your limits.

RPD (Relative Percent Difference)

Analytical precision is expressed as a percentage of the difference between the results of duplicate samples for a given analyst. Relative percent difference (RPD) is calculated as follows:

$$RPD = 2 \times \frac{(\text{Sample Result} - \text{Duplicate Result})}{(\text{Sample Result} + \text{Duplicate Result})} \times 100$$

Uncertainty Measurements

Uncertainty, as defined by ISO, is the parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurement. Ultimately, uncertainty measurements are used to state how good a test result is and to allow the end user of the data to properly interpret their reported data. All procedures allow for some uncertainty. For most analyses, the components and estimates of uncertainty are reduced by following well-established test methods. To further reduce uncertainty, results generally are not reported below the lowest calibration point (PQL) or above the highest calibration point (UQL). Understanding that there are many influential quantities affecting a measurement result, so many in fact that it is impossible to identify all of them, HEAL calculates measurement uncertainty at least annually using LCSs. These estimations of measurement uncertainty are kept on file in the method folders in the QA/QC office.

Measurement Uncertainty contributors are those that may be determined statistically. These shall be generated by estimating the overall uncertainty in the entire analytical process by measuring the dispersion of values obtained from laboratory control samples over time. At least 20 of the most recent LCS data points are gathered. The standard deviation(s) is calculated using these LCS data points. Since it can be assumed that the possible estimated values of the spikes are approximately normally distributed with approximate standard deviation(s), the unknown value of the spike is believed to lie in 95% confidence interval, corresponding to an uncertainty range of +/- 2(s).

Calculate standard deviation (s) and 95% confidence interval according to the following formulae:

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{(n-1)}}$$

Where: s = standard deviation
x = number in series
$\bar{x}$ = calculated mean of series
n = number of samples taken

$$95\%\ confidence = 2 \times s$$

Example: Assuming that after gathering 20 of the most recent LCS results for Bromide, we have calculated the standard deviations of the values and achieved a result of 0.0326, our measurement of uncertainty for Bromide (at 95% confidence = 2 x s) is 0.0652.

Total Nitrogen

Total nitrogen is calculated as follows:

Total Nitrogen = TKN + NO_2 + NO_3

Langelier Saturation Index

The Langelier Saturation Index (LSI) is calculated as follows:

Solids Factor (SF) =(Log10[TDS] - 1) / 10
Ca Hardness Factor (HF) = Log10([Ca] x 2.497) - 0.4
Alkalinity Factor (AF) = Log10[Alkalinity]
Temp. Factor (TF) = -13.12 x Log10(°C + 273) + 34.55
pHs (pH @ saturation) =(9.3 + SF + TF) - (HF + AF)
LSI = pH - pH_s

Calibration Calculations

1. Response Factor or Calibration Factor:

   $RF = ((A_x)(C_{is}))/((A_{is})(C_x))$ $CF = (A_x)/(C_x)$

   a. Average RF or CF

      $RF_{AVE} = \Sigma\, RF_i / n$

   b. Standard Deviation

      $s = SQRT\,\{ [\, \Sigma\, (RF_i - RF_{AVE})^2 \,] / (n-1) \}$

   c. Relative Standard Deviation

      $RSD = s / RF_{AVE}$

   Where:
   A_x = Area of the compound
   C_x = Concentration of the compound
   A_{is} = Area of the internal standard
   C_{is} = Concentration of the internal standard
   n = number of pairs of data
   RF_i = Response Factor (or other determined value)
   RF_{AVE} = Average of all the response factors
   Σ = the sum of all the individual values

2. Linear Regression

   $y=mx+b$

   a. Slope (m)

      $m = (n\Sigma x_i y_i - (n\Sigma x_i)^*(n\Sigma y_i)) / (n\Sigma x_i^2 - (\Sigma x_i)^2)$

   b. Intercept (b)

      $b = y_{AVE} - m^*(x_{AVE})$

   c. Correlation Coefficient (cc)

$$CC\ (r) = \{ \Sigma((x_i - x_{ave})*(y_i - y_{ave})) \} / \{ SQRT((\Sigma(x_i - x_{ave})^2)*(\Sigma(y_i - y_{ave})^2)) \}$$

Or

$$CC\ (r) = [(\Sigma w * \Sigma wxy) - (\Sigma wx * \Sigma wy)] / (sqrt(([(\Sigma w * \Sigma wx^2) - (\Sigma wx * \Sigma wx)] * [(\Sigma w * \Sigma wy^2) - (\Sigma wy * \Sigma wy)])))]$$

d. Coefficient of Determination

$$COD\ (r^2) = CC*CC$$

Where:
y = Response (Area) Ratio A_x/A_{is}
x = Concentration Ratio C_x/C_{is}
m = slope
b = intercept
n = number of replicate x,y pairs
x_i = individual values for independent variable
y_i = individual values for dependent variable
Σ = the sum of all the individual values
x_{ave} = average of the x values
y_{ave} = average of the y values
w = weighting factor, for equal weighting $w=1$

3. Quadratic Regression

$$y = ax^2 + bx + c$$

a. Coefficient of Determination

$$COD\ (r^2) = (\Sigma(y_i - y_{ave})^2 - \{[(n-1)/(n-p)] * [\Sigma(y_i - Y_i)^2]\}) / \Sigma(y_i - y_{ave})^2$$

Where:
y = Response (Area) Ratio A_x/A_{is}
x = Concentration Ratio C_x/C_{is}
a = x^2 coefficient
b = x coefficient
c = intercept
y_i = individual values for each dependent variable
x_i = individual values for each independent variable
y_{ave} = average of the y values
n = number of pairs of data
p = number of parameters in the polynomial equation (I.e., 3 for third order, 2 for second order)

$Yi = ((2{*}a{*}(C_x/C_{is}){^\wedge}2)-b{^\wedge}2+b+(4{*}a{*}c))/(4a)$

b. Coefficients (a,b,c) of a Quadratic Regression

$a = S_{(x2y)}S_{(xx)}-S_{(xy)}S_{(xx2)} / S_{(xx)}S_{(x2x2)}-[S_{(xx2)}]^2$

$b = S_{(xy)}S_{(x2x2)}-S_{(x2y)}S_{(xx2)} / S_{(xx)}S_{(x2x2)}-[S_{(xx2)}]^2$

$c = [(\Sigma yw)/n] - b{*}[(\Sigma xw)/n] - a{*}[\Sigma(x^2w)/n]$

Where:
n = number of replicate x,y pairs
x = x values
y = y values
$w = S^{-2} / (\Sigma S^{-2}/n)$
$S_{(xx)} = (\Sigma x^2w) - [(\Sigma xw)^2 / n]$
$S_{(xy)} = (\Sigma xyw) - [(\Sigma xw){*}(\Sigma yw) / n]$
$S_{(xx2)} = (\Sigma x^3w) - [(\Sigma xw){*}(\Sigma x^2w) / n]$
$S_{(x2y)} = (\Sigma x^2yw) - [(\Sigma x^2w){*}(\Sigma yw) / n]$
$S_{(x2x2)} = (\Sigma x^4w) - [(\Sigma x^2w)^2 / n]$
Or If unweighted calibration, w=1
S(xx) = (Sx2) - [(Sx)2 / n]
S(xy) = (Sxy) - [(Sx)*(Sy) / n]
S(xx2) = (Sx3) - [(Sx)*(Sx2) / n]
S(x2y) = (Sx2y) - [(Sx2)*(Sy) / n]
S(x2x2) = (Sx4) - [(Sx2)2 / n]

Weighting

Weighting of 1/x or 1/x^2 is permissible for linear calibrations. Weighting shall not be employed for quadratic calibrations. When weighting, use the above equations by substituting x for 1/x or 1/x.

Concentration Calculations

On-Column Concentration for Average RRF Calibration using Internal Standard

On-Column Concentration $C_x = ((A_x)(C_{is}))/((A_{is})(RF_{AVE}))$

On-Column Concentration for Average CF Calibration using External Standard

On-Column Concentration $C_x = (A_x)/(CF_{AVE})$

On-Column Concentration for Linear Calibration

If determining an external standard, then exclude the A_{is} and C_{is} for internal standards

On-Column Concentration C_x = ((Absolute{[(A_x)/(A_{is})] - b})/m) * C_{is}

Where: m = slope
b = intercept
A_x = Area of the Sample
C_{is} = Concentration of the Internal Standard
A_{is} = Area of the Internal Standard

On-Column Concentration for Quadratic Calibration

If determining an external standard, then exclude the A_{is} and C_{is} for internal standards

On-Column Concentration =[(+SQRT(b^2-(4*a*(c-y)))-b)/(2*a)] * C_{is}

Where: a = x^2 coefficient
b = x coefficient
c = intercept
y = Area Ratio = A_x/A_{is}
C_{is} = Concentration of the Internal Standard

Final Concentration (Wet Weight)

$$\text{Concentration for Extracted Samples} = \frac{\text{(On-Column Conc)(Dilution)(Final Volume)}}{\text{(Initial Amount)(Injection Volume)}}$$

$$\text{Concentration for Purged Samples} = \frac{\text{(On-Column Conc)(Purged Amount)(Dilution)}}{\text{(Purged Amount)}}$$

Dry Weight Concentration

$$\text{Dry Weight Concentration} = \frac{\text{Final Concentration Wet Weight} \; {*}100}{\text{\% Solids}}$$

Percent Difference

$$\text{\% Difference} = \frac{\text{Absolute(Continuing Calibration RRF - Average RRF)}}{\text{Average RRF}} \; {*}\,100$$

Percent Drift

$$\text{\% Drift} = \frac{\text{Absolute(Calculated Concentration - Theoretical Concentration)}}{\text{Theoretical Concentration}} \; {*}\,100$$

Dilution Factor

Dilution Factor =(Volume of Solvent + Solute) / Volume of Solute

Relative Retention Time

RRT =RT of Compound / RT of ISTD

Breakdown Percent

$$\text{Breakdown} = \frac{\text{Area of DDD} + \text{Area of DDE}}{\text{Average (DDT, DDE and DDD)}}$$

-or-

$$\frac{\text{Area of Endrin Ketone} + \text{Area of Endrin Aldehyde}}{\text{Average (Endrin, Endrin Ketone, Endrin Aldehyde)}}$$

11.0 Data Reduction, Validation, Reporting, and Record Keeping

All data reported must be of the highest possible accuracy and quality. During the processes of data reduction, validation, and report generation, all work is thoroughly checked to insure that error is minimized.

Data Reduction

The analyst who generated the data usually performs the data reduction. The calculations include evaluation of surrogate recoveries (where applicable), and other miscellaneous calculations related to the sample quantitation.

If the results are computer generated, then the formulas must be confirmed by hand calculations, at minimum, one per batch.

See the current Data Validation SOP for details regarding data reduction.

Validation

A senior analyst, most often the section supervisor, validates the data. All data undergoes peer review. If an error is detected, it is brought to the analyst's attention so that he or she can rectify the error, and perform further checks to ensure that all data for that batch is sound. Previous and/or common mistakes are stringently monitored throughout the validation process. Data is reported using appropriate significant figure criteria. In most cases, two significant digits are utilized, but three significant digits can be used in QC calculations. Significant digits are not rounded until after the last step of a sample calculation. All final reports undergo a review by the laboratory manager, the project manager, or their designee, to provide a logical review of all results before they are released to the client.

If data is to be manually transferred between media, the transcribed data is checked by a peer. This includes data typing, computer data entry, chromatographic data transfer, data table inclusion to a cover letter, or when data results are combined with other data fields.

All hand-written data from run logs, analytical standard logbooks, hand-entered data logbooks, or on instrument-generated chromatograms, are systematically archived should the need for future retrieval arise.

See the current Data Validation SOP for details regarding data validation.

Reports and Records

All records at HEAL are retained and maintained through the procedures outlined in the most recent version of the Records Control SOP.

Sample reports are compiled by the Laboratory Information Management System (LIMS). Most data is transferred directly from the instruments to the LIMS. After being processed by the analyst and reviewed by a data reviewer, final reports are approved and signed by the senior laboratory management. A comparative analysis of the data is performed at this point. For example, if TKN and NH3 are analyzed on the same sample, the NH3 result should never be greater than the TKN result. Lab results and reports are released only to appropriately designated individuals. Release of the data can be by fax, email, electronic deliverables, or mailed hard copy.

When a project is completed, the final report, chain of custody, any relevant supporting data, and the quality assurance/control worksheets are scanned as a .pdf file onto the main server. Original client folders are kept on file and are arranged by project number. Additionally, all electronic data is backed up routinely on the HEAL main server. The backup includes raw data, chromatograms, and report documents. Hard copies of chromatograms are stored separately according to the instrument and the analysis date. All records and analytical data reports are retained in a secure location as permanent records for a minimum period of five years (unless specified otherwise in a client contract). Access to archived information shall be documented with an access log. Access to archived electronic reports and data will be password protected. In the event that HEAL transfers ownership or terminates business practices, complete records will be maintained or transferred according to the client's instructions.

After issuance, the original report shall remain unchanged. If a correction to the report is necessary, then an additional document shall be issued. This document shall have a title of "Addendum to Test Report or Correction to Original Report", or equivalent. Demonstration of original report integrity comes in two forms. First, the report date is included on each page of the final report. Second, each page is numbered in sequential order, making the addition or omission of any data page(s) readily detectable.

12.0 Corrective Action

Refer to the most recent version of the Data Validation SOP for the procedure utilized in filling out a Corrective Action Report. A blank copy of the corrective action report is available in the current Document Control Logbook.

The limits that have been defined for data acceptability also form the basis for corrective action initiation. Initiation of corrective action occurs when the data generated from continuing calibration standard, sample surrogate recovery, laboratory control spike, matrix spike, or sample duplicates exceed acceptance criteria. If corrective action is necessary, the analyst or the section supervisor will coordinate to take the following guidelines into consideration in order to determine and correct the measurement system deficiency:

Check all calculations and data measurements systems (Calibrations, reagents, instrument performance checks, etc.).

Assure that proper procedures were followed.

Unforeseen problems that arise during sample preparation and/or sample analysis that lead to treating a sample differently from documented procedures shall be documented with a corrective action report. The section supervisor and laboratory manager shall be made aware of the problem at the time of the occurrence. See the appropriate SOP regarding departures from documented procedures.

Continuing calibration standards below acceptance criteria cannot be used for reporting analytical data unless method specific criteria states otherwise.

Continuing calibration standards above acceptance criteria can be used to report data as long as the failure is isolated to a single standard and the corresponding samples are non-detect for the failing analyte.

Samples with non-compliant surrogate recoveries should be reanalyzed, unless deemed un-necessary by the supervisor for matrix, historical data, or other analysis-related anomalies.

Laboratory and Matrix Spike acceptance criteria vary significantly depending on method and matrix. Analysts and supervisors meet and discuss appropriate corrective action measures as spike failures occur.

In the event that results must be reported with associated QC failures, the data must be qualified appropriately to notify the end user of the QC failure.

Sample duplicates with RPD values outside control limits require supervisor evaluation and possible reanalysis.

A second mechanism for initiation of corrective action is that resulting from Quality Assurance performance audits, system audits, inter- and intra-laboratory comparison studies. Corrective Actions initiated through this mechanism will be monitored and coordinated by the laboratory QA/QCO.

All corrective action forms are entered in the LIMS and included with the raw data for peer review, signed by the technical director of the section and included in the case narrative to the client whose samples were affected. All Corrective action forms in the LIMS are reviewed by the QA/QCO.

13.0 Quality Assurance Audits, Reports and Complaints

Internal/External Systems' Audits, Performance Evaluations, and Complaints

Several procedures are used to assess the effectiveness of the quality control system. One of these methods includes internal performance evaluations, which are conducted by the use of control samples, replicate measurements, and control charts. External performance audits, which are conducted by the use of inter-laboratory checks, such as participation in laboratory evaluation programs and performance evaluation samples available from a NELAC-accredited Proficiency Standard Vendor, are another method.

Proficiency samples will be obtained twice per year from an appropriate vendor for all tests and matrices for which we are accredited and for which PTs are available. HEAL participates in soil, waste water, drinking water, and underground storage tank PT studies. Copies of results are available upon request. HEAL's management and all analysts shall ensure that all PT samples are handled in the same manner as real environmental samples utilizing the same staff, methods, procedures, equipment, facilities, and frequency of analysis as used for routine analysis of that analyte. When analyzing a PT, HEAL shall employ the same calibration, laboratory quality control and acceptance criteria, sequence of analytical steps, number of replicates, and other procedures as used when analyzing routine samples.

With regards to analyzing PT Samples, HEAL shall not send any PT sample, or portion of a PT sample, to another laboratory for any analysis for which we seek accreditation, or are accredited. HEAL shall not knowingly receive any PT sample or portion of a PT sample from another laboratory for any analysis for which the sending laboratory seeks accreditation, or is accredited. Laboratory management or staff will not communicate with any individual at another laboratory concerning the PT sample. Laboratory management or staff shall not attempt to obtain the assigned value of any PT sample from the PT Provider.

Internal Audits are performed annually by the QA/QCO in accordance with the current Internal Audit SOP. The system audit consists of a qualitative inspection of the QA system in the laboratory and an assessment of the adequacy of the physical facilities for sampling, calibration, and measurement. This audit includes a careful evaluation and review of laboratory quality control procedures. Internal audits are performed using the guidelines outlined below, which include, but are not limited to:

1. Review of staff qualifications, demonstration of capability, and personnel training programs
2. Storage and handling of reagents, standards, and samples
3. Standard preparation logbook and LIMS procedures
4. Extraction logbooks
5. Raw data logbooks
6. Analytical logbooks or batch printouts and instrument maintenance logbooks

7. Data review procedures
8. Corrective action procedures
9. Review of data packages, which is performed regularly by the lab manager/QA Officer.

The QA/QCO will conduct these audits on an annual basis.

Management Reviews

HEAL management shall periodically, and at least annually, conduct a review of the laboratory's quality system and environmental testing activities to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements. The review shall take account of:

1. the suitability and implementation of policies and procedures
2. reports from managerial and supervisory personnel
3. the outcome of recent internal audits
4. corrective and preventive actions
5. assessments by external bodies
6. the results of inter-laboratory comparisons or proficiency tests
7. changes in volume and type of work
8. client feed back
9. complaints
10. other relevant factors, such as laboratory health and safety, QC activities, resources, and staff training.

Findings from management reviews and the actions that arise from them shall be recorded and any corrective actions that arise shall be completed in an appropriate and agreed upon timescale.

Complaints

Complaints from clients are documented and given to the laboratory manager. The lab manager shall review the information and contact the client. If doubt is raised concerning the laboratory's policies or procedures, then an audit of the section or sections may be performed. All records of complaints and subsequent actions shall be maintained in the client compliant logbook for five years unless otherwise stated.

Internal and External Reports

The QA/QCO is responsible for preparation and submission of quality assurance reports to the appropriate management personnel as problems and issues arise. These reports include the assessment of measurement systems, data precision and accuracy, and the results of performance and system audits. Additionally, they include significant QA problems, corrective actions, and recommended resolution measures. Reports of these Quality Assurance Audits describe the particular activities audited, procedures utilized in the examination and evaluation of laboratory records, and data validation procedures. Finally, there are procedures for evaluating the performance of Quality Control and Quality Assurance activities, and laboratory deficiencies and the implementation of corrective actions with the review requirements.

14.0 References (Analytical Protocols Utilized at HEAL)

1. Analytical Chemistry of PCB's. Erickson, Mitchell D., CRC Press, Inc. 1992.
2. Diagnosis & Improvement of Saline & Alkali Soils. Agriculture Handbook No. 60, USDA, 1954
3. Environmental Perspective on the Emerging Oil Shale Industry, EPA Oil & Shale Research Group.
4. Field and Laboratory Methods Applicable to Overburdens and Mine Soils, USEPA, EPA-600/2-78-054, March 1978
5. Handbook of Chemistry and Physics, 62nd Edition, CRC Press, Inc. 1981-1982.
6. Handbook on Reference Methods for Soil Testing, The Council on Soil Testing & Plant Analysis, 1980 and 1992
7. Laboratory Procedures for Analyses of Oilfield Waste. Department of Natural Resources, Office of Conservation, Injection and Mining Division, Louisiana, August 1988
8. Langelier index calculation. http://www.corrosion-doctors.org/NaturalWaters/Langelier.htm.
9. Manual for the Certification of Laboratories Analyzing Drinking Water, Criteria and procedures Quality Assurance Fifth Edition, U.S. Environmental Protection Agency, January 2005.
10. Manual of Operating Procedures for the Analysis of Selected Soil, Water, Plant Tissue and Wastes Chemical and physical Parameter. Soil, Water, and Plant Analysis Laboratory, Dept. of Soil and Water Science, The University of Arizona, August 1989
11. The Merck Index, Eleventh Edition, Merck & Co., Inc. 1989.
12. Methods for Chemical Analysis of Water and Wastes, USEPA, EPA-600/4-79-020, March 1979 and as amended December, 1982 (EPA-600/4-82-055)
13. Methods for the Determination of Metals in Environmental Samples, USEPA, EPA-600/4-91-010, June 1991
14. Methods of Soil Analysis: Parts 1 & 2, 2nd Edition, Agronomy Society of America, Monograph 9
15. Polycyclic Aromatic Hydrocarbons in Water Systems, CRC Press, Inc.

16. Procedures for Collecting Soil Samples and Methods of Analysis for Soil Survey. USDA Soil Conservation Service, SSIR No. 1

17. Quality Systems for Analytical Services, Revision 2.2, U.S. Department of Energy, October 2006.

18. Sampling Procedures and Chemical Methods in Use at the U.S. Salinity Laboratory for Characterizing Salt-Affected Soils and Water. USDA Salinity Laboratory.

19. Soil Survey Laboratory Methods Manual. Soil Survey Laboratory Staff. Soil Survey Investigations Report No. 42, version 2.0, August 1992.

20. Soil Testing Methods Used at Colorado State University for the Evaluation of Fertility, Salinity and Trace Element Toxicity, Technical Bulletin LT B88-2 January, 1988

21. Standard Methods for the Examination of Water and Wastewater: AOHA, AWWA, and WPCG; 20th Edition, 1999.

22. Technical Notes on Drinking Water Methods, U.S. Environmental Protection Agency, October 1994.

23. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, USEPA SW-846, 3rd Edition, Updates I, II, IIA, IIB, III, December, 1996.

Appendix D

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413
Phone #: 505-632-4135
email or Fax#:
QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
Accreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name: 4-28-15
River Terrace Lowflow
Project #:
Project Manager:
Sampler: Bob + MATT
On Ice: ~~☐ Yes~~ ☒ No
Sample Temperature: ~~[illegible]~~ N/A

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C14	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX only	8270 (Semi-VOA)					Air Bubbles (Y or N)
-15	8:00	Air	Tp-13	Tedlar Bag		-001			X							X						
	8:15		Tp-12			-002			X							X						
	8:30		Tp-11			-003			X							X						
	8:45		Tp-10			-004			X							X						
	9:00		Tp-3			-005			X							X						
	9:45		Tp-7			-006			X							X						
	10:00		DW-1			-007			X							X						

Date:	Time:	Relinquished by:	Received by:	Date	Time
-28-15	1500	Robert Krakow	Christ Walte	4/28/15	1500
4/28/15	1820	Christa Walters		04/29/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR4990
Bloomfield, NM 87413
Phone #: 505-632-4135
email or Fax#:
QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
Accreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name: 4-28-15
River Terrace Low flow
Project #:
Project Manager:
Sampler: Bob + MATT
On Ice: ☐ Yes ☒ No
Sample Temperature: N/A

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www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C15	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [illegible])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX only	8270 (Semi-VOA)					Air Bubbles (Y or N)
-28-15	10:15	Air	Dw-3	Tedlar Bag		-001			X							X						
	11:30		Mw-49			-002			X							X						
	9:15		~~A~~ Tp-5			-003			X							X						
	10:45		Tp-6			-004			X							X						
	11:00		Tp-8			-005			X							X						
	11:00		Tp-8 Dup			-006			X							X						
	9:30		Tp-9			-007			X							X						

Date:	Time:	Relinquished by:	Received by:	Date	Time
-28-15	1500	Robert Brakon	Christie Walter	4/28/15	1500
1/28/15	1820	Christie Walter		04/29/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report

Chain-of-Custody Record

HALL ENVIRONMENTAL ANALYSIS LABORATORY

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4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other ____________

☐ EDD (Type) ____________

Turn-Around Time:
☒ Standard ☐ Rush ____________

Project Name: 4-28-15
River Terrace Lowflow

Project #:
PO# 12610954

Project Manager:

Sampler: Bob & MATT

On Ice: ☒ Yes ☐ No

Sample Temperature: 3.4

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C17	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals Pb only	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Ext, 8015B				Air Bubbles (Y or N)
8-15	10:15	H2O	DW-3	5-VOA	HCl	-001			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3								X									
	9:15		TP-5	5-VOA	HCl	-002			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3								X									
	10:45		TP-6	5-VOA	HCl	-003			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3								X									
	11:00		TP-8	5-VOA	HCl	-004			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3								X									

Date:	Time:	Relinquished by:	Received by:	Date	Time
-28-15	1500	Robert Brakow	Christine Walters	4/28/15	1500
28/15	1820	Christine Walters		04/29/15	0700

Remarks:

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413
Phone #: 505-632-4135
email or Fax#:
QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
Accreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name: 4-28-15
River Terrace Low flow
Project #:
PO# 12610954
Project Manager:
Sampler: Bob + MATT
On Ice: ☒ Yes ☐ No
Sample Temperature: 3.4

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4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C17	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted]	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals Pb only	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Ext. 8015B				Air Bubbles (Y or N)
4-28-15	11:00	H2O	Tp-8 Dup	5-VOA	HCl	-005			X							X						
				1-500ml	Amber													X				
				1-500ml	HNO3								X									
	9:30		Tp-9	5-VOA	HCl	-006			X							X						
				1-500ml	Amber													X				
				1-500ml	HNO3								X									
	11:30		MW-49	5-VOA	HCl	-007			X							X						
				1-500ml	Amber													X				
				1-500ml	HNO3								X									

Date:	Time:	Relinquished by:	Received by:	Date	Time
4-28-15	1500	Robert Krakow	Christina Walter	4/28/15	1500
4/28/15	1820	Christina Walter		04/29/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

lient: WesTerN RefiNiNg

lailing Address: #50 CR 4990
Bloomfield, NM 87413

'hone #: 505-632-4135

mail or Fax#:

A/QC Package:
] Standard ☒ Level 4 (Full Validation)

ccreditation
] NELAP ☐ Other ______

] EDD (Type) ______

Turn-Around Time:
☒ Standard ☐ Rush______

Project Name: 4-28-15
River Terrace Low flow-BiANNual

Project #:
PO#12610954

Project Manager:

Sampler: Bob+MATT

On Ice: ☒ Yes ☐ No

Sample Temperature: 3.4

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4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C22	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	~~8260B (VOA)~~ BTEX, MTBE only	8270 (Semi-VOA)	DRO EXT 8015B	Total Metal Hg only	Total Metal Pb only		Air Bubbles (Y or N)
-15	10:00	H_2O	DW-1	5-VoA	HCl	-001			X							X						
				1-500ml	amber													X				
				1-500ml	HNO_3														X			
	9:45		TP-7	5-VOA	HCl	-002			X							X						
				1-500ml	amber													X				
				1-500ml	HNO_3															X		
	9:00		TP-3 4	5-VOA	HCl	-003			X							X						
			CS 04/30/15	1-500ml	amber													X				
				1-500ml	HNO_3															X		
	8:45		TP-10	5-VOA	HCl	-004			X							X						
				1-500ml	amber													X				
				1-500ml	HNO_3															X		

Date:	Time:	Relinquished by:	Received by:	Date	Time
28-15	1500	Robert Krakow	Christa Waite	4/28/15	1500
/28/15	1820	Christa Waite		04/29/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

lient: WesTerN RefiNiNg

ailing Address: #50 CR 4990
Bloomfield, NM 87413
hone #: 505-632-4135
mail or Fax#:
A/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
ccreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name: 4-28-15
River Terrace Low Flow-BiANNual
Project #:
PO#12610954
Project Manager:

Sampler: Bob & MATT
On Ice: ☒ Yes ☐ No
Sample Temperature: 3,4

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Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C22	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Ext. 8015B	TOTAL MeTAl Pb only			Air Bubbles (Y or N)
28-15	8:30	H_2O	TP-11	5-VOA	HCl	-005			X							X						
				1-500ml	amber													X				
				1-500ml	HNO_3														X			
	8:15		TP-12	5-VOA	HCl	-006			X							X						
				1-500ml	amber													X				
				1-500ml	HNO_3														X			
	8:00		Tp-13	5-VoA	HCl	-007			X							X						
				1-500ml	amber													X				
				1-500ml	HNO_3														X			
			Trip Blank CS 04/30/15													X						

Date:	Time:	Relinquished by:	Received by:	Date	Time
28.15	1500	Robert Krakow	Christa Waele	4/28/15	1500
4/28/15	1820	Christa Waele		04/29/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

Client: WesTerN Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413
Phone #: 505-632-4135
email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC - 1-5-15

Project #:

Project Manager:

Sampler: Bob
On Ice: ☒ Yes ☐ No
Sample Temperature: 1.8

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1501054	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO EXT, 8015B				Air Bubbles (Y or N)
-5-15	1030	H_2O	GAC - LAg	5-VOA	HCl	-001			X							X						
			\	1-500	amber													X				
	1040		GAC - Lead	5-VOA	HCl	-002			X							X						
			\	1-500	amber													X				
	1050		GAC - inlet	5-VOA	HCl	-003			X							X						
			\	1-500	amber													X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
1-5-15	1457	Robert Krakow	Christie White	1/5/15	1457
1/5/15	1822	Christie White		01/06/15	0710

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Client: Western Refining

Mailing Address: #50 CR 4990

Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:

☐ Standard ☒ Level 4 (Full Validation)

Accreditation

☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:

☒ Standard ☐ **Rush**

Project Name: GAC 2-2-15

Project #: 13010954 per Bob Ag 02/05

Project Manager:

Sampler: Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.2

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1502055	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE	8270 (Semi-VOA)	DRO-Ext, 8015B				Air Bubbles (Y or N)
-2-15	9:15	H_2O	GAC-inleT	5-VOA	HCl	-001			X							X						
|	\	|	\	1-500ml	amber													X				
|	9:25	|	GAC-[redacted]Lead	5-VOA	HCl	-002			X							X						
|	\	|	\	1-500ml	amber													X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-2-15	1556	Robert Krakow	Cht Walt	2/2/15	1556
2/2/15	1744	Cht Walt		02/03/15	0920

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413
Phone #: 505-632-4135
email or Fax#:
QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
Accreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name:
GAC 3-2-15
Project #:

Project Manager:

Sampler: Bob
On Ice: ☒ Yes ☐ No
Sample Temperature: 1.4

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1503057	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted]	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX/MTBE only	8270 (Semi-VOA)	DRO-Extended 8015B				Air Bubbles (Y or N)
-15	9:20	H2O	GAC-inlet	4-VOA	HCl	-001			X							X						
				1-500ml	amber	-001												X				
	9:10		GAC-Lead	4-VOA	HCl	-002			X							X						
				1-500ml	amber	-002												X				
	9:00		GAC-Lag	4-VOA	HCl	-003			X							X						
				1-500ml	amber	-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-2-15	1320	Robert Krakow	Christina Walters	3/2/15	1320
/2/15	1737	Christina Walters		03/03/15	0720

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

Client: WesTerN RefiNiNg

Mailing Address: #50 CR 4990
Bloomfield, NM 87413
Phone #: 505-632-4135
email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC 4-1-15

Project #:
PO# 12610954

Project Manager:

Sampler: Bob
On Ice: ☒ Yes ☐ No
Sample Temperature: 1.8

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504079	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / DRO / [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO EXT. 8015B				Air Bubbles (Y or N)
4-1-15	10:30	H2O	GAC-Lag	5-VOA	HCl	-001			X							X						
|		|	\	1-500ml	amber	-001												X				
|	10:45	|	GAC-Lead	5-VOA	HCl	-002			X							X						
|		|	\	1-500ml	amber	-002												X				
|	10:55	|	GAC-inlet	5-VOA	HCl	-003			X							X						
|		|	\	1-500ml	amber	-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
4-1-15	1624	Robert Krakow	Christa Waite	4/1/15	1624
4/1/15	1825	Christa Waite		04/02/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Client: WesTerN RefiNiNg

Mailing Address: #50 CR 4990
BloomField NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: 5-6-15
RiverTerrace GAC

Project #:
PO#12610954

Project Manager:

Sampler: Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.8

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1505293	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted]	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA)	8260 VOA [redacted] BTEX, MTBE only	DRO-Ext. 8015B				Air Bubbles (Y or N)
-15	10:00	H2O	GAC-lead	5-VoA	HCl	-001			X								X					
			\	1-500ml	amber	-001												X				
	10:10		GAC-iNlet	5-VoA	HCl	-002			X								X					
			\	1-500ml	amber	-002												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-6-15	1405	Robert Krakow	Christa Waite	5/6/15	1405
/6/15	1740	Christa Waite		05/07/15	0740

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413
Phone #: 505-632-4135
email or Fax#:
QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
Accreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name:
GAC 6-1-15
Project #:
Project Manager:
Sampler: Bob
On Ice: ☒ Yes ☐ No
Sample Temperature: 1.3

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1506059	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted]	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO·EXT. 8015B				Air Bubbles (Y or N)
-1-15	8:00	H_2O	Lead	5-VOA	HCl	-001			X							X						
	\		\	1-500ml	amber													X				
	8:15		inlet	5-VOA	HCl	-002			X							X						
	\		\	1-500ml	amber													X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-1-15	1250	Robert Krakow	Christina Waltz	6/1/15	1250
1/15	1834	Christina Waltz		06/02/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

Client: WesTern Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other ____________

☐ EDD (Type) ____________

Turn-Around Time:
☒ Standard ☐ Rush ____________

Project Name: GAC 3rd QTR 7-1-15

Project #: PO# 12610954

Project Manager:

Sampler: Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.0

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1507084	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted]	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Ext. 8015B				Air Bubbles (Y or N)
-15	7:30	H2O	GAC - Lag	5-VOA	Hcl	-001			X							X						
				1-500ml	amber	-001												X				
	7:40		GAC - Lead	5-VOA	HCl	-002			X							X						
				1-500ml	amber	-002												X				
	7:50		GAC - inlet	5-VOA		-003			X							X						
						-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
7-1-15	1215	Robert Krakow	Christie Walters	7/1/15	1215
7/1/15	1810	Christie Walters		07/02/15	0700

Remarks:

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield NM 87413
Phone #: 505-632-4135
email or Fax#:
QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
Accreditation
☐ NELAP ☐ Other ________________
☐ EDD (Type) ________________

Turn-Around Time:
☒ Standard ☐ Rush ____________
Project Name: GAC 8-3-15
Project #: PO # ~~[illegible]~~ 126109 54
Project Manager:
Sampler: Bob
On Ice: ☒ Yes ☐ No
Sample Temperature: 1.8

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1508080	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / DRO / MRO)	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE	8270 (Semi-VOA)	DRO-EXT. 8015B				Air Bubbles (Y or N)
-3-15	8:00	H_2O	GAC-inlet	5-VOA	HCl	-001										X						
					amber													X				
	8:10	H_2O	GAC-Lead	5-VOA	HCl	-002										X						
					amber													X				
	8:20	H_2O	GAC-outlet	5-VOA	HCl	-003										X						
					amber													X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-3-15	1040	Robb Krakow	Christine Waltz	8/3/15	1040
8/3/15	1932	Christine Waltz		08/04/15	0745

Remarks:

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 5280
Bloomfield, NM 87413

Phone #:

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: GAC – 9-1-15

Project #:

Project Manager:

Sampler: Bob & MATT

Cooler: ☒ Yes ☐ No

Sample Temperature: [illegible]

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1509089	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted]	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX ~~MTBE~~ only	8270 (Semi-VOA)	DRO-Ext, 8015B				Air Bubbles (Y or N)
-1-15	10:45	H2O	GAC-Lag	5-VOA	HCl	-001			X							X						
|	\	|	\	1-500ml	amber	-001												X				
|	10:50	|	GAC-Lead	5-VOA	HCl	-002			X							X						
|	\	|	\	1-500ml	amber	-002												X				
|	10:55	|	GAC-inlet	5-VOA	HCl	-003			X							X						
|		|	\	1-500ml	amber	-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-1-15	1315	Robert Krakow		9/1/15	1315
9/1/15	1805			09/02/15	0800

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #:

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: GAC 10-1-15

Project #: PO# 1261124

Project Manager:

Sampler: Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.0

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1510083	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Ext 8015B				Air Bubbles (Y or N)
10-1-15	9:45	H_2O	GAC-Lag	3-VOA	HCl	-001			X							X						
			\	1-500ml	amber	-001												X				
	9:50		GAC-Lead	3-VOA	HCl	-002			X							X						
			\	1-500ml	amber	-002												X				
	9:55		GAC-inlet	3-VOA	HCl	-003			X							X						
			\	1-500ml	amber	-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
0/1/15	1527	Robert Krakow	Christ Walters	10/1/15	1527
10/1/15	1934	Christ Walters	Jose Ochoa	10/02/15	0800

Remarks:

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR4990
Bloomfield, NM 87413
Phone #: 505-632-4169
email or Fax#:
QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
Accreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name:
GAC 11-11-15
Project #:
PO# 12610954
Project Manager:

Sampler: Bob
[redacted]
[redacted]

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	[redacted]	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	8015B DRO Ext.				Air Bubbles (Y or N)
-15	9:50	H_2O	GAC - LAG	4-VOA	HCl	-001			X							X						
│	\	│	\	1-500ml	amber	-001												X				
│	10:00	│	GAC - Lead	4-VOA	HCl	-002			X							X						
│	\	│	\	1-500ml	amber	-002												X				
│	10:10	│	GAC - inleT	4-VOA	HCl	-003			X							X						
│	\	│	\	1-500ml	amber	-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-11-15	1530	Robert Krakow	Christa Walls	11/11/15	1530
11/15	1814	Christa Walls		11/12/15	0100

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

lient: Western Refining

lailing Address: #50 CR4990
Bloomfield NM 87413
hone #: 505-632-4169
mail or Fax#:
A/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
ccreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: GAC 11-11-15

Project #: PO# 12610954

Project Manager:

Sampler: Matt
On Ice: ☒ Yes ☐ No
Sample Temperature: 1.0

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4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1512C26
0/15	2:15	H_2O	GAC-Inlet	4-VOA	HCL	-001
\	\	\	\	1-500mL	amber	-001
0/15	2:30	H_2O	GAC-lead	4-VOA	HCL	-002
\	\	\	\	1-500mL	amber	-002

Analysis Request

HEAL No.	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	8015B DRO Ext.				Air Bubbles (Y or N)
-001			X							X						
-001												X				
-002			X							X						
-002												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
0/15	4:00 pm	Matt Krakow	Christie Walk	12/30/15	1650
0/15	1710	Christie Walk		12/31/15	0745

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

GW – 001

River Terrace Voluntary Corrective Measures Bioventing System Annual Report (2)

2015

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

May 20, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: River Terrace Low Flow 4-28-15 OrderNo.: 1504C17

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 7 sample(s) on 4/29/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1504C17**
Date Reported: **5/20/2015**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: DW-3
Project: River Terrace Low Flow 4-28-15
Collection Date: 4/28/2015 10:15:00 AM
Lab ID: 1504C17-001
Matrix: AQUEOUS
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	0.76	0.20		mg/L	1	4/29/2015 3:47:27 PM	18946
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/29/2015 3:47:27 PM	18946
Surr: DNOP	116	69.6-155		%REC	1	4/29/2015 3:47:27 PM	18946
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	ND	0.0050		mg/L	1	5/2/2015 12:08:10 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	2.1	0.50		mg/L	10	5/1/2015 1:00:41 PM	R25914
Surr: BFB	123	80-120	S	%REC	10	5/1/2015 1:00:41 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**cadg**
Benzene	82	10		µg/L	10	4/29/2015 12:44:48 PM	R25860
Toluene	ND	10		µg/L	10	4/29/2015 12:44:48 PM	R25860
Ethylbenzene	400	10		µg/L	10	4/29/2015 12:44:48 PM	R25860
Methyl tert-butyl ether (MTBE)	ND	10		µg/L	10	4/29/2015 12:44:48 PM	R25860
Xylenes, Total	290	15		µg/L	10	4/29/2015 12:44:48 PM	R25860
Surr: 1,2-Dichloroethane-d4	102	70-130		%REC	10	4/29/2015 12:44:48 PM	R25860
Surr: 4-Bromofluorobenzene	74.2	70-130		%REC	10	4/29/2015 12:44:48 PM	R25860
Surr: Dibromofluoromethane	99.9	70-130		%REC	10	4/29/2015 12:44:48 PM	R25860
Surr: Toluene-d8	101	70-130		%REC	10	4/29/2015 12:44:48 PM	R25860

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: TP-5
Project: River Terrace Low Flow 4-28-15
Collection Date: 4/28/2015 9:15:00 AM
Lab ID: 1504C17-002
Matrix: AQUEOUS
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	0.75	0.20		mg/L	1	4/29/2015 5:07:56 PM	18946
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/29/2015 5:07:56 PM	18946
Surr: DNOP	115	69.6-155		%REC	1	4/29/2015 5:07:56 PM	18946
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	0.019	0.0050		mg/L	1	5/2/2015 12:09:44 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	7.1	0.50		mg/L	10	5/1/2015 2:28:17 PM	R25914
Surr: BFB	127	80-120	S	%REC	10	5/1/2015 2:28:17 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**cadg**
Benzene	ND	10		µg/L	10	4/29/2015 2:11:16 PM	R25860
Toluene	ND	10		µg/L	10	4/29/2015 2:11:16 PM	R25860
Ethylbenzene	63	10		µg/L	10	4/29/2015 2:11:16 PM	R25860
Methyl tert-butyl ether (MTBE)	ND	10		µg/L	10	4/29/2015 2:11:16 PM	R25860
Xylenes, Total	1300	15		µg/L	10	4/29/2015 2:11:16 PM	R25860
Surr: 1,2-Dichloroethane-d4	97.2	70-130		%REC	10	4/29/2015 2:11:16 PM	R25860
Surr: 4-Bromofluorobenzene	95.4	70-130		%REC	10	4/29/2015 2:11:16 PM	R25860
Surr: Dibromofluoromethane	99.0	70-130		%REC	10	4/29/2015 2:11:16 PM	R25860
Surr: Toluene-d8	97.7	70-130		%REC	10	4/29/2015 2:11:16 PM	R25860

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** TP-6
Project: River Terrace Low Flow 4-28-15 **Collection Date:** 4/28/2015 10:45:00 AM
Lab ID: 1504C17-003 **Matrix:** AQUEOUS **Received Date:** 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	1.6	0.20		mg/L	1	4/29/2015 5:34:57 PM	18946
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/29/2015 5:34:57 PM	18946
Surr: DNOP	117	69.6-155		%REC	1	4/29/2015 5:34:57 PM	18946
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	0.015	0.0050		mg/L	1	5/2/2015 12:11:39 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	1.5	0.50		mg/L	10	5/1/2015 2:57:38 PM	R25914
Surr: BFB	124	80-120	S	%REC	10	5/1/2015 2:57:38 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**cadg**
Benzene	ND	1.0		µg/L	1	4/29/2015 2:40:01 PM	R25860
Toluene	ND	1.0		µg/L	1	4/29/2015 2:40:01 PM	R25860
Ethylbenzene	8.7	1.0		µg/L	1	4/29/2015 2:40:01 PM	R25860
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	4/29/2015 2:40:01 PM	R25860
Xylenes, Total	4.8	1.5		µg/L	1	4/29/2015 2:40:01 PM	R25860
Surr: 1,2-Dichloroethane-d4	99.5	70-130		%REC	1	4/29/2015 2:40:01 PM	R25860
Surr: 4-Bromofluorobenzene	21.0	70-130	S	%REC	1	4/29/2015 2:40:01 PM	R25860
Surr: Dibromofluoromethane	106	70-130		%REC	1	4/29/2015 2:40:01 PM	R25860
Surr: Toluene-d8	100	70-130		%REC	1	4/29/2015 2:40:01 PM	R25860

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
	O	RSD is greater than RSDlimit	P	Sample pH Not In Range
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** TP-8
Project: River Terrace Low Flow 4-28-15 **Collection Date:** 4/28/2015 11:00:00 AM
Lab ID: 1504C17-004 **Matrix:** AQUEOUS **Received Date:** 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	1.3	0.20		mg/L	1	4/29/2015 6:02:05 PM	18946
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/29/2015 6:02:05 PM	18946
Surr: DNOP	115	69.6-155		%REC	1	4/29/2015 6:02:05 PM	18946
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	0.0091	0.0050		mg/L	1	5/2/2015 12:13:20 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	1.4	0.50		mg/L	10	5/1/2015 3:26:56 PM	R25914
Surr: BFB	104	80-120		%REC	10	5/1/2015 3:26:56 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**cadg**
Benzene	ND	5.0		µg/L	5	4/29/2015 3:08:46 PM	R25860
Toluene	ND	5.0		µg/L	5	4/29/2015 3:08:46 PM	R25860
Ethylbenzene	9.9	5.0		µg/L	5	4/29/2015 3:08:46 PM	R25860
Methyl tert-butyl ether (MTBE)	ND	5.0		µg/L	5	4/29/2015 3:08:46 PM	R25860
Xylenes, Total	44	7.5		µg/L	5	4/29/2015 3:08:46 PM	R25860
Surr: 1,2-Dichloroethane-d4	95.5	70-130		%REC	5	4/29/2015 3:08:46 PM	R25860
Surr: 4-Bromofluorobenzene	97.9	70-130		%REC	5	4/29/2015 3:08:46 PM	R25860
Surr: Dibromofluoromethane	101	70-130		%REC	5	4/29/2015 3:08:46 PM	R25860
Surr: Toluene-d8	101	70-130		%REC	5	4/29/2015 3:08:46 PM	R25860

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** TP-8 Dup
Project: River Terrace Low Flow 4-28-15 **Collection Date:** 4/28/2015 11:00:00 AM
Lab ID: 1504C17-005 **Matrix:** AQUEOUS **Received Date:** 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	1.6	0.20		mg/L	1	4/29/2015 6:28:47 PM	18946
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/29/2015 6:28:47 PM	18946
Surr: DNOP	113	69.6-155		%REC	1	4/29/2015 6:28:47 PM	18946
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	0.0090	0.0050		mg/L	1	5/2/2015 12:15:18 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	1.7	0.50		mg/L	10	5/1/2015 3:56:14 PM	R25914
Surr: BFB	108	80-120		%REC	10	5/1/2015 3:56:14 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**cadg**
Benzene	ND	5.0		µg/L	5	4/29/2015 3:37:34 PM	R25860
Toluene	ND	5.0		µg/L	5	4/29/2015 3:37:34 PM	R25860
Ethylbenzene	9.0	5.0		µg/L	5	4/29/2015 3:37:34 PM	R25860
Methyl tert-butyl ether (MTBE)	ND	5.0		µg/L	5	4/29/2015 3:37:34 PM	R25860
Xylenes, Total	40	7.5		µg/L	5	4/29/2015 3:37:34 PM	R25860
Surr: 1,2-Dichloroethane-d4	100	70-130		%REC	5	4/29/2015 3:37:34 PM	R25860
Surr: 4-Bromofluorobenzene	97.9	70-130		%REC	5	4/29/2015 3:37:34 PM	R25860
Surr: Dibromofluoromethane	105	70-130		%REC	5	4/29/2015 3:37:34 PM	R25860
Surr: Toluene-d8	99.8	70-130		%REC	5	4/29/2015 3:37:34 PM	R25860

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: TP-9
Project: River Terrace Low Flow 4-28-15
Collection Date: 4/28/2015 9:30:00 AM
Lab ID: 1504C17-006
Matrix: AQUEOUS
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	0.35	0.20		mg/L	1	4/29/2015 6:55:49 PM	18946
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/29/2015 6:55:49 PM	18946
Surr: DNOP	122	69.6-155		%REC	1	4/29/2015 6:55:49 PM	18946
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	0.0056	0.0050		mg/L	1	5/2/2015 12:17:03 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	5/1/2015 4:25:28 PM	R25914
Surr: BFB	91.4	80-120		%REC	1	5/1/2015 4:25:28 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**cadg**
Benzene	ND	1.0		µg/L	1	4/29/2015 4:06:24 PM	R25860
Toluene	ND	1.0		µg/L	1	4/29/2015 4:06:24 PM	R25860
Ethylbenzene	ND	1.0		µg/L	1	4/29/2015 4:06:24 PM	R25860
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	4/29/2015 4:06:24 PM	R25860
Xylenes, Total	ND	1.5		µg/L	1	4/29/2015 4:06:24 PM	R25860
Surr: 1,2-Dichloroethane-d4	95.0	70-130		%REC	1	4/29/2015 4:06:24 PM	R25860
Surr: 4-Bromofluorobenzene	96.4	70-130		%REC	1	4/29/2015 4:06:24 PM	R25860
Surr: Dibromofluoromethane	104	70-130		%REC	1	4/29/2015 4:06:24 PM	R25860
Surr: Toluene-d8	100	70-130		%REC	1	4/29/2015 4:06:24 PM	R25860

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: MW-49
Project: River Terrace Low Flow 4-28-15
Collection Date: 4/28/2015 11:30:00 AM
Lab ID: 1504C17-007
Matrix: AQUEOUS
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/29/2015 7:22:22 PM	18946
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/29/2015 7:22:22 PM	18946
Surr: DNOP	123	69.6-155		%REC	1	4/29/2015 7:22:22 PM	18946
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	ND	0.0050		mg/L	1	5/2/2015 12:18:47 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	5/1/2015 4:54:41 PM	R25914
Surr: BFB	97.9	80-120		%REC	1	5/1/2015 4:54:41 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**cadg**
Benzene	ND	1.0		µg/L	1	4/29/2015 4:35:11 PM	R25860
Toluene	ND	1.0		µg/L	1	4/29/2015 4:35:11 PM	R25860
Ethylbenzene	ND	1.0		µg/L	1	4/29/2015 4:35:11 PM	R25860
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	4/29/2015 4:35:11 PM	R25860
Xylenes, Total	ND	1.5		µg/L	1	4/29/2015 4:35:11 PM	R25860
Surr: 1,2-Dichloroethane-d4	96.1	70-130		%REC	1	4/29/2015 4:35:11 PM	R25860
Surr: 4-Bromofluorobenzene	96.4	70-130		%REC	1	4/29/2015 4:35:11 PM	R25860
Surr: Dibromofluoromethane	99.0	70-130		%REC	1	4/29/2015 4:35:11 PM	R25860
Surr: Toluene-d8	99.7	70-130		%REC	1	4/29/2015 4:35:11 PM	R25860

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Client: Western Refining Southwest, Inc.
Project: River Terrace Low Flow 4-28-15

Sample ID **MB-18946**	SampType: **MBLK**	TestCode: **EPA Method 8015D: Diesel Range**	
Client ID: **PBW**	Batch ID: **18946**	RunNo: **25837**	
Prep Date: **4/29/2015**	Analysis Date: **4/29/2015**	SeqNo: **766286**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.56		0.5000		112	69.6	155			

Sample ID **1504C17-001CMS**	SampType: **MS**	TestCode: **EPA Method 8015D: Diesel Range**	
Client ID: **DW-3**	Batch ID: **18946**	RunNo: **25837**	
Prep Date: **4/29/2015**	Analysis Date: **4/29/2015**	SeqNo: **766289**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.6	0.20	2.500	0.7650	112	82.6	172			
Surr: DNOP	0.27		0.2500		109	69.6	155			

Sample ID **1504C17-001CMSD**	SampType: **MSD**	TestCode: **EPA Method 8015D: Diesel Range**	
Client ID: **DW-3**	Batch ID: **18946**	RunNo: **25837**	
Prep Date: **4/29/2015**	Analysis Date: **4/29/2015**	SeqNo: **766290**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.7	0.20	2.500	0.7650	118	82.6	172	4.64	33.9	
Surr: DNOP	0.28		0.2500		113	69.6	155	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1504C17**

20-May-15

Client: Western Refining Southwest, Inc.

Project: River Terrace Low Flow 4-28-15

Sample ID **5ML RB** SampType: **MBLK** TestCode: **EPA Method 8015D: Gasoline Range**

Client ID: **PBW** Batch ID: **R25914** RunNo: **25914**

Prep Date: Analysis Date: **5/1/2015** SeqNo: **768109** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	17		20.00		87.4	80	120			

Sample ID **1504C17-001BMS** SampType: **MS** TestCode: **EPA Method 8015D: Gasoline Range**

Client ID: **DW-3** Batch ID: **R25914** RunNo: **25914**

Prep Date: Analysis Date: **5/1/2015** SeqNo: **768118** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	6.9	0.50	5.000	2.088	95.9	51	131			
Surr: BFB	250		200.0		127	80	120			S

Sample ID **1504C17-001BMSD** SampType: **MSD** TestCode: **EPA Method 8015D: Gasoline Range**

Client ID: **DW-3** Batch ID: **R25914** RunNo: **25914**

Prep Date: Analysis Date: **5/1/2015** SeqNo: **768119** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	6.9	0.50	5.000	2.088	96.6	51	131	0.464	20	
Surr: BFB	260		200.0		128	80	120	0	0	S

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1504C17**

20-May-15

Client: Western Refining Southwest, Inc.

Project: River Terrace Low Flow 4-28-15

Sample ID	**5mL rb**	SampType:	**MBLK**	TestCode:	**EPA Method 8260: Volatiles Short List**		
Client ID:	**PBW**	Batch ID:	**R25860**	RunNo:	**25860**		
Prep Date:		Analysis Date:	**4/29/2015**	SeqNo:	**766381**	Units:	**µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	9.7		10.00		96.8	70	130			
Surr: 4-Bromofluorobenzene	10		10.00		104	70	130			
Surr: Dibromofluoromethane	10		10.00		101	70	130			
Surr: Toluene-d8	9.9		10.00		99.2	70	130			

Sample ID	**1504c17-001a ms**	SampType:	**MS**	TestCode:	**EPA Method 8260: Volatiles Short List**		
Client ID:	**DW-3**	Batch ID:	**R25860**	RunNo:	**25860**		
Prep Date:		Analysis Date:	**4/29/2015**	SeqNo:	**766384**	Units:	**µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	280	10	200.0	82.09	99.5	70	130			
Toluene	200	10	200.0	0	99.3	70	130			
Surr: 1,2-Dichloroethane-d4	110		100.0		109	70	130			
Surr: 4-Bromofluorobenzene	69		100.0		69.2	70	130			S
Surr: Dibromofluoromethane	99		100.0		99.2	70	130			
Surr: Toluene-d8	100		100.0		101	70	130			

Sample ID	**1504c17-001a msd**	SampType:	**MSD**	TestCode:	**EPA Method 8260: Volatiles Short List**		
Client ID:	**DW-3**	Batch ID:	**R25860**	RunNo:	**25860**		
Prep Date:		Analysis Date:	**4/29/2015**	SeqNo:	**766385**	Units:	**µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	260	10	200.0	82.09	89.4	70	130	7.51	20	
Toluene	190	10	200.0	0	96.7	70	130	2.74	20	
Surr: 1,2-Dichloroethane-d4	100		100.0		101	70	130	0	0	
Surr: 4-Bromofluorobenzene	75		100.0		74.6	70	130	0	0	
Surr: Dibromofluoromethane	97		100.0		97.3	70	130	0	0	
Surr: Toluene-d8	100		100.0		101	70	130	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1504C17**

20-May-15

Client: Western Refining Southwest, Inc.

Project: River Terrace Low Flow 4-28-15

Sample ID	**MB-19014**	SampType:	**MBLK**	TestCode:	**EPA 6010B: Total Recoverable Metals**
Client ID:	**PBW**	Batch ID:	**19014**	RunNo:	**25937**
Prep Date:	**5/1/2015**	Analysis Date:	**5/2/2015**	SeqNo:	**768782** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Lead	ND	0.0050								

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: **Western Refining Southw**   Work Order Number: **1504C17**   RcptNo: **1**

Received by/date: 04/29/15

Logged By: **Ashley Gallegos**   **4/29/2015 7:00:00 AM**

Completed By: **Ashley Gallegos**   **4/29/2015 9:12:47 AM**

Reviewed By: / CS   04/29/15

Chain of Custody

1. Custody seals intact on sample bottles?   Yes ☐   No ☐   Not Present ☑
2. Is Chain of Custody complete?   Yes ☑   No ☐   Not Present ☐
3. How was the sample delivered?   Client

Log In

4. Was an attempt made to cool the samples?   Yes ☑   No ☐   NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C   Yes ☑   No ☐   NA ☐
6. Sample(s) in proper container(s)?   Yes ☑   No ☐
7. Sufficient sample volume for indicated test(s)?   Yes ☑   No ☐
8. Are samples (except VOA and ONG) properly preserved?   Yes ☑   No ☐
9. Was preservative added to bottles?   Yes ☐   No ☑   NA ☐
10. VOA vials have zero headspace?   ~~Yes ☑~~   No ☑   No VOA Vials ☐
11. Were any sample containers received broken?   Yes ☐   No ☑
12. Does paperwork match bottle labels?   Yes ☑   No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody?   Yes ☑   No ☐
14. Is it clear what analyses were requested?   Yes ☑   No ☐
15. Were all holding times able to be met?   Yes ☑   No ☐
    (If no, notify customer for authorization.)

\# of preserved bottles checked for pH: 7
([✓ <2] ~~or~~ >12 unless noted)
Adjusted? no

Checked by: CS

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order?   Yes ☐   No ☐   NA ☑

Person Notified: Date:
By Whom: Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:
Client Instructions:

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	3.4	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413
Phone #: 505-632-4135
email or Fax#:
QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
Accreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name: 4-28-15
River Terrace Lowflow
Project #:
PO# 12610954
Project Manager:
Sampler: Bob & Matt
On Ice: ☒ Yes ☐ No
Sample Temperature: 3.4

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C17	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals Pb only	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Ext. 8015B				Air Bubbles (Y or N)
-28-15	10:15	H2O	Dw-3	5-VOA	HCl	-001			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3								X									
	9:15		TP-5	5-VOA	HCl	-002			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3								X									
	10:45		TP-6	5-VOA	HCl	-003			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3								X									
	11:00		TP-8	5-VOA	HCl	-004			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3								X									

Date:	Time:	Relinquished by:	Received by:	Date	Time
-28-15	1500	Robert Brakow	Chris Walt	4/28/15	1500
/28/15	1820	Christine Walters		04/29/15	0700

Remarks:

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: 4-28-15
River Terrace Low flow

Project #:
PO# 12610954

Project Manager:

Sampler: Bob + MATT

On Ice: ☒ Yes ☐ No

Sample Temperature: 3.4

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C17	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals Pb only	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Ext. 8015B				Air Bubbles (Y or N)
-28-15	11:00	H_2O	Tp-8 Dup	5-VOA	HCl	-005			X							X						
				1-500ml	Amber													X				
				1-500ml	HNO_3								X									
	9:30		Tp-9	5-VOA	HCl	-006			X							X						
				1-500ml	Amber													X				
				1-500ml	HNO_3								X									
	11:30		MW-49	5-VOA	HCl	-007			X							X						
				1-500ml	Amber													X				
				1-500ml	HNO_3								X									

Date:	Time:	Relinquished by:	Received by:	Date	Time
4-28-15	1500	Robert Krakow	Christa Walter	4/28/15	1500
4/28/15	1820	Christa Walter		04/29/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

**HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY**

*Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com*

May 20, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: 4-28-15 River Terrace Low Flow Biannual OrderNo.: 1504C22

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 8 sample(s) on 4/29/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: 4-28-15 River Terrace Low Flow Biannu
Lab ID: 1504C22-001 **Matrix:** AQUEOUS

Client Sample ID: DW-1
Collection Date: 4/28/2015 10:00:00 AM
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/30/2015 3:05:34 PM	18978
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/30/2015 3:05:34 PM	18978
Surr: DNOP	112	69.6-155		%REC	1	4/30/2015 3:05:34 PM	18978
EPA METHOD 7470: MERCURY						Analyst:	**MED**
Mercury	ND	0.00020		mg/L	1	5/7/2015 9:33:50 AM	19098
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	5/1/2015 5:23:53 PM	R25914
Surr: BFB	91.5	80-120		%REC	1	5/1/2015 5:23:53 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	5/1/2015 3:03:29 PM	R25915
Toluene	ND	1.0		µg/L	1	5/1/2015 3:03:29 PM	R25915
Ethylbenzene	ND	1.0		µg/L	1	5/1/2015 3:03:29 PM	R25915
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	5/1/2015 3:03:29 PM	R25915
Xylenes, Total	ND	1.5		µg/L	1	5/1/2015 3:03:29 PM	R25915
Surr: 1,2-Dichloroethane-d4	101	70-130		%REC	1	5/1/2015 3:03:29 PM	R25915
Surr: 4-Bromofluorobenzene	98.2	70-130		%REC	1	5/1/2015 3:03:29 PM	R25915
Surr: Dibromofluoromethane	99.5	70-130		%REC	1	5/1/2015 3:03:29 PM	R25915
Surr: Toluene-d8	96.6	70-130		%REC	1	5/1/2015 3:03:29 PM	R25915

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** TP-7
Project: 4-28-15 River Terrace Low Flow Biannu **Collection Date:** 4/28/2015 9:45:00 AM
Lab ID: 1504C22-002 **Matrix:** AQUEOUS **Received Date:** 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/30/2015 4:25:38 PM	18978
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/30/2015 4:25:38 PM	18978
Surr: DNOP	125	69.6-155		%REC	1	4/30/2015 4:25:38 PM	18978
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	ND	0.0050		mg/L	1	5/2/2015 12:20:31 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	5/1/2015 5:53:04 PM	R25914
Surr: BFB	93.1	80-120		%REC	1	5/1/2015 5:53:04 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	2.0		µg/L	2	5/1/2015 4:26:11 PM	R25915
Toluene	ND	2.0		µg/L	2	5/1/2015 4:26:11 PM	R25915
Ethylbenzene	ND	2.0		µg/L	2	5/1/2015 4:26:11 PM	R25915
Methyl tert-butyl ether (MTBE)	ND	2.0		µg/L	2	5/1/2015 4:26:11 PM	R25915
Xylenes, Total	ND	3.0		µg/L	2	5/1/2015 4:26:11 PM	R25915
Surr: 1,2-Dichloroethane-d4	98.8	70-130		%REC	2	5/1/2015 4:26:11 PM	R25915
Surr: 4-Bromofluorobenzene	108	70-130		%REC	2	5/1/2015 4:26:11 PM	R25915
Surr: Dibromofluoromethane	100	70-130		%REC	2	5/1/2015 4:26:11 PM	R25915
Surr: Toluene-d8	94.4	70-130		%REC	2	5/1/2015 4:26:11 PM	R25915

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	TP-3
Project:	4-28-15 River Terrace Low Flow Biannu	**Collection Date:**	4/28/2015 9:00:00 AM
Lab ID:	1504C22-003 **Matrix:** AQUEOUS	**Received Date:**	4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/30/2015 4:52:26 PM	18978
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/30/2015 4:52:26 PM	18978
Surr: DNOP	110	69.6-155		%REC	1	4/30/2015 4:52:26 PM	18978
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	ND	0.0050		mg/L	1	5/2/2015 12:28:35 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	5/1/2015 6:22:14 PM	R25914
Surr: BFB	92.9	80-120		%REC	1	5/1/2015 6:22:14 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	4/30/2015 6:44:32 PM	R25895
Toluene	ND	1.0		µg/L	1	4/30/2015 6:44:32 PM	R25895
Ethylbenzene	ND	1.0		µg/L	1	4/30/2015 6:44:32 PM	R25895
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	4/30/2015 6:44:32 PM	R25895
Xylenes, Total	ND	1.5		µg/L	1	4/30/2015 6:44:32 PM	R25895
Surr: 1,2-Dichloroethane-d4	105	70-130		%REC	1	4/30/2015 6:44:32 PM	R25895
Surr: 4-Bromofluorobenzene	97.7	70-130		%REC	1	4/30/2015 6:44:32 PM	R25895
Surr: Dibromofluoromethane	95.1	70-130		%REC	1	4/30/2015 6:44:32 PM	R25895
Surr: Toluene-d8	98.4	70-130		%REC	1	4/30/2015 6:44:32 PM	R25895

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
	O	RSD is greater than RSDlimit	P	Sample pH Not In Range
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Project: 4-28-15 River Terrace Low Flow Biannu
Lab ID: 1504C22-004
Matrix: AQUEOUS
Client Sample ID: TP-10
Collection Date: 4/28/2015 8:45:00 AM
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/30/2015 5:19:06 PM	18978
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/30/2015 5:19:06 PM	18978
Surr: DNOP	122	69.6-155		%REC	1	4/30/2015 5:19:06 PM	18978
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	0.024	0.0050		mg/L	1	5/2/2015 12:30:39 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	5/1/2015 8:48:35 PM	R25914
Surr: BFB	91.6	80-120		%REC	1	5/1/2015 8:48:35 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	5/1/2015 4:53:41 PM	R25915
Toluene	ND	1.0		µg/L	1	5/1/2015 4:53:41 PM	R25915
Ethylbenzene	ND	1.0		µg/L	1	5/1/2015 4:53:41 PM	R25915
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	5/1/2015 4:53:41 PM	R25915
Xylenes, Total	ND	1.5		µg/L	1	5/1/2015 4:53:41 PM	R25915
Surr: 1,2-Dichloroethane-d4	101	70-130		%REC	1	5/1/2015 4:53:41 PM	R25915
Surr: 4-Bromofluorobenzene	98.6	70-130		%REC	1	5/1/2015 4:53:41 PM	R25915
Surr: Dibromofluoromethane	95.9	70-130		%REC	1	5/1/2015 4:53:41 PM	R25915
Surr: Toluene-d8	100	70-130		%REC	1	5/1/2015 4:53:41 PM	R25915

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: TP-11
Project: 4-28-15 River Terrace Low Flow Biannu
Collection Date: 4/28/2015 8:30:00 AM
Lab ID: 1504C22-005
Matrix: AQUEOUS
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/30/2015 5:45:49 PM	18978
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/30/2015 5:45:49 PM	18978
Surr: DNOP	112	69.6-155		%REC	1	4/30/2015 5:45:49 PM	18978
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	ND	0.0050		mg/L	1	5/2/2015 12:32:24 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	5/1/2015 9:17:47 PM	R25914
Surr: BFB	90.8	80-120		%REC	1	5/1/2015 9:17:47 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	5/1/2015 5:21:09 PM	R25915
Toluene	ND	1.0		µg/L	1	5/1/2015 5:21:09 PM	R25915
Ethylbenzene	ND	1.0		µg/L	1	5/1/2015 5:21:09 PM	R25915
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	5/1/2015 5:21:09 PM	R25915
Xylenes, Total	ND	1.5		µg/L	1	5/1/2015 5:21:09 PM	R25915
Surr: 1,2-Dichloroethane-d4	110	70-130		%REC	1	5/1/2015 5:21:09 PM	R25915
Surr: 4-Bromofluorobenzene	98.6	70-130		%REC	1	5/1/2015 5:21:09 PM	R25915
Surr: Dibromofluoromethane	99.1	70-130		%REC	1	5/1/2015 5:21:09 PM	R25915
Surr: Toluene-d8	97.4	70-130		%REC	1	5/1/2015 5:21:09 PM	R25915

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: 4-28-15 River Terrace Low Flow Biannu
Lab ID: 1504C22-006
Matrix: AQUEOUS
Client Sample ID: TP-12
Collection Date: 4/28/2015 8:15:00 AM
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/30/2015 6:12:28 PM	18978
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/30/2015 6:12:28 PM	18978
Surr: DNOP	119	69.6-155		%REC	1	4/30/2015 6:12:28 PM	18978
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	ND	0.0050		mg/L	1	5/2/2015 12:34:11 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	5/1/2015 9:46:57 PM	R25914
Surr: BFB	92.6	80-120		%REC	1	5/1/2015 9:46:57 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	4/30/2015 8:07:01 PM	R25895
Toluene	ND	1.0		µg/L	1	4/30/2015 8:07:01 PM	R25895
Ethylbenzene	ND	1.0		µg/L	1	4/30/2015 8:07:01 PM	R25895
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	4/30/2015 8:07:01 PM	R25895
Xylenes, Total	ND	1.5		µg/L	1	4/30/2015 8:07:01 PM	R25895
Surr: 1,2-Dichloroethane-d4	99.7	70-130		%REC	1	4/30/2015 8:07:01 PM	R25895
Surr: 4-Bromofluorobenzene	100	70-130		%REC	1	4/30/2015 8:07:01 PM	R25895
Surr: Dibromofluoromethane	96.9	70-130		%REC	1	4/30/2015 8:07:01 PM	R25895
Surr: Toluene-d8	93.3	70-130		%REC	1	4/30/2015 8:07:01 PM	R25895

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Analytical Report
Lab Order **1504C22**
Date Reported: **5/20/2015**

Hall Environmental Analysis Laboratory, Inc.

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	TP-13
Project:	4-28-15 River Terrace Low Flow Biannu	**Collection Date:**	4/28/2015 8:00:00 AM
Lab ID:	1504C22-007 **Matrix:** AQUEOUS	**Received Date:**	4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	0.22	0.20		mg/L	1	4/30/2015 6:39:17 PM	18978
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/30/2015 6:39:17 PM	18978
Surr: DNOP	112	69.6-155		%REC	1	4/30/2015 6:39:17 PM	18978
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst:	**ELS**
Lead	0.0064	0.0050		mg/L	1	5/2/2015 12:35:46 PM	19014
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	5/1/2015 10:16:04 PM	R25914
Surr: BFB	92.7	80-120		%REC	1	5/1/2015 10:16:04 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	2.0		µg/L	2	4/30/2015 8:34:37 PM	R25895
Toluene	ND	2.0		µg/L	2	4/30/2015 8:34:37 PM	R25895
Ethylbenzene	ND	2.0		µg/L	2	4/30/2015 8:34:37 PM	R25895
Methyl tert-butyl ether (MTBE)	ND	2.0		µg/L	2	4/30/2015 8:34:37 PM	R25895
Xylenes, Total	ND	3.0		µg/L	2	4/30/2015 8:34:37 PM	R25895
Surr: 1,2-Dichloroethane-d4	107	70-130		%REC	2	4/30/2015 8:34:37 PM	R25895
Surr: 4-Bromofluorobenzene	96.6	70-130		%REC	2	4/30/2015 8:34:37 PM	R25895
Surr: Dibromofluoromethane	99.6	70-130		%REC	2	4/30/2015 8:34:37 PM	R25895
Surr: Toluene-d8	95.5	70-130		%REC	2	4/30/2015 8:34:37 PM	R25895

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: Trip Blank
Project: 4-28-15 River Terrace Low Flow Biannu
Collection Date:
Lab ID: 1504C22-008
Matrix: TRIP BLANK
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	5/1/2015 10:45:12 PM	R25914
Surr: BFB	92.5	80-120		%REC	1	5/1/2015 10:45:12 PM	R25914
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	1.0		µg/L	1	4/30/2015 9:02:12 PM	R25895
Toluene	ND	1.0		µg/L	1	4/30/2015 9:02:12 PM	R25895
Ethylbenzene	ND	1.0		µg/L	1	4/30/2015 9:02:12 PM	R25895
Xylenes, Total	ND	1.5		µg/L	1	4/30/2015 9:02:12 PM	R25895
Surr: 1,2-Dichloroethane-d4	96.2	70-130		%REC	1	4/30/2015 9:02:12 PM	R25895
Surr: 4-Bromofluorobenzene	99.3	70-130		%REC	1	4/30/2015 9:02:12 PM	R25895
Surr: Dibromofluoromethane	100	70-130		%REC	1	4/30/2015 9:02:12 PM	R25895
Surr: Toluene-d8	94.7	70-130		%REC	1	4/30/2015 9:02:12 PM	R25895

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1504C22**

20-May-15

Client: Western Refining Southwest, Inc.

Project: 4-28-15 River Terrace Low Flow Biannual

Sample ID	**MB-18978**	SampType:	**MBLK**	TestCode:	**EPA Method 8015D: Diesel Range**		
Client ID:	**PBW**	Batch ID:	**18978**	RunNo:	**25862**		
Prep Date:	**4/30/2015**	Analysis Date:	**4/30/2015**	SeqNo:	**767023**	Units:	**mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.58		0.5000		116	69.6	155			

Sample ID	**1504C22-001CMS**	SampType:	**MS**	TestCode:	**EPA Method 8015D: Diesel Range**		
Client ID:	**DW-1**	Batch ID:	**18978**	RunNo:	**25862**		
Prep Date:	**4/30/2015**	Analysis Date:	**4/30/2015**	SeqNo:	**767220**	Units:	**mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.1	0.20	2.500	0	123	82.6	172			
Surr: DNOP	0.28		0.2500		114	69.6	155			

Sample ID	**1504C22-001CMSD**	SampType:	**MSD**	TestCode:	**EPA Method 8015D: Diesel Range**		
Client ID:	**DW-1**	Batch ID:	**18978**	RunNo:	**25862**		
Prep Date:	**4/30/2015**	Analysis Date:	**4/30/2015**	SeqNo:	**767221**	Units:	**mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.9	0.20	2.500	0	115	82.6	172	6.60	33.9	
Surr: DNOP	0.29		0.2500		117	69.6	155	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1504C22**

20-May-15

Client: Western Refining Southwest, Inc.

Project: 4-28-15 River Terrace Low Flow Biannual

Sample ID	**5ML RB**	SampType:	**MBLK**	TestCode:	**EPA Method 8015D: Gasoline Range**
Client ID:	**PBW**	Batch ID:	**R25914**	RunNo:	**25914**
Prep Date:		Analysis Date:	**5/1/2015**	SeqNo:	**768109** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	17		20.00		87.4	80	120			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Client: Western Refining Southwest, Inc.

Project: 4-28-15 River Terrace Low Flow Biannual

Sample ID **5ml rb** SampType: **MBLK** TestCode: **EPA Method 8260: Volatiles Short List**

Client ID: **PBW** Batch ID: **R25895** RunNo: **25895**

Prep Date: Analysis Date: **4/30/2015** SeqNo: **767551** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	9.5		10.00		94.7	70	130			
Surr: 4-Bromofluorobenzene	9.4		10.00		94.1	70	130			
Surr: Dibromofluoromethane	10		10.00		100	70	130			
Surr: Toluene-d8	9.5		10.00		94.8	70	130			

Sample ID **5ml rb** SampType: **MBLK** TestCode: **EPA Method 8260: Volatiles Short List**

Client ID: **PBW** Batch ID: **R25915** RunNo: **25915**

Prep Date: Analysis Date: **5/1/2015** SeqNo: **768153** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	11		10.00		106	70	130			
Surr: 4-Bromofluorobenzene	9.9		10.00		99.0	70	130			
Surr: Dibromofluoromethane	9.9		10.00		98.8	70	130			
Surr: Toluene-d8	9.0		10.00		90.3	70	130			

Sample ID **1504c22-001a ms** SampType: **MS** TestCode: **EPA Method 8260: Volatiles Short List**

Client ID: **DW-1** Batch ID: **R25915** RunNo: **25915**

Prep Date: Analysis Date: **5/1/2015** SeqNo: **768156** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	21	1.0	20.00	0	104	70	130			
Toluene	20	1.0	20.00	0	99.5	70	130			
Surr: 1,2-Dichloroethane-d4	9.9		10.00		99.0	70	130			
Surr: 4-Bromofluorobenzene	9.7		10.00		97.1	70	130			
Surr: Dibromofluoromethane	10		10.00		103	70	130			
Surr: Toluene-d8	9.7		10.00		97.4	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1504C22**

20-May-15

Client: Western Refining Southwest, Inc.

Project: 4-28-15 River Terrace Low Flow Biannual

Sample ID	**1504c22-001a msd**	SampType:	**MSD**	TestCode:	**EPA Method 8260: Volatiles Short List**
Client ID:	**DW-1**	Batch ID:	**R25915**	RunNo:	**25915**
Prep Date:		Analysis Date:	**5/1/2015**	SeqNo:	**768157** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	21	1.0	20.00	0	103	70	130	1.24	20	
Toluene	20	1.0	20.00	0	101	70	130	1.26	20	
Surr: 1,2-Dichloroethane-d4	10		10.00		104	70	130	0	0	
Surr: 4-Bromofluorobenzene	9.9		10.00		99.5	70	130	0	0	
Surr: Dibromofluoromethane	11		10.00		105	70	130	0	0	
Surr: Toluene-d8	9.6		10.00		96.1	70	130	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Client: Western Refining Southwest, Inc.

Project: 4-28-15 River Terrace Low Flow Biannual

Sample ID **MB-19098** SampType: **MBLK** TestCode: **EPA Method 7470: Mercury**
Client ID: **PBW** Batch ID: **19098** RunNo: **26025**
Prep Date: **5/6/2015** Analysis Date: **5/7/2015** SeqNo: **771543** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	ND	0.00020								

Sample ID **1504C22-001DMS** SampType: **MS** TestCode: **EPA Method 7470: Mercury**
Client ID: **DW-1** Batch ID: **19098** RunNo: **26025**
Prep Date: **5/6/2015** Analysis Date: **5/7/2015** SeqNo: **771546** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0045	0.00020	0.005000	0	89.7	75	125			

Sample ID **1504C22-001DMSD** SampType: **MSD** TestCode: **EPA Method 7470: Mercury**
Client ID: **DW-1** Batch ID: **19098** RunNo: **26025**
Prep Date: **5/6/2015** Analysis Date: **5/7/2015** SeqNo: **771547** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0046	0.00020	0.005000	0	92.9	75	125	3.43	20	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1504C22**

20-May-15

Client: Western Refining Southwest, Inc.

Project: 4-28-15 River Terrace Low Flow Biannual

Sample ID	**MB-19014**	SampType:	**MBLK**	TestCode:	**EPA 6010B: Total Recoverable Metals**
Client ID:	**PBW**	Batch ID:	**19014**	RunNo:	**25937**
Prep Date:	**5/1/2015**	Analysis Date:	**5/2/2015**	SeqNo:	**768782** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Lead	ND	0.0050								

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

**HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY**

*Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com*

Sample Log-In Check List

Client Name: **Western Refining Southw** Work Order Number: **1504C22** RcptNo: **1**

Received by/date: 04/29/15

Logged By: **Ashley Gallegos** **4/29/2015 7:00:00 AM**

Completed By: **Ashley Gallegos** **4/29/2015 9:45:49 AM**

Reviewed By: 04/30/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☒
2. Is Chain of Custody complete? Yes ☒ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☒ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☒ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☒ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☒ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☒ No ☐
9. Was preservative added to bottles? Yes ☐ No ☒ NA ☐
10. VOA vials have zero headspace? Yes ☒ No ☐ No VOA Vials ☐
11. Were any sample containers received broken? Yes ☐ No ☒
12. Does paperwork match bottle labels? Yes ☒ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☒ No ☐
14. Is it clear what analyses were requested? Yes ☒ No ☐
15. Were all holding times able to be met? Yes ☒ No ☐
    (If no, notify customer for authorization.)

# of preserved bottles checked for pH: 7
([✓ <2] or >12 unless noted)
Adjusted? no
Checked by: CS

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☒

Person Notified: Date
By Whom: Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:
Client Instructions:

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	3.4	Good	Yes			

Chain-of-Custody Record

lient: Western Refining

lailing Address: #50 CR 4990
Bloomfield, NM 87413
hone #: 505-632-4135
mail or Fax#:
A/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
ccreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name: 4-28-15
River Terrace Low flow-Biannual
Project #:
PO#126109354
Project Manager:

Sampler: Bob & MATT
On Ice: ☒ Yes ☐ No
Sample Temperature: 3.4

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C22	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO EXT 8015B	Total Metal Hg only	Total MetA Pb only		Air Bubbles (Y or N)
28-15	10:00	H2O	DW-1	5-VOA	HCl	-001			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3														X			
	9:45		Tp-7	5-VOA	HCl	-002			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3															X		
	9:00		Tp-3	4 ~~5~~-VOA	HCl	-003			X							X						
			CS 04/30/15	1-500ml	amber													X				
				1-500ml	HNO3															X		
	8:45		TP-10	5-VOA	HCl	-004			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3															X		

Date:	Time:	Relinquished by:	Received by:	Date	Time
28-15	1500	Robert Krakow	Christine Walters	4/28/15	1500
/28/15	1820	Christine Walters		04/29/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

lient: WesTerN RefiNiNg
lailing Address: #50 CR 4990
Bloomfield, NM 87413
hone #: 505-632-4135
mail or Fax#:
A/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
ccreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name: 4-28-15
River Terrace Low Flow-BiANNual
Project #:
PO#12610954
Project Manager:
Sampler: Bob & MATT
On Ice: ☒ Yes ☐ No
Sample Temperature: 3.4

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C22	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO$_3$,NO$_2$,PO$_4$,SO$_4$)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX,MTBE only	8270 (Semi-VOA)	DRO-Ext. 8015B	TOTAL MeTal Pb only			Air Bubbles (Y or N)
28-15	8:30	H$_2$O	TP-11	5-VOA	HCl	-005			X							X						
				1-500ml	amber													X				
				1-500ml	HNO$_3$														X			
	8:15		TP-12	5-VOA	HCl	-006			X							X						
				1-500ml	amber													X				
				1-500ml	HNO$_3$														X			
	8:00		TP-13	5-VOA	HCl	-007			X							X						
				1-500ml	amber													X				
				1-500ml	HNO$_3$														X			
			Trip Blank CS 04/30/15													X						

Date:	Time:	Relinquished by:	Received by:	Date	Time
28-15	1500	Robert Krakow	Christine Walker	4/28/15	1500
4/28/15	1820	Christine Walker		04/29/15	0708

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

May 07, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: River Terrace Low Flow 4/28/15 OrderNo.: 1504C14

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 7 sample(s) on 4/29/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: TP-13
Project: River Terrace Low Flow 4/28/15
Collection Date: 4/28/2015 8:00:00 AM
Lab ID: 1504C14-001 **Matrix:** AIR
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/30/2015 9:31:57 AM	R25890
Surr: BFB	90.0	44.5-202		%REC	1	4/30/2015 9:31:57 AM	R25890
EPA METHOD 8260B: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	0.10		µg/L	1	4/30/2015 1:14:18 PM	R25895
Toluene	ND	0.10		µg/L	1	4/30/2015 1:14:18 PM	R25895
Ethylbenzene	ND	0.10		µg/L	1	4/30/2015 1:14:18 PM	R25895
Xylenes, Total	ND	0.30		µg/L	1	4/30/2015 1:14:18 PM	R25895
Surr: 1,2-Dichloroethane-d4	115	70-130		%REC	1	4/30/2015 1:14:18 PM	R25895
Surr: 4-Bromofluorobenzene	95.9	70-130		%REC	1	4/30/2015 1:14:18 PM	R25895
Surr: Dibromofluoromethane	114	70-130		%REC	1	4/30/2015 1:14:18 PM	R25895
Surr: Toluene-d8	98.2	70-130		%REC	1	4/30/2015 1:14:18 PM	R25895

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
	O	RSD is greater than RSDlimit	P	Sample pH Not In Range
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: TP-12
Project: River Terrace Low Flow 4/28/15
Collection Date: 4/28/2015 8:15:00 AM
Lab ID: 1504C14-002
Matrix: AIR
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE						Analyst: **NSB**	
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/30/2015 9:59:31 AM	R25890
Surr: BFB	89.0	44.5-202		%REC	1	4/30/2015 9:59:31 AM	R25890
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst: **DJF**	
Benzene	ND	0.10		µg/L	1	4/30/2015 1:41:49 PM	R25895
Toluene	ND	0.10		µg/L	1	4/30/2015 1:41:49 PM	R25895
Ethylbenzene	ND	0.10		µg/L	1	4/30/2015 1:41:49 PM	R25895
Xylenes, Total	ND	0.30		µg/L	1	4/30/2015 1:41:49 PM	R25895
Surr: 1,2-Dichloroethane-d4	97.4	70-130		%REC	1	4/30/2015 1:41:49 PM	R25895
Surr: 4-Bromofluorobenzene	97.2	70-130		%REC	1	4/30/2015 1:41:49 PM	R25895
Surr: Dibromofluoromethane	102	70-130		%REC	1	4/30/2015 1:41:49 PM	R25895
Surr: Toluene-d8	96.1	70-130		%REC	1	4/30/2015 1:41:49 PM	R25895

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: River Terrace Low Flow 4/28/15
Lab ID: 1504C14-003
Matrix: AIR
Client Sample ID: TP-11
Collection Date: 4/28/2015 8:30:00 AM
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE						Analyst: **NSB**	
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/30/2015 10:54:57 AM	R25890
Surr: BFB	89.8	44.5-202		%REC	1	4/30/2015 10:54:57 AM	R25890
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst: **DJF**	
Benzene	ND	0.10		µg/L	1	4/30/2015 2:09:30 PM	R25895
Toluene	ND	0.10		µg/L	1	4/30/2015 2:09:30 PM	R25895
Ethylbenzene	ND	0.10		µg/L	1	4/30/2015 2:09:30 PM	R25895
Xylenes, Total	ND	0.30		µg/L	1	4/30/2015 2:09:30 PM	R25895
Surr: 1,2-Dichloroethane-d4	108	70-130		%REC	1	4/30/2015 2:09:30 PM	R25895
Surr: 4-Bromofluorobenzene	102	70-130		%REC	1	4/30/2015 2:09:30 PM	R25895
Surr: Dibromofluoromethane	105	70-130		%REC	1	4/30/2015 2:09:30 PM	R25895
Surr: Toluene-d8	94.7	70-130		%REC	1	4/30/2015 2:09:30 PM	R25895

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: TP-10
Project: River Terrace Low Flow 4/28/15
Collection Date: 4/28/2015 8:45:00 AM
Lab ID: 1504C14-004
Matrix: AIR
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/30/2015 11:22:33 AM	R25890
Surr: BFB	87.9	44.5-202		%REC	1	4/30/2015 11:22:33 AM	R25890
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	0.10		µg/L	1	4/30/2015 2:37:00 PM	R25895
Toluene	ND	0.10		µg/L	1	4/30/2015 2:37:00 PM	R25895
Ethylbenzene	ND	0.10		µg/L	1	4/30/2015 2:37:00 PM	R25895
Xylenes, Total	ND	0.30		µg/L	1	4/30/2015 2:37:00 PM	R25895
Surr: 1,2-Dichloroethane-d4	105	70-130		%REC	1	4/30/2015 2:37:00 PM	R25895
Surr: 4-Bromofluorobenzene	97.3	70-130		%REC	1	4/30/2015 2:37:00 PM	R25895
Surr: Dibromofluoromethane	112	70-130		%REC	1	4/30/2015 2:37:00 PM	R25895
Surr: Toluene-d8	97.5	70-130		%REC	1	4/30/2015 2:37:00 PM	R25895

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** TP-3
Project: River Terrace Low Flow 4/28/15 **Collection Date:** 4/28/2015 9:00:00 AM
Lab ID: 1504C14-005 **Matrix:** AIR **Received Date:** 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/30/2015 11:49:49 AM	R25890
Surr: BFB	89.6	44.5-202		%REC	1	4/30/2015 11:49:49 AM	R25890
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	0.10		µg/L	1	4/30/2015 3:04:30 PM	R25895
Toluene	ND	0.10		µg/L	1	4/30/2015 3:04:30 PM	R25895
Ethylbenzene	ND	0.10		µg/L	1	4/30/2015 3:04:30 PM	R25895
Xylenes, Total	ND	0.30		µg/L	1	4/30/2015 3:04:30 PM	R25895
Surr: 1,2-Dichloroethane-d4	118	70-130		%REC	1	4/30/2015 3:04:30 PM	R25895
Surr: 4-Bromofluorobenzene	100	70-130		%REC	1	4/30/2015 3:04:30 PM	R25895
Surr: Dibromofluoromethane	105	70-130		%REC	1	4/30/2015 3:04:30 PM	R25895
Surr: Toluene-d8	91.3	70-130		%REC	1	4/30/2015 3:04:30 PM	R25895

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: TP-7
Project: River Terrace Low Flow 4/28/15
Collection Date: 4/28/2015 9:45:00 AM
Lab ID: 1504C14-006
Matrix: AIR
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/30/2015 12:17:23 PM	R25890
Surr: BFB	87.7	44.5-202		%REC	1	4/30/2015 12:17:23 PM	R25890
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	0.10		µg/L	1	4/30/2015 3:32:13 PM	R25895
Toluene	ND	0.10		µg/L	1	4/30/2015 3:32:13 PM	R25895
Ethylbenzene	ND	0.10		µg/L	1	4/30/2015 3:32:13 PM	R25895
Xylenes, Total	ND	0.30		µg/L	1	4/30/2015 3:32:13 PM	R25895
Surr: 1,2-Dichloroethane-d4	116	70-130		%REC	1	4/30/2015 3:32:13 PM	R25895
Surr: 4-Bromofluorobenzene	104	70-130		%REC	1	4/30/2015 3:32:13 PM	R25895
Surr: Dibromofluoromethane	107	70-130		%REC	1	4/30/2015 3:32:13 PM	R25895
Surr: Toluene-d8	94.8	70-130		%REC	1	4/30/2015 3:32:13 PM	R25895

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	DW-1
Project:	River Terrace Low Flow 4/28/15	**Collection Date:**	4/28/2015 10:00:00 AM
Lab ID:	1504C14-007 **Matrix:** AIR	**Received Date:**	4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	5/1/2015 9:17:48 AM	R25914
Surr: BFB	93.1	44.5-202		%REC	1	5/1/2015 9:17:48 AM	R25914
EPA METHOD 8260B: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	0.10		µg/L	1	5/1/2015 11:23:25 AM	R25915
Toluene	ND	0.10		µg/L	1	5/1/2015 11:23:25 AM	R25915
Ethylbenzene	ND	0.10		µg/L	1	5/1/2015 11:23:25 AM	R25915
Xylenes, Total	ND	0.30		µg/L	1	5/1/2015 11:23:25 AM	R25915
Surr: 1,2-Dichloroethane-d4	97.0	70-130		%REC	1	5/1/2015 11:23:25 AM	R25915
Surr: 4-Bromofluorobenzene	97.9	70-130		%REC	1	5/1/2015 11:23:25 AM	R25915
Surr: Dibromofluoromethane	92.6	70-130		%REC	1	5/1/2015 11:23:25 AM	R25915
Surr: Toluene-d8	91.6	70-130		%REC	1	5/1/2015 11:23:25 AM	R25915

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Client: Western Refining Southwest, Inc.

Project: River Terrace Low Flow 4/28/15

Sample ID	**1504C14-001ADUP**	SampType:	**DUP**	TestCode:	**EPA Method 8015D: Gasoline Range**
Client ID:	**TP-13**	Batch ID:	**R25890**	RunNo:	**25890**
Prep Date:		Analysis Date:	**4/30/2015**	SeqNo:	**767322** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	5.0						0	20	
Surr: BFB	1600		2000		78.8	44.5	202	0	0	

Sample ID	**1504C14-007ADUP**	SampType:	**DUP**	TestCode:	**EPA Method 8015D: Gasoline Range**
Client ID:	**DW-1**	Batch ID:	**R25914**	RunNo:	**25914**
Prep Date:		Analysis Date:	**5/1/2015**	SeqNo:	**768112** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	5.0						0	20	
Surr: BFB	1800		2000		90.0	44.5	202	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT
Hall Environmental Analysis Laboratory, Inc.

WO#: **1504C14**

07-May-15

Client: Western Refining Southwest, Inc.
Project: River Terrace Low Flow 4/28/15

Sample ID **1504c14-007a dup** SampType: **DUP** TestCode: **EPA Method 8260B: Volatiles Short List**
Client ID: **DW-1** Batch ID: **R25915** RunNo: **25915**
Prep Date: Analysis Date: **5/1/2015** SeqNo: **768168** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	0.10						0	20	
Toluene	ND	0.10						0	20	
Ethylbenzene	ND	0.10						0	20	
Xylenes, Total	ND	0.15						0	20	
Surr: 1,2-Dichloroethane-d4	1.0		1.000		104	70	130	0	0	
Surr: 4-Bromofluorobenzene	0.97		1.000		96.9	70	130	0	0	
Surr: Dibromofluoromethane	1.0		1.000		104	70	130	0	0	
Surr: Toluene-d8	0.96		1.000		96.0	70	130	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

**HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY**

*Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com*

Sample Log-In Check List

Client Name: Western Refining Southw Work Order Number: 1504C14 RcptNo: 1

Received by/date: 04/29/15

Logged By: Lindsay Mangin 4/29/2015 7:00:00 AM

Completed By: Lindsay Mangin 4/29/2015 8:55:21 AM

Reviewed By: CS 04/29/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☐ No ☐ NA ☑
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☐ No ☐ NA ☑
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? Yes ☐ No ☐ No VOA Vials ☑
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

# of preserved bottles checked for pH: ________ (<2 or >12 unless noted)
Adjusted? ________
Checked by: ________

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: Date:
By Whom: Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:
Client Instructions:

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	NA	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413
Phone #: 505-632-4135
Email or Fax#:
QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
Accreditation
☐ NELAP ☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush
Project Name: 4-28-15
River Terrace Lowflow
Project #:
Project Manager:
Sampler: Bob + MATT
On Ice: ~~Yes~~ ☒ No
Sample Temperature: ~~3.~~ N/A

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C14	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX only	8270 (Semi-VOA)					Air Bubbles (Y or N)
28-15	8:00	Air	Tp-13	Tedlar Bag		-001			X							X						
	8:15		Tp-12			-002			X							X						
	8:30		Tp-11			-003			X							X						
	8:45		Tp-10			-004			X							X						
	9:00		Tp-3			-005			X							X						
	9:45		Tp-7			-006			X							X						
	10:00		Dw-1			-007			X							X						

Date:	Time:	Relinquished by:	Received by:	Date	Time
-28-15	1500	Robert Krakow	Christ Walte	4/28/15	1500
4/28/15	1820	Christa Walters		04/29/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

**HALL
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TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com*

May 07, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: River Terrace Low Flow 4/28/15 OrderNo.: 1504C15

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 7 sample(s) on 4/29/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: DW-3
Project: River Terrace Low Flow 4/28/15
Collection Date: 4/28/2015 10:15:00 AM
Lab ID: 1504C15-001 **Matrix:** AIR
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	61	5.0		µg/L	1	4/30/2015 12:45:01 PM	R25890
Surr: BFB	168	44.5-202		%REC	1	4/30/2015 12:45:01 PM	R25890
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	0.79	0.20		µg/L	2	4/30/2015 3:59:47 PM	R25895
Toluene	ND	0.20		µg/L	2	4/30/2015 3:59:47 PM	R25895
Ethylbenzene	7.0	0.20		µg/L	2	4/30/2015 3:59:47 PM	R25895
Xylenes, Total	4.4	0.60		µg/L	2	4/30/2015 3:59:47 PM	R25895
Surr: 1,2-Dichloroethane-d4	116	70-130		%REC	2	4/30/2015 3:59:47 PM	R25895
Surr: 4-Bromofluorobenzene	102	70-130		%REC	2	4/30/2015 3:59:47 PM	R25895
Surr: Dibromofluoromethane	97.3	70-130		%REC	2	4/30/2015 3:59:47 PM	R25895
Surr: Toluene-d8	98.5	70-130		%REC	2	4/30/2015 3:59:47 PM	R25895

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

Code	Description	Code	Description
*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: MW-49
Project: River Terrace Low Flow 4/28/15
Collection Date: 4/28/2015 11:30:00 AM
Lab ID: 1504C15-002
Matrix: AIR
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/30/2015 1:12:24 PM	R25890
Surr: BFB	92.3	44.5-202		%REC	1	4/30/2015 1:12:24 PM	R25890
EPA METHOD 8260B: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	0.10		µg/L	1	4/30/2015 4:27:18 PM	R25895
Toluene	ND	0.10		µg/L	1	4/30/2015 4:27:18 PM	R25895
Ethylbenzene	ND	0.10		µg/L	1	4/30/2015 4:27:18 PM	R25895
Xylenes, Total	ND	0.30		µg/L	1	4/30/2015 4:27:18 PM	R25895
Surr: 1,2-Dichloroethane-d4	104	70-130		%REC	1	4/30/2015 4:27:18 PM	R25895
Surr: 4-Bromofluorobenzene	104	70-130		%REC	1	4/30/2015 4:27:18 PM	R25895
Surr: Dibromofluoromethane	99.3	70-130		%REC	1	4/30/2015 4:27:18 PM	R25895
Surr: Toluene-d8	100	70-130		%REC	1	4/30/2015 4:27:18 PM	R25895

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	TP-5
Project:	River Terrace Low Flow 4/28/15	**Collection Date:**	4/28/2015 9:15:00 AM
Lab ID:	1504C15-003 **Matrix:** AIR	**Received Date:**	4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/30/2015 1:39:41 PM	R25890
Surr: BFB	88.6	44.5-202		%REC	1	4/30/2015 1:39:41 PM	R25890
EPA METHOD 8260B: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	0.10		µg/L	1	5/1/2015 12:18:26 PM	R25915
Toluene	ND	0.10		µg/L	1	5/1/2015 12:18:26 PM	R25915
Ethylbenzene	ND	0.10		µg/L	1	5/1/2015 12:18:26 PM	R25915
Xylenes, Total	ND	0.30		µg/L	1	5/1/2015 12:18:26 PM	R25915
Surr: 1,2-Dichloroethane-d4	111	70-130		%REC	1	5/1/2015 12:18:26 PM	R25915
Surr: 4-Bromofluorobenzene	101	70-130		%REC	1	5/1/2015 12:18:26 PM	R25915
Surr: Dibromofluoromethane	105	70-130		%REC	1	5/1/2015 12:18:26 PM	R25915
Surr: Toluene-d8	96.7	70-130		%REC	1	5/1/2015 12:18:26 PM	R25915

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: TP-6
Project: River Terrace Low Flow 4/28/15
Collection Date: 4/28/2015 10:45:00 AM
Lab ID: 1504C15-004
Matrix: AIR
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/30/2015 2:14:39 PM	R25890
Surr: BFB	90.3	44.5-202		%REC	1	4/30/2015 2:14:39 PM	R25890
EPA METHOD 8260B: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	0.10		µg/L	1	5/1/2015 12:45:52 PM	R25915
Toluene	ND	0.10		µg/L	1	5/1/2015 12:45:52 PM	R25915
Ethylbenzene	ND	0.10		µg/L	1	5/1/2015 12:45:52 PM	R25915
Xylenes, Total	ND	0.30		µg/L	1	5/1/2015 12:45:52 PM	R25915
Surr: 1,2-Dichloroethane-d4	108	70-130		%REC	1	5/1/2015 12:45:52 PM	R25915
Surr: 4-Bromofluorobenzene	98.8	70-130		%REC	1	5/1/2015 12:45:52 PM	R25915
Surr: Dibromofluoromethane	96.8	70-130		%REC	1	5/1/2015 12:45:52 PM	R25915
Surr: Toluene-d8	94.4	70-130		%REC	1	5/1/2015 12:45:52 PM	R25915

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: TP-8
Project: River Terrace Low Flow 4/28/15
Collection Date: 4/28/2015 11:00:00 AM
Lab ID: 1504C15-005
Matrix: AIR
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	5/1/2015 9:45:25 AM	R25914
Surr: BFB	88.2	44.5-202		%REC	1	5/1/2015 9:45:25 AM	R25914
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	0.10		µg/L	1	5/1/2015 1:13:22 PM	R25915
Toluene	ND	0.10		µg/L	1	5/1/2015 1:13:22 PM	R25915
Ethylbenzene	ND	0.10		µg/L	1	5/1/2015 1:13:22 PM	R25915
Xylenes, Total	ND	0.30		µg/L	1	5/1/2015 1:13:22 PM	R25915
Surr: 1,2-Dichloroethane-d4	108	70-130		%REC	1	5/1/2015 1:13:22 PM	R25915
Surr: 4-Bromofluorobenzene	100	70-130		%REC	1	5/1/2015 1:13:22 PM	R25915
Surr: Dibromofluoromethane	96.5	70-130		%REC	1	5/1/2015 1:13:22 PM	R25915
Surr: Toluene-d8	104	70-130		%REC	1	5/1/2015 1:13:22 PM	R25915

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Project: River Terrace Low Flow 4/28/15
Lab ID: 1504C15-006 **Matrix:** AIR

Client Sample ID: TP-8 Dup
Collection Date: 4/28/2015 11:00:00 AM
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE						Analyst: **NSB**	
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	5/1/2015 10:40:36 AM	R25914
Surr: BFB	90.6	44.5-202		%REC	1	5/1/2015 10:40:36 AM	R25914
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst: **DJF**	
Benzene	ND	0.10		µg/L	1	5/1/2015 1:40:55 PM	R25915
Toluene	ND	0.10		µg/L	1	5/1/2015 1:40:55 PM	R25915
Ethylbenzene	ND	0.10		µg/L	1	5/1/2015 1:40:55 PM	R25915
Xylenes, Total	ND	0.30		µg/L	1	5/1/2015 1:40:55 PM	R25915
Surr: 1,2-Dichloroethane-d4	103	70-130		%REC	1	5/1/2015 1:40:55 PM	R25915
Surr: 4-Bromofluorobenzene	101	70-130		%REC	1	5/1/2015 1:40:55 PM	R25915
Surr: Dibromofluoromethane	107	70-130		%REC	1	5/1/2015 1:40:55 PM	R25915
Surr: Toluene-d8	97.5	70-130		%REC	1	5/1/2015 1:40:55 PM	R25915

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: TP-9
Project: River Terrace Low Flow 4/28/15
Collection Date: 4/28/2015 9:30:00 AM
Lab ID: 1504C15-007
Matrix: AIR
Received Date: 4/29/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	5/1/2015 11:07:53 AM	R25914
Surr: BFB	89.8	44.5-202		%REC	1	5/1/2015 11:07:53 AM	R25914
EPA METHOD 8260B: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	0.10		µg/L	1	5/1/2015 2:08:27 PM	R25915
Toluene	ND	0.10		µg/L	1	5/1/2015 2:08:27 PM	R25915
Ethylbenzene	ND	0.10		µg/L	1	5/1/2015 2:08:27 PM	R25915
Xylenes, Total	ND	0.30		µg/L	1	5/1/2015 2:08:27 PM	R25915
Surr: 1,2-Dichloroethane-d4	101	70-130		%REC	1	5/1/2015 2:08:27 PM	R25915
Surr: 4-Bromofluorobenzene	97.0	70-130		%REC	1	5/1/2015 2:08:27 PM	R25915
Surr: Dibromofluoromethane	98.6	70-130		%REC	1	5/1/2015 2:08:27 PM	R25915
Surr: Toluene-d8	96.9	70-130		%REC	1	5/1/2015 2:08:27 PM	R25915

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southw   Work Order Number: 1504C15   RcptNo: 1

Received by/date: 04/29/15

Logged By: Lindsay Mangin   4/29/2015 7:00:00 AM

Completed By: Lindsay Mangin   4/29/2015 9:00:27 AM

Reviewed By: CS   04/29/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☐ No ☐ NA ☑
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☐ No ☐ NA ☑
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? Yes ☐ No ☐ No VOA Vials ☑
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

# of preserved bottles checked for pH: ______ (<2 or >12 unless noted)
Adjusted? ______
Checked by: ______

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: ______ Date: ______
By Whom: ______ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ______
Client Instructions: ______

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	NA	Good	Yes			

Chain-of-Custody Record

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Client: Western Refining

Mailing Address: #50 CR4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: 4-28-15
River Terrace Low flow

Project #:

Project Manager:

Sampler: Bob + MATT

On Ice: ☐ Yes ☒ No

Sample Temperature: N/A

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504C15	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX only	8270 (Semi-VOA)					Air Bubbles (Y or N)
-28-15	10:15	Air	Dw-3	Tedlar Bag		-001			X							X						
	11:30		MW-49			-002			X							X						
	9:15		~~#~~Tp-5			-003			X							X						
	10:45		Tp-6			-004			X							X						
	11:00		Tp-8			-005			X							X						
	11:00		Tp-8 Dup			-006			X							X						
	9:30		Tp-9			-007			X							X						

Date:	Time:	Relinquished by:	Received by:	Date	Time
-28-15	1500	Robert Brakow	Christie Walte	4/28/15	1500
/28/15	1820	Christie Walter		04/29/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

January 13, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 1-5-15 OrderNo.: 1501054

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 1/6/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Lag
Project: GAC 1-5-15
Collection Date: 1/5/2015 10:30:00 AM
Lab ID: 1501054-001
Matrix: AQUEOUS
Received Date: 1/6/2015 7:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**BCN**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	1/6/2015 3:12:09 PM	17084
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	1/6/2015 3:12:09 PM	17084
Surr: DNOP	105	75.2-161		%REC	1	1/6/2015 3:12:09 PM	17084
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	1/6/2015 4:16:39 PM	R23499
Surr: BFB	88.2	80-120		%REC	1	1/6/2015 4:16:39 PM	R23499
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	1/9/2015 12:23:04 PM	R23576
Toluene	ND	1.0		µg/L	1	1/9/2015 12:23:04 PM	R23576
Ethylbenzene	ND	1.0		µg/L	1	1/9/2015 12:23:04 PM	R23576
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	1/9/2015 12:23:04 PM	R23576
Xylenes, Total	ND	1.5		µg/L	1	1/9/2015 12:23:04 PM	R23576
Surr: 1,2-Dichloroethane-d4	77.9	70-130		%REC	1	1/9/2015 12:23:04 PM	R23576
Surr: 4-Bromofluorobenzene	85.9	70-130		%REC	1	1/9/2015 12:23:04 PM	R23576
Surr: Dibromofluoromethane	94.3	70-130		%REC	1	1/9/2015 12:23:04 PM	R23576
Surr: Toluene-d8	95.8	70-130		%REC	1	1/9/2015 12:23:04 PM	R23576

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT:	Western Refining Southwest, Inc.		**Client Sample ID:**	GAC-Lead
Project:	GAC 1-5-15		**Collection Date:**	1/5/2015 10:40:00 AM
Lab ID:	1501054-002	**Matrix:** AQUEOUS	**Received Date:**	1/6/2015 7:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**BCN**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	1/6/2015 4:42:33 PM	17084
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	1/6/2015 4:42:33 PM	17084
Surr: DNOP	105	75.2-161		%REC	1	1/6/2015 4:42:33 PM	17084
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	1/6/2015 4:45:15 PM	R23499
Surr: BFB	90.4	80-120		%REC	1	1/6/2015 4:45:15 PM	R23499
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	1/9/2015 1:45:40 PM	R23576
Toluene	ND	1.0		µg/L	1	1/9/2015 1:45:40 PM	R23576
Ethylbenzene	ND	1.0		µg/L	1	1/9/2015 1:45:40 PM	R23576
Methyl tert-butyl ether (MTBE)	1.6	1.0		µg/L	1	1/9/2015 1:45:40 PM	R23576
Xylenes, Total	ND	1.5		µg/L	1	1/9/2015 1:45:40 PM	R23576
Surr: 1,2-Dichloroethane-d4	79.0	70-130		%REC	1	1/9/2015 1:45:40 PM	R23576
Surr: 4-Bromofluorobenzene	86.6	70-130		%REC	1	1/9/2015 1:45:40 PM	R23576
Surr: Dibromofluoromethane	95.4	70-130		%REC	1	1/9/2015 1:45:40 PM	R23576
Surr: Toluene-d8	92.8	70-130		%REC	1	1/9/2015 1:45:40 PM	R23576

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
	O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Inlet
Project: GAC 1-5-15
Collection Date: 1/5/2015 10:50:00 AM
Lab ID: 1501054-003
Matrix: AQUEOUS
Received Date: 1/6/2015 7:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**BCN**
Diesel Range Organics (DRO)	1.1	0.20		mg/L	1	1/6/2015 5:12:46 PM	17084
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	1/6/2015 5:12:46 PM	17084
Surr: DNOP	104	75.2-161		%REC	1	1/6/2015 5:12:46 PM	17084
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	4.2	0.50		mg/L	10	1/6/2015 5:13:57 PM	R23499
Surr: BFB	141	80-120	S	%REC	10	1/6/2015 5:13:57 PM	R23499
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	81	10		µg/L	10	1/9/2015 2:13:16 PM	R23576
Toluene	ND	10		µg/L	10	1/9/2015 2:13:16 PM	R23576
Ethylbenzene	720	10		µg/L	10	1/9/2015 2:13:16 PM	R23576
Methyl tert-butyl ether (MTBE)	ND	10		µg/L	10	1/9/2015 2:13:16 PM	R23576
Xylenes, Total	500	15		µg/L	10	1/9/2015 2:13:16 PM	R23576
Surr: 1,2-Dichloroethane-d4	78.9	70-130		%REC	10	1/9/2015 2:13:16 PM	R23576
Surr: 4-Bromofluorobenzene	84.8	70-130		%REC	10	1/9/2015 2:13:16 PM	R23576
Surr: Dibromofluoromethane	94.8	70-130		%REC	10	1/9/2015 2:13:16 PM	R23576
Surr: Toluene-d8	93.5	70-130		%REC	10	1/9/2015 2:13:16 PM	R23576

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
	O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	Spike Recovery outside accepted recovery limits		

Client: Western Refining Southwest, Inc.
Project: GAC 1-5-15

Sample ID	**MB-17084**	SampType:	**MBLK**	TestCode:	**EPA Method 8015D: Diesel Range**
Client ID:	**PBW**	Batch ID:	**17084**	RunNo:	**23504**
Prep Date:	**1/6/2015**	Analysis Date:	**1/6/2015**	SeqNo:	**694274** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.45		0.5000		89.6	75.2	161			

Sample ID	**1501054-001CMS**	SampType:	**MS**	TestCode:	**EPA Method 8015D: Diesel Range**
Client ID:	**GAC-Lag**	Batch ID:	**17084**	RunNo:	**23504**
Prep Date:	**1/6/2015**	Analysis Date:	**1/6/2015**	SeqNo:	**694371** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.1	0.20	2.500	0	126	82.6	172			
Surr: DNOP	0.31		0.2500		123	75.2	161			

Sample ID	**1501054-001CMSD**	SampType:	**MSD**	TestCode:	**EPA Method 8015D: Diesel Range**
Client ID:	**GAC-Lag**	Batch ID:	**17084**	RunNo:	**23504**
Prep Date:	**1/6/2015**	Analysis Date:	**1/6/2015**	SeqNo:	**694372** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.9	0.20	2.500	0	117	82.6	172	7.58	33.9	
Surr: DNOP	0.27		0.2500		108	75.2	161	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1501054**

13-Jan-15

Client: Western Refining Southwest, Inc.

Project: GAC 1-5-15

Sample ID **5ML RB**		SampType: **MBLK**			TestCode: **EPA Method 8015D: Gasoline Range**					
Client ID: **PBW**		Batch ID: **R23499**			RunNo: **23499**					
Prep Date:		Analysis Date: **1/6/2015**			SeqNo: **694364**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	17		20.00		86.6	80	120			

Sample ID **1501054-003BMS**		SampType: **MS**			TestCode: **EPA Method 8015D: Gasoline Range**					
Client ID: **GAC-Inlet**		Batch ID: **R23499**			RunNo: **23499**					
Prep Date:		Analysis Date: **1/6/2015**			SeqNo: **694369**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	8.3	0.50	5.000	4.250	80.3	70.4	127			
Surr: BFB	290		200.0		147	80	120			S

Sample ID **1501054-003BMSD**		SampType: **MSD**			TestCode: **EPA Method 8015D: Gasoline Range**					
Client ID: **GAC-Inlet**		Batch ID: **R23499**			RunNo: **23499**					
Prep Date:		Analysis Date: **1/6/2015**			SeqNo: **694370**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	7.6	0.50	5.000	4.250	66.6	70.4	127	8.61	20	S
Surr: BFB	280		200.0		141	80	120	0	0	S

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1501054**

13-Jan-15

Client: Western Refining Southwest, Inc.
Project: GAC 1-5-15

Sample ID **5ml rb** SampType: **MBLK** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW** Batch ID: **R23576** RunNo: **23576**
Prep Date: Analysis Date: **1/9/2015** SeqNo: **696442** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	8.3		10.00		82.9	70	130			
Surr: 4-Bromofluorobenzene	8.4		10.00		83.6	70	130			
Surr: Dibromofluoromethane	9.5		10.00		95.3	70	130			
Surr: Toluene-d8	9.5		10.00		95.2	70	130			

Sample ID **1501054-001ams** SampType: **MS** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **GAC-Lag** Batch ID: **R23576** RunNo: **23576**
Prep Date: Analysis Date: **1/9/2015** SeqNo: **696445** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	19	1.0	20.00	0	94.8	70	130			
Toluene	23	1.0	20.00	0	113	70	130			
Surr: 1,2-Dichloroethane-d4	8.2		10.00		81.7	70	130			
Surr: 4-Bromofluorobenzene	8.8		10.00		88.2	70	130			
Surr: Dibromofluoromethane	10		10.00		100	70	130			
Surr: Toluene-d8	9.4		10.00		93.6	70	130			

Sample ID **1501054-001amsd** SampType: **MSD** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **GAC-Lag** Batch ID: **R23576** RunNo: **23576**
Prep Date: Analysis Date: **1/9/2015** SeqNo: **696446** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	19	1.0	20.00	0	92.8	70	130	2.09	20	
Toluene	22	1.0	20.00	0	108	70	130	4.48	20	
Surr: 1,2-Dichloroethane-d4	8.1		10.00		80.9	70	130	0	0	
Surr: 4-Bromofluorobenzene	8.6		10.00		85.6	70	130	0	0	
Surr: Dibromofluoromethane	9.5		10.00		95.4	70	130	0	0	
Surr: Toluene-d8	8.9		10.00		88.9	70	130	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southw Work Order Number: 1501054 RcptNo: 1

Received by/date: 01/06/15
Logged By: **Lindsay Mangin** 1/6/2015 7:10:00 AM
Completed By: **Lindsay Mangin** 1/6/2015 7:49:51 AM
Reviewed By: AT 01/06/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? ~~Yes ☑~~ No ☑ No VOA Vials ☐ CS 01/06/15
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

Samples -002A (2 of 3 and 3 of 3) and -002E (2 of 2) have air bubbles.

# of preserved bottles checked for pH: ______
(<2 or >12 unless noted)
Adjusted? ______
Checked by: ______

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: ______ Date: ______
By Whom: ______ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ______
Client Instructions: ______

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp ºC	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.8	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC - 1-5-15

Project #:

Project Manager:

Sampler: Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.8

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1501054	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO Ext. 8015B				Air Bubbles (Y or N)
-5-15	1030	H_2O	GAC - LAG	5-VOA	HCl	-001			X							X						
				1-500	amber													X				
	1040		GAC - Lead	5-VOA	HCl	-002			X							X						
				1-500	amber													X				
	1050		GAC - inlet	5-VOA	HCl	-003			X							X						
				1-500	amber													X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
1-5-15	1457	Robert Krakow	Mistie White	1/5/15	1457
1/5/15	1822	Mistie White		01/06/15	0710

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

February 09, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 2-2-15 OrderNo.: 1502055

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 2 sample(s) on 2/3/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Hall Environmental Analysis Laboratory, Inc.

Analytical Report
Lab Order **1502055**
Date Reported: **2/9/2015**

CLIENT: Western Refining Southwest, Inc.
Project: GAC 2-2-15
Lab ID: 1502055-001
Matrix: AQUEOUS
Client Sample ID: GAC-Inlet
Collection Date: 2/2/2015 9:15:00 AM
Received Date: 2/3/2015 8:20:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	3.2	0.20		mg/L	1	2/4/2015 2:36:33 AM	17543
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	2/4/2015 2:36:33 AM	17543
Surr: DNOP	109	69.6-155		%REC	1	2/4/2015 2:36:33 AM	17543
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	3.8	0.50		mg/L	10	2/5/2015 11:50:44 AM	R24131
Surr: BFB	125	80-120	S	%REC	10	2/5/2015 11:50:44 AM	R24131
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**KJH**
Benzene	90	10		µg/L	10	2/4/2015 6:27:19 PM	R24108
Toluene	ND	10		µg/L	10	2/4/2015 6:27:19 PM	R24108
Ethylbenzene	490	10		µg/L	10	2/4/2015 6:27:19 PM	R24108
Methyl tert-butyl ether (MTBE)	ND	10		µg/L	10	2/4/2015 6:27:19 PM	R24108
Xylenes, Total	270	15		µg/L	10	2/4/2015 6:27:19 PM	R24108
Surr: 1,2-Dichloroethane-d4	98.0	70-130		%REC	10	2/4/2015 6:27:19 PM	R24108
Surr: 4-Bromofluorobenzene	90.0	70-130		%REC	10	2/4/2015 6:27:19 PM	R24108
Surr: Dibromofluoromethane	97.3	70-130		%REC	10	2/4/2015 6:27:19 PM	R24108
Surr: Toluene-d8	101	70-130		%REC	10	2/4/2015 6:27:19 PM	R24108

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date Reported: **2/9/2015**

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Lead
Project: GAC 2-2-15
Collection Date: 2/2/2015 9:25:00 AM
Lab ID: 1502055-002
Matrix: AQUEOUS
Received Date: 2/3/2015 8:20:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE							Analyst: **JME**
Diesel Range Organics (DRO)	0.40	0.20		mg/L	1	2/4/2015 3:58:29 AM	17543
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	2/4/2015 3:58:29 AM	17543
Surr: DNOP	123	69.6-155		%REC	1	2/4/2015 3:58:29 AM	17543
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	2/5/2015 1:39:22 PM	R24131
Surr: BFB	91.3	80-120		%REC	1	2/5/2015 1:39:22 PM	R24131
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **KJH**
Benzene	ND	1.0		µg/L	1	2/4/2015 6:56:01 PM	R24108
Toluene	ND	1.0		µg/L	1	2/4/2015 6:56:01 PM	R24108
Ethylbenzene	ND	1.0		µg/L	1	2/4/2015 6:56:01 PM	R24108
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	2/4/2015 6:56:01 PM	R24108
Xylenes, Total	ND	1.5		µg/L	1	2/4/2015 6:56:01 PM	R24108
Surr: 1,2-Dichloroethane-d4	92.6	70-130		%REC	1	2/4/2015 6:56:01 PM	R24108
Surr: 4-Bromofluorobenzene	90.8	70-130		%REC	1	2/4/2015 6:56:01 PM	R24108
Surr: Dibromofluoromethane	93.8	70-130		%REC	1	2/4/2015 6:56:01 PM	R24108
Surr: Toluene-d8	88.1	70-130		%REC	1	2/4/2015 6:56:01 PM	R24108

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
	O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1502055**

09-Feb-15

Client: Western Refining Southwest, Inc.

Project: GAC 2-2-15

Sample ID **MB-17543** SampType: **MBLK** TestCode: **EPA Method 8015D: Diesel Range**

Client ID: **PBW** Batch ID: **17543** RunNo: **24055**

Prep Date: **2/3/2015** Analysis Date: **2/4/2015** SeqNo: **711095** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.44		0.5000		87.8	69.6	155			

Sample ID **1502055-001CMS** SampType: **MS** TestCode: **EPA Method 8015D: Diesel Range**

Client ID: **GAC-Inlet** Batch ID: **17543** RunNo: **24055**

Prep Date: **2/3/2015** Analysis Date: **2/4/2015** SeqNo: **711102** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	5.6	0.20	2.500	3.189	97.0	82.6	172			
Surr: DNOP	0.31		0.2500		122	69.6	155			

Sample ID **1502055-001CMSD** SampType: **MSD** TestCode: **EPA Method 8015D: Diesel Range**

Client ID: **GAC-Inlet** Batch ID: **17543** RunNo: **24055**

Prep Date: **2/3/2015** Analysis Date: **2/4/2015** SeqNo: **711103** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	7.1	0.20	2.500	3.189	155	82.6	172	22.7	33.9	
Surr: DNOP	0.32		0.2500		129	69.6	155	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1502055**

09-Feb-15

Client: Western Refining Southwest, Inc.

Project: GAC 2-2-15

Sample ID **5ML RB**		SampType: **MBLK**			TestCode: **EPA Method 8015D: Gasoline Range**					
Client ID: **PBW**		Batch ID: **R24131**			RunNo: **24131**					
Prep Date:		Analysis Date: **2/5/2015**			SeqNo: **711504**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	17		20.00		84.2	80	120			

Sample ID **1502055-001BMS**		SampType: **MS**			TestCode: **EPA Method 8015D: Gasoline Range**					
Client ID: **GAC-Inlet**		Batch ID: **R24131**			RunNo: **24131**					
Prep Date:		Analysis Date: **2/5/2015**			SeqNo: **711509**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	8.3	0.50	5.000	3.798	90.6	70.4	127			
Surr: BFB	260		200.0		132	80	120			S

Sample ID **1502055-001BMSD**		SampType: **MSD**			TestCode: **EPA Method 8015D: Gasoline Range**					
Client ID: **GAC-Inlet**		Batch ID: **R24131**			RunNo: **24131**					
Prep Date:		Analysis Date: **2/5/2015**			SeqNo: **711510**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	8.0	0.50	5.000	3.798	84.4	70.4	127	3.77	20	
Surr: BFB	260		200.0		130	80	120	0	0	S

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Client: Western Refining Southwest, Inc.

Project: GAC 2-2-15

Sample ID	**5mL-rb**	SampType:	**MBLK**	TestCode:	**EPA Method 8260: Volatiles Short List**
Client ID:	**PBW**	Batch ID:	**R24108**	RunNo:	**24108**
Prep Date:		Analysis Date:	**2/4/2015**	SeqNo:	**710603** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	8.8		10.00		88.2	70	130			
Surr: 4-Bromofluorobenzene	9.9		10.00		99.3	70	130			
Surr: Dibromofluoromethane	9.1		10.00		91.1	70	130			
Surr: Toluene-d8	10		10.00		102	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southw Work Order Number: 1502055 RcptNo: 1

Received by/date: AT 02/03/15

Logged By: **Ashley Gallegos** 2/3/2015 8:20:00 AM

Completed By: **Ashley Gallegos** 2/3/2015 8:51:22 AM

Reviewed By: Mg 02/03/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

# of preserved bottles checked for pH: ______
(<2 or >12 unless noted)
Adjusted? ______
Checked by: ______

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: ______ Date ______
By Whom: ______ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ______
Client Instructions: ______

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.2	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC 2-2-15

Project #:
12610954 per Bob Ag 02/05

Project Manager:

Sampler: Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.2

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1502055	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / ~~DRO / MRO~~)	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Ext, 8015B				Air Bubbles (Y or N)
-2-15	9:15	H_2O	GAC-inlet	5-VOA	HCl	-001			X							X						
|	\	|	\	1-500ml	amber													X				
|	9:25	|	GAC-~~[illegible]~~Lead	5-VOA	HCl	-002			X							X						
|	\		\	1-500ml	amber													X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-2-15	1556	Robert Krakow		2/2/15	1556
2/2/15	1744	Cht Walker		02/03/15	0820

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

March 06, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 3-2-15 OrderNo.: 1503057

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 3/3/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1503057**
Date Reported: **3/6/2015**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC Inlet
Project: GAC 3-2-15
Collection Date: 3/2/2015 9:20:00 AM
Lab ID: 1503057-001
Matrix: AQUEOUS
Received Date: 3/3/2015 7:20:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE							Analyst: **JME**
Diesel Range Organics (DRO)	2.2	0.20		mg/L	1	3/4/2015 12:19:12 PM	17973
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	3/4/2015 12:19:12 PM	17973
Surr: DNOP	138	69.6-155		%REC	1	3/4/2015 12:19:12 PM	17973
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	7.3	0.50		mg/L	10	3/3/2015 12:58:59 PM	R24608
Surr: BFB	152	80-120	S	%REC	10	3/3/2015 12:58:59 PM	R24608
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **KJH**
Benzene	120	10		µg/L	10	3/3/2015 3:53:48 PM	R24599
Toluene	ND	10		µg/L	10	3/3/2015 3:53:48 PM	R24599
Ethylbenzene	770	10		µg/L	10	3/3/2015 3:53:48 PM	R24599
Methyl tert-butyl ether (MTBE)	ND	10		µg/L	10	3/3/2015 3:53:48 PM	R24599
Xylenes, Total	1800	15		µg/L	10	3/3/2015 3:53:48 PM	R24599
Surr: 1,2-Dichloroethane-d4	107	70-130		%REC	10	3/3/2015 3:53:48 PM	R24599
Surr: 4-Bromofluorobenzene	90.7	70-130		%REC	10	3/3/2015 3:53:48 PM	R24599
Surr: Dibromofluoromethane	110	70-130		%REC	10	3/3/2015 3:53:48 PM	R24599
Surr: Toluene-d8	96.7	70-130		%REC	10	3/3/2015 3:53:48 PM	R24599

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC Lead
Project: GAC 3-2-15
Collection Date: 3/2/2015 9:10:00 AM
Lab ID: 1503057-002
Matrix: AQUEOUS
Received Date: 3/3/2015 7:20:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	3/4/2015 8:20:11 AM	17973
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	3/4/2015 8:20:11 AM	17973
Surr: DNOP	182	69.6-155	S	%REC	1	3/4/2015 8:20:11 AM	17973
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	3/3/2015 2:55:49 PM	R24608
Surr: BFB	84.0	80-120		%REC	1	3/3/2015 2:55:49 PM	R24608
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**KJH**
Benzene	ND	1.0		µg/L	1	3/3/2015 4:22:29 PM	R24599
Toluene	ND	1.0		µg/L	1	3/3/2015 4:22:29 PM	R24599
Ethylbenzene	ND	1.0		µg/L	1	3/3/2015 4:22:29 PM	R24599
Methyl tert-butyl ether (MTBE)	1.7	1.0		µg/L	1	3/3/2015 4:22:29 PM	R24599
Xylenes, Total	ND	1.5		µg/L	1	3/3/2015 4:22:29 PM	R24599
Surr: 1,2-Dichloroethane-d4	104	70-130		%REC	1	3/3/2015 4:22:29 PM	R24599
Surr: 4-Bromofluorobenzene	90.9	70-130		%REC	1	3/3/2015 4:22:29 PM	R24599
Surr: Dibromofluoromethane	112	70-130		%REC	1	3/3/2015 4:22:29 PM	R24599
Surr: Toluene-d8	96.3	70-130		%REC	1	3/3/2015 4:22:29 PM	R24599

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC Lag
Project: GAC 3-2-15
Collection Date: 3/2/2015 9:00:00 AM
Lab ID: 1503057-003
Matrix: AQUEOUS
Received Date: 3/3/2015 7:20:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE							Analyst: **JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	3/4/2015 8:47:29 AM	17973
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	3/4/2015 8:47:29 AM	17973
Surr: DNOP	119	69.6-155		%REC	1	3/4/2015 8:47:29 AM	17973
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	3/3/2015 3:25:01 PM	R24608
Surr: BFB	87.1	80-120		%REC	1	3/3/2015 3:25:01 PM	R24608
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **KJH**
Benzene	ND	1.0		µg/L	1	3/3/2015 4:51:10 PM	R24599
Toluene	ND	1.0		µg/L	1	3/3/2015 4:51:10 PM	R24599
Ethylbenzene	ND	1.0		µg/L	1	3/3/2015 4:51:10 PM	R24599
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	3/3/2015 4:51:10 PM	R24599
Xylenes, Total	ND	1.5		µg/L	1	3/3/2015 4:51:10 PM	R24599
Surr: 1,2-Dichloroethane-d4	94.2	70-130		%REC	1	3/3/2015 4:51:10 PM	R24599
Surr: 4-Bromofluorobenzene	96.3	70-130		%REC	1	3/3/2015 4:51:10 PM	R24599
Surr: Dibromofluoromethane	100	70-130		%REC	1	3/3/2015 4:51:10 PM	R24599
Surr: Toluene-d8	98.3	70-130		%REC	1	3/3/2015 4:51:10 PM	R24599

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1503057**

06-Mar-15

Client: Western Refining Southwest, Inc.

Project: GAC 3-2-15

Sample ID **MB-17973**	SampType: **MBLK**	TestCode: **EPA Method 8015D: Diesel Range**	
Client ID: **PBW**	Batch ID: **17973**	RunNo: **24589**	
Prep Date: **3/3/2015**	Analysis Date: **3/4/2015**	SeqNo: **725503**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.56		0.5000		111	69.6	155			

Sample ID **LCS-17973**	SampType: **LCS**	TestCode: **EPA Method 8015D: Diesel Range**	
Client ID: **LCSW**	Batch ID: **17973**	RunNo: **24617**	
Prep Date: **3/3/2015**	Analysis Date: **3/4/2015**	SeqNo: **725618**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.8	0.20	2.500	0	111	65.8	162			
Surr: DNOP	0.27		0.2500		109	69.6	155			

Sample ID **1503057-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015D: Diesel Range**	
Client ID: **GAC Inlet**	Batch ID: **17973**	RunNo: **24617**	
Prep Date: **3/3/2015**	Analysis Date: **3/4/2015**	SeqNo: **725673**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	5.9	0.20	2.500	2.152	151	82.6	172			
Surr: DNOP	0.35		0.2500		142	69.6	155			

Sample ID **1503057-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015D: Diesel Range**	
Client ID: **GAC Inlet**	Batch ID: **17973**	RunNo: **24617**	
Prep Date: **3/3/2015**	Analysis Date: **3/4/2015**	SeqNo: **725742**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	6.0	0.20	2.500	2.152	152	82.6	172	0.500	33.9	
Surr: DNOP	0.34		0.2500		134	69.6	155	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Client: Western Refining Southwest, Inc.
Project: GAC 3-2-15

Sample ID **5ML RB** SampType: **MBLK** TestCode: **EPA Method 8015D: Gasoline Range**
Client ID: **PBW** Batch ID: **R24608** RunNo: **24608**
Prep Date: Analysis Date: **3/3/2015** SeqNo: **725169** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	18		20.00		87.7	80	120			

Sample ID **2.5UG GRO LCS** SampType: **LCS** TestCode: **EPA Method 8015D: Gasoline Range**
Client ID: **LCSW** Batch ID: **R24608** RunNo: **24608**
Prep Date: Analysis Date: **3/3/2015** SeqNo: **725185** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.46	0.050	0.5000	0	91.9	80	120			
Surr: BFB	20		20.00		101	80	120			

Sample ID **1503057-001AMS** SampType: **MS** TestCode: **EPA Method 8015D: Gasoline Range**
Client ID: **GAC Inlet** Batch ID: **R24608** RunNo: **24608**
Prep Date: Analysis Date: **3/3/2015** SeqNo: **725216** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	12	0.50	5.000	7.332	103	51	131			
Surr: BFB	320		200.0		162	80	120			S

Sample ID **1503057-001AMSD** SampType: **MSD** TestCode: **EPA Method 8015D: Gasoline Range**
Client ID: **GAC Inlet** Batch ID: **R24608** RunNo: **24608**
Prep Date: Analysis Date: **3/3/2015** SeqNo: **725234** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	12	0.50	5.000	7.332	97.7	51	131	2.27	20	
Surr: BFB	330		200.0		165	80	120	0	0	S

Qualifiers:

*	Value exceeds Maximum Contaminant Level.
E	Value above quantitation range
J	Analyte detected below quantitation limits
O	RSD is greater than RSDlimit
R	RPD outside accepted recovery limits
S	Spike Recovery outside accepted recovery limits
B	Analyte detected in the associated Method Blank
H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit
P	Sample pH Not In Range
RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1503057**

06-Mar-15

Client: Western Refining Southwest, Inc.
Project: GAC 3-2-15

Sample ID **5mL-rb** SampType: **MBLK** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW** Batch ID: **R24599** RunNo: **24599**
Prep Date: Analysis Date: **3/3/2015** SeqNo: **724971** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	10		10.00		102	70	130			
Surr: 4-Bromofluorobenzene	9.0		10.00		89.7	70	130			
Surr: Dibromofluoromethane	11		10.00		114	70	130			
Surr: Toluene-d8	10		10.00		102	70	130			

Sample ID **100ng lcs** SampType: **LCS** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **LCSW** Batch ID: **R24599** RunNo: **24599**
Prep Date: Analysis Date: **3/3/2015** SeqNo: **724972** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	20	1.0	20.00	0	102	70	130			
Toluene	19	1.0	20.00	0	95.5	70	130			
Surr: 1,2-Dichloroethane-d4	9.3		10.00		92.9	70	130			
Surr: 4-Bromofluorobenzene	9.0		10.00		89.8	70	130			
Surr: Dibromofluoromethane	9.9		10.00		98.6	70	130			
Surr: Toluene-d8	9.4		10.00		94.3	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southw   Work Order Number: 1503057   RcptNo: 1

Received by/date: LM 03/03/15

Logged By: Anne Thorne   3/3/2015 7:20:00 AM

Completed By: Anne Thorne   3/3/2015

Reviewed By: IO   03/03/15

Chain of Custody

1.	Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
2.	Is Chain of Custody complete?	Yes ☑	No ☐	Not Present ☐
3.	How was the sample delivered?	Courier		

Log In

4.	Was an attempt made to cool the samples?	Yes ☑	No ☐	NA ☐
5.	Were all samples received at a temperature of >0° C to 6.0°C	Yes ☑	No ☐	NA ☐
6.	Sample(s) in proper container(s)?	Yes ☑	No ☐	
7.	Sufficient sample volume for indicated test(s)?	Yes ☑	No ☐	
8.	Are samples (except VOA and ONG) properly preserved?	Yes ☑	No ☐	
9.	Was preservative added to bottles?	Yes ☐	No ☑	NA ☐
10.	VOA vials have zero headspace?	Yes ☐	No ☐	No VOA Vials ☑
11.	Were any sample containers received broken?	Yes ☐	No ☑	
12.	Does paperwork match bottle labels? (Note discrepancies on chain of custody)	Yes ☑	No ☐	
13.	Are matrices correctly identified on Chain of Custody?	Yes ☑	No ☐	
14.	Is it clear what analyses were requested?	Yes ☑	No ☐	
15.	Were all holding times able to be met? (If no, notify customer for authorization.)	Yes ☑	No ☐	

# of preserved bottles checked for pH: ______
(<2 or >12 unless noted)
Adjusted? ______
Checked by: ______

Special Handling (if applicable)

16.	Was client notified of all discrepancies with this order?	Yes ☐	No ☑	NA ☐

Person Notified: ______   Date ______
By Whom: ______   Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ______
Client Instructions: ______

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.4	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: GAC 3-2-15

Project #:

Project Manager:

Sampler: Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.4

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1503057	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted]	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Extended 8015B				Air Bubbles (Y or N)
-2-15	9:20	H_2O	GAC-inlet	4-VOA	HCl	-001			X							X						
				1-500ml	amber	-001												X				
	9:10		GAC-Lead	4-VOA	HCl	-002			X							X						
				1-500ml	amber	-002												X				
	9:00		GAC-Lag	4-VOA	HCl	-003			X							X						
				1-500ml	amber	-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-2-15	1320	Robert Krakow	Christina Walters	3/2/15	1320
3/2/15	1737	Christina Walters		03/03/15	0720

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

**HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY**

*Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com*

April 08, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 4-1-15 OrderNo.: 1504079

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 4/2/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1504079**
Date Reported: **4/8/2015**

Hall Environmental Analysis Laboratory, Inc.

CLIENT:	Western Refining Southwest, Inc.			**Client Sample ID:**	GAC-Lag
Project:	GAC 4-1-15			**Collection Date:**	4/1/2015 10:30:00 AM
Lab ID:	1504079-001	**Matrix:**	AQUEOUS	**Received Date:**	4/2/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/2/2015 8:34:31 PM	18478
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/2/2015 8:34:31 PM	18478
Surr: DNOP	142	69.6-155		%REC	1	4/2/2015 8:34:31 PM	18478
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**RAA**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	4/6/2015 12:12:06 PM	R25329
Surr: BFB	86.1	80-120		%REC	1	4/6/2015 12:12:06 PM	R25329
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	4/2/2015 2:53:13 PM	R25251
Toluene	ND	1.0		µg/L	1	4/2/2015 2:53:13 PM	R25251
Ethylbenzene	ND	1.0		µg/L	1	4/2/2015 2:53:13 PM	R25251
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	4/2/2015 2:53:13 PM	R25251
Xylenes, Total	ND	1.5		µg/L	1	4/2/2015 2:53:13 PM	R25251
Surr: 1,2-Dichloroethane-d4	90.1	70-130		%REC	1	4/2/2015 2:53:13 PM	R25251
Surr: 4-Bromofluorobenzene	99.0	70-130		%REC	1	4/2/2015 2:53:13 PM	R25251
Surr: Dibromofluoromethane	102	70-130		%REC	1	4/2/2015 2:53:13 PM	R25251
Surr: Toluene-d8	93.0	70-130		%REC	1	4/2/2015 2:53:13 PM	R25251

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
	O	RSD is greater than RSDlimit	P	Sample pH Not In Range
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Lead
Project: GAC 4-1-15
Collection Date: 4/1/2015 10:45:00 AM
Lab ID: 1504079-002
Matrix: AQUEOUS
Received Date: 4/2/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/2/2015 9:55:19 PM	18478
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/2/2015 9:55:19 PM	18478
Surr: DNOP	144	69.6-155		%REC	1	4/2/2015 9:55:19 PM	18478
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**RAA**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	4/2/2015 5:40:26 PM	R25270
Surr: BFB	85.2	80-120		%REC	1	4/2/2015 5:40:26 PM	R25270
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	4/2/2015 4:16:19 PM	R25251
Toluene	ND	1.0		µg/L	1	4/2/2015 4:16:19 PM	R25251
Ethylbenzene	ND	1.0		µg/L	1	4/2/2015 4:16:19 PM	R25251
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	4/2/2015 4:16:19 PM	R25251
Xylenes, Total	ND	1.5		µg/L	1	4/2/2015 4:16:19 PM	R25251
Surr: 1,2-Dichloroethane-d4	99.4	70-130		%REC	1	4/2/2015 4:16:19 PM	R25251
Surr: 4-Bromofluorobenzene	90.5	70-130		%REC	1	4/2/2015 4:16:19 PM	R25251
Surr: Dibromofluoromethane	103	70-130		%REC	1	4/2/2015 4:16:19 PM	R25251
Surr: Toluene-d8	88.0	70-130		%REC	1	4/2/2015 4:16:19 PM	R25251

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Inlet
Project: GAC 4-1-15
Collection Date: 4/1/2015 10:55:00 AM
Lab ID: 1504079-003
Matrix: AQUEOUS
Received Date: 4/2/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	2.9	0.20		mg/L	1	4/2/2015 10:22:19 PM	18478
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/2/2015 10:22:19 PM	18478
Surr: DNOP	144	69.6-155		%REC	1	4/2/2015 10:22:19 PM	18478
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**RAA**
Gasoline Range Organics (GRO)	4.6	0.50		mg/L	10	4/2/2015 6:09:42 PM	R25270
Surr: BFB	150	80-120	S	%REC	10	4/2/2015 6:09:42 PM	R25270
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	130	10		µg/L	10	4/2/2015 4:43:47 PM	R25251
Toluene	ND	10		µg/L	10	4/2/2015 4:43:47 PM	R25251
Ethylbenzene	790	10		µg/L	10	4/2/2015 4:43:47 PM	R25251
Methyl tert-butyl ether (MTBE)	ND	10		µg/L	10	4/2/2015 4:43:47 PM	R25251
Xylenes, Total	1000	15		µg/L	10	4/2/2015 4:43:47 PM	R25251
Surr: 1,2-Dichloroethane-d4	94.9	70-130		%REC	10	4/2/2015 4:43:47 PM	R25251
Surr: 4-Bromofluorobenzene	92.3	70-130		%REC	10	4/2/2015 4:43:47 PM	R25251
Surr: Dibromofluoromethane	90.9	70-130		%REC	10	4/2/2015 4:43:47 PM	R25251
Surr: Toluene-d8	93.5	70-130		%REC	10	4/2/2015 4:43:47 PM	R25251

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1504079**

08-Apr-15

Client: Western Refining Southwest, Inc.

Project: GAC 4-1-15

Sample ID **1504079-001CMS**	SampType: **MS**	TestCode: **EPA Method 8015D: Diesel Range**	
Client ID: **GAC-Lag**	Batch ID: **18478**	RunNo: **25230**	
Prep Date: **4/2/2015**	Analysis Date: **4/2/2015**	SeqNo: **746998**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.5	0.20	2.500	0.1220	135	82.6	172			
Surr: DNOP	0.37		0.2500		146	69.6	155			

Sample ID **1504079-001CMSD**	SampType: **MSD**	TestCode: **EPA Method 8015D: Diesel Range**	
Client ID: **GAC-Lag**	Batch ID: **18478**	RunNo: **25230**	
Prep Date: **4/2/2015**	Analysis Date: **4/2/2015**	SeqNo: **746999**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.6	0.20	2.500	0.1220	140	82.6	172	3.94	33.9	
Surr: DNOP	0.36		0.2500		144	69.6	155	0	0	

Sample ID **MB-18478**	SampType: **MBLK**	TestCode: **EPA Method 8015D: Diesel Range**	
Client ID: **PBW**	Batch ID: **18478**	RunNo: **25267**	
Prep Date: **4/2/2015**	Analysis Date: **4/3/2015**	SeqNo: **747190**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.60		0.5000		121	69.6	155			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

WO#: **1504079**

Hall Environmental Analysis Laboratory, Inc.

08-Apr-15

Client: Western Refining Southwest, Inc.
Project: GAC 4-1-15

Sample ID **5ML-RB**		SampType: **MBLK**			TestCode: **EPA Method 8015D: Gasoline Range**					
Client ID: **PBW**		Batch ID: **R25270**			RunNo: **25270**					
Prep Date:		Analysis Date: **4/2/2015**			SeqNo: **747217**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	17		20.00		87.4	80	120			

Sample ID **5ML-RB**		SampType: **MBLK**			TestCode: **EPA Method 8015D: Gasoline Range**					
Client ID: **PBW**		Batch ID: **R25296**			RunNo: **25296**					
Prep Date:		Analysis Date: **4/3/2015**			SeqNo: **748061**		Units: **%REC**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Surr: BFB	16		20.00		82.0	80	120			

Sample ID **5ML-RB**		SampType: **MBLK**			TestCode: **EPA Method 8015D: Gasoline Range**					
Client ID: **PBW**		Batch ID: **R25329**			RunNo: **25329**					
Prep Date:		Analysis Date: **4/6/2015**			SeqNo: **749426**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	17		20.00		84.0	80	120			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1504079**

08-Apr-15

Client: Western Refining Southwest, Inc.

Project: GAC 4-1-15

Sample ID	**5ml rb**	SampType:	**MBLK**	TestCode:	**EPA Method 8260: Volatiles Short List**
Client ID:	**PBW**	Batch ID:	**R25251**	RunNo:	**25251**
Prep Date:		Analysis Date:	**4/2/2015**	SeqNo:	**747003** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	9.0		10.00		90.2	70	130			
Surr: 4-Bromofluorobenzene	9.9		10.00		98.5	70	130			
Surr: Dibromofluoromethane	10		10.00		100	70	130			
Surr: Toluene-d8	8.9		10.00		89.1	70	130			

Sample ID	**1504079-001a ms**	SampType:	**MS**	TestCode:	**EPA Method 8260: Volatiles Short List**
Client ID:	**GAC-Lag**	Batch ID:	**R25251**	RunNo:	**25251**
Prep Date:		Analysis Date:	**4/2/2015**	SeqNo:	**747006** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	22	1.0	20.00	0	108	70	130			
Toluene	22	1.0	20.00	0	110	70	130			
Surr: 1,2-Dichloroethane-d4	9.5		10.00		94.6	70	130			
Surr: 4-Bromofluorobenzene	9.6		10.00		95.8	70	130			
Surr: Dibromofluoromethane	10		10.00		103	70	130			
Surr: Toluene-d8	9.0		10.00		90.0	70	130			

Sample ID	**1504079-001a msd**	SampType:	**MSD**	TestCode:	**EPA Method 8260: Volatiles Short List**
Client ID:	**GAC-Lag**	Batch ID:	**R25251**	RunNo:	**25251**
Prep Date:		Analysis Date:	**4/2/2015**	SeqNo:	**747007** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	21	1.0	20.00	0	106	70	130	1.82	20	
Toluene	22	1.0	20.00	0	110	70	130	0.0913	20	
Surr: 1,2-Dichloroethane-d4	8.9		10.00		89.3	70	130	0	0	
Surr: 4-Bromofluorobenzene	9.5		10.00		94.8	70	130	0	0	
Surr: Dibromofluoromethane	9.9		10.00		98.6	70	130	0	0	
Surr: Toluene-d8	9.1		10.00		90.9	70	130	0	0	

Sample ID	**vcb2**	SampType:	**MBLK**	TestCode:	**EPA Method 8260: Volatiles Short List**
Client ID:	**PBW**	Batch ID:	**R25251**	RunNo:	**25251**
Prep Date:		Analysis Date:	**4/2/2015**	SeqNo:	**747027** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1504079**

08-Apr-15

Client: Western Refining Southwest, Inc.

Project: GAC 4-1-15

Sample ID	**vcb2**	SampType:	**MBLK**	TestCode:	**EPA Method 8260: Volatiles Short List**
Client ID:	**PBW**	Batch ID:	**R25251**	RunNo:	**25251**
Prep Date:		Analysis Date:	**4/2/2015**	SeqNo:	**747027** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	8.8		10.00		88.4	70	130			
Surr: 4-Bromofluorobenzene	9.8		10.00		97.6	70	130			
Surr: Dibromofluoromethane	9.6		10.00		95.7	70	130			
Surr: Toluene-d8	8.9		10.00		89.5	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southw   Work Order Number: 1504079   RcptNo: 1

Received by/date: AT 04/02/15

Logged By: **Lindsay Mangin** 4/2/2015 7:00:00 AM

Completed By: **Lindsay Mangin** 4/2/2015 8:43:30 AM

Reviewed By: 04/02/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? ~~Yes ☑~~ CS 04/02/15 No ☑ No VOA Vials ☐

Sample -001A (2 of 3 and 3 of 3), sample -002A (3 of 3), and sample -00 -003B all have bubbles. —CS 04/02/15

11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

# of preserved bottles checked for pH: ____
(<2 or >12 unless noted)
Adjusted? ____
Checked by: ____

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: ____ Date ____
By Whom: ____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ____
Client Instructions: ____

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.0	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other ____________

☐ EDD (Type) ____________

Turn-Around Time:
☒ Standard ☐ **Rush** ____________

Project Name: GAC 4-1-15

Project #: PO# 12610954

Project Manager:

Sampler: Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.0

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1504079	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / DRO / [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO EXT. 8015B				Air Bubbles (Y or N)
4-1-15	10:30	H2O	GAC-LAG	5-VOA	HCl	-001			X							X						
				1-500ml	amber	-001												X				
	10:45		GAC-Lead	5-VOA	HCl	-002			X							X						
				1-500ml	amber	-002												X				
	10:55		GAC-inlet	5-VOA	HCl	-003			X							X						
				1-500ml	amber	-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
4-1-15	1624	Robert Krakow	Christie Waite	4/1/15	1624
4/1/15	1825	Christie Waite		04/02/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

May 20, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: River Terrace GAC 5-6-15 OrderNo.: 1505293

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 2 sample(s) on 5/7/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1505293**
Date Reported: **5/20/2015**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** GAC-lead
Project: River Terrace GAC 5-6-15 **Collection Date:** 5/6/2015 10:00:00 AM
Lab ID: 1505293-001 **Matrix:** AQUEOUS **Received Date:** 5/7/2015 7:40:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE							Analyst: **KJH**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	5/11/2015 7:23:02 PM	19118
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	5/11/2015 7:23:02 PM	19118
Surr: DNOP	151	69.6-155		%REC	1	5/11/2015 7:23:02 PM	19118
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	5/13/2015 1:36:28 PM	R26168
Surr: BFB	81.7	80-120		%REC	1	5/13/2015 1:36:28 PM	R26168
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	1.0		µg/L	1	5/12/2015 7:04:58 PM	R26144
Toluene	ND	1.0		µg/L	1	5/12/2015 7:04:58 PM	R26144
Ethylbenzene	ND	1.0		µg/L	1	5/12/2015 7:04:58 PM	R26144
Xylenes, Total	ND	1.5		µg/L	1	5/12/2015 7:04:58 PM	R26144
Surr: 1,2-Dichloroethane-d4	105	70-130		%REC	1	5/12/2015 7:04:58 PM	R26144
Surr: 4-Bromofluorobenzene	98.3	70-130		%REC	1	5/12/2015 7:04:58 PM	R26144
Surr: Dibromofluoromethane	103	70-130		%REC	1	5/12/2015 7:04:58 PM	R26144
Surr: Toluene-d8	104	70-130		%REC	1	5/12/2015 7:04:58 PM	R26144

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-inlet
Project: River Terrace GAC 5-6-15
Collection Date: 5/6/2015 10:10:00 AM
Lab ID: 1505293-002
Matrix: AQUEOUS
Received Date: 5/7/2015 7:40:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**KJH**
Diesel Range Organics (DRO)	3.1	0.20		mg/L	1	5/12/2015 11:04:16 AM	19118
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	5/12/2015 11:04:16 AM	19118
Surr: DNOP	141	69.6-155		%REC	1	5/12/2015 11:04:16 AM	19118
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	4.0	0.50		mg/L	10	5/13/2015 2:05:42 PM	R26168
Surr: BFB	134	80-120	S	%REC	10	5/13/2015 2:05:42 PM	R26168
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	140	5.0		µg/L	5	5/12/2015 8:27:26 PM	R26144
Toluene	ND	5.0		µg/L	5	5/12/2015 8:27:26 PM	R26144
Ethylbenzene	670	50		µg/L	50	5/12/2015 7:59:51 PM	R26144
Xylenes, Total	550	7.5		µg/L	5	5/12/2015 8:27:26 PM	R26144
Surr: 1,2-Dichloroethane-d4	103	70-130		%REC	5	5/12/2015 8:27:26 PM	R26144
Surr: 4-Bromofluorobenzene	98.2	70-130		%REC	5	5/12/2015 8:27:26 PM	R26144
Surr: Dibromofluoromethane	94.9	70-130		%REC	5	5/12/2015 8:27:26 PM	R26144
Surr: Toluene-d8	103	70-130		%REC	5	5/12/2015 8:27:26 PM	R26144

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1505293**

20-May-15

Client: Western Refining Southwest, Inc.

Project: River Terrace GAC 5-6-15

Sample ID **MB-19118**		SampType: **MBLK**		TestCode: **EPA Method 8015D: Diesel Range**					
Client ID: **PBW**		Batch ID: **19118**		RunNo: **26100**					
Prep Date: **5/7/2015**		Analysis Date: **5/11/2015**		SeqNo: **774688**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.71		0.5000		143	69.6	155			

Sample ID **1505293-001CMS**		SampType: **MS**		TestCode: **EPA Method 8015D: Diesel Range**						
Client ID: **GAC-lead**		Batch ID: **19118**		RunNo: **26100**						
Prep Date: **5/7/2015**		Analysis Date: **5/11/2015**		SeqNo: **774693**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.0	0.20	2.500	0.1352	114	82.6	172			
Surr: DNOP	0.31		0.2500		122	69.6	155			

Sample ID **1505293-001CMSD**		SampType: **MSD**		TestCode: **EPA Method 8015D: Diesel Range**						
Client ID: **GAC-lead**		Batch ID: **19118**		RunNo: **26100**						
Prep Date: **5/7/2015**		Analysis Date: **5/11/2015**		SeqNo: **774694**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.6	0.20	2.500	0.1352	138	82.6	172	18.1	33.9	
Surr: DNOP	0.36		0.2500		144	69.6	155	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1505293**

20-May-15

Client: Western Refining Southwest, Inc.

Project: River Terrace GAC 5-6-15

Sample ID	**5ML RB**	SampType:	**MBLK**	TestCode:	**EPA Method 8015D: Gasoline Range**
Client ID:	**PBW**	Batch ID:	**R26168**	RunNo:	**26168**
Prep Date:		Analysis Date:	**5/13/2015**	SeqNo:	**776492** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	16		20.00		80.8	80	120			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1505293**

20-May-15

Client: Western Refining Southwest, Inc.

Project: River Terrace GAC 5-6-15

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**	
Client ID: **PBW**	Batch ID: **R26144**	RunNo: **26144**	
Prep Date:	Analysis Date: **5/12/2015**	SeqNo: **775673**	Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	10		10.00		103	70	130			
Surr: 4-Bromofluorobenzene	10		10.00		102	70	130			
Surr: Dibromofluoromethane	10		10.00		103	70	130			
Surr: Toluene-d8	9.6		10.00		96.5	70	130			

Sample ID **b6**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**	
Client ID: **PBW**	Batch ID: **R26144**	RunNo: **26144**	
Prep Date:	Analysis Date: **5/12/2015**	SeqNo: **775732**	Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	9.8		10.00		97.8	70	130			
Surr: 4-Bromofluorobenzene	9.9		10.00		99.3	70	130			
Surr: Dibromofluoromethane	10		10.00		99.7	70	130			
Surr: Toluene-d8	10		10.00		102	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: **Western Refining Southw** Work Order Number: **1505293** RcptNo: **1**

Received by/date: 05/07/15

Logged By: **Lindsay Mangin** **5/7/2015 7:40:00 AM**

Completed By: **Lindsay Mangin** **5/7/2015 9:11:51 AM**

Reviewed By: IO 05/07/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

# of preserved bottles checked for pH: ______
(<2 or >12 unless noted)
Adjusted? ______
Checked by: ______

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: ______ Date: ______
By Whom: ______ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ______
Client Instructions: ______

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.8	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413
Phone #: 505-632-4135
email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: 5-6-15
River Terrace GAC

Project #:
PO#12610954

Project Manager:

Sampler: Bob
On Ice: ☒ Yes ☐ No
Sample Temperature: 1.8

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1505293	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / ~~[illegible]~~)	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA)	8260 VOA ~~8270 (Semi-VOA)~~ BTEX, MB only	DRO-Ext. 8015B				Air Bubbles (Y or N)
-6-15	10:00	H2O	GAC-lead	5-VOA	HCl	-001			X								X					
				1-500ml	amber	-001												X				
	10:10		GAC-inlet	5-VOA	HCl	-002			X								X					
				1-500ml	amber	-002												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-6-15	1405	Robert Krakow	Christi Walters	5/6/15	1405
/6/15	1740	Chris Walt		05/07/15	0740

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

June 16, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 6-1-15 OrderNo.: 1506059

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 2 sample(s) on 6/2/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1506059**

Hall Environmental Analysis Laboratory, Inc.

Date Reported: **6/16/2015**

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	Lead
Project:	GAC 6-1-15	**Collection Date:**	6/1/2015 8:00:00 AM
Lab ID:	1506059-001 **Matrix:** AQUEOUS	**Received Date:**	6/2/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE							Analyst: **KJH**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	6/4/2015 1:48:09 PM	19568
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	6/4/2015 1:48:09 PM	19568
Surr: DNOP	119	69.6-155		%REC	1	6/4/2015 1:48:09 PM	19568
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	6/2/2015 2:08:30 PM	R26570
Surr: BFB	80.5	57.8-137		%REC	1	6/2/2015 2:08:30 PM	R26570
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	1.0		µg/L	1	6/3/2015 4:45:31 AM	R26571
Toluene	ND	1.0		µg/L	1	6/3/2015 4:45:31 AM	R26571
Ethylbenzene	ND	1.0		µg/L	1	6/3/2015 4:45:31 AM	R26571
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	6/3/2015 4:45:31 AM	R26571
Xylenes, Total	ND	1.5		µg/L	1	6/3/2015 4:45:31 AM	R26571
Surr: 1,2-Dichloroethane-d4	100	70-130		%REC	1	6/3/2015 4:45:31 AM	R26571
Surr: 4-Bromofluorobenzene	99.5	70-130		%REC	1	6/3/2015 4:45:31 AM	R26571
Surr: Dibromofluoromethane	101	70-130		%REC	1	6/3/2015 4:45:31 AM	R26571
Surr: Toluene-d8	102	70-130		%REC	1	6/3/2015 4:45:31 AM	R26571

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
	O	RSD is greater than RSDlimit	P	Sample pH Not In Range
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: Inlet
Project: GAC 6-1-15
Collection Date: 6/1/2015 8:15:00 AM
Lab ID: 1506059-002
Matrix: AQUEOUS
Received Date: 6/2/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**KJH**
Diesel Range Organics (DRO)	1.6	0.20		mg/L	1	6/4/2015 3:08:59 PM	19568
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	6/4/2015 3:08:59 PM	19568
Surr: DNOP	131	69.6-155		%REC	1	6/4/2015 3:08:59 PM	19568
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	2.0	0.50		mg/L	10	6/2/2015 2:33:43 PM	R26570
Surr: BFB	120	57.8-137		%REC	10	6/2/2015 2:33:43 PM	R26570
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	18	5.0		µg/L	10	6/3/2015 5:13:06 AM	R26571
Toluene	ND	10		µg/L	10	6/3/2015 5:13:06 AM	R26571
Ethylbenzene	440	10		µg/L	10	6/3/2015 5:13:06 AM	R26571
Methyl tert-butyl ether (MTBE)	ND	10		µg/L	10	6/3/2015 5:13:06 AM	R26571
Xylenes, Total	220	15		µg/L	10	6/3/2015 5:13:06 AM	R26571
Surr: 1,2-Dichloroethane-d4	103	70-130		%REC	10	6/3/2015 5:13:06 AM	R26571
Surr: 4-Bromofluorobenzene	102	70-130		%REC	10	6/3/2015 5:13:06 AM	R26571
Surr: Dibromofluoromethane	102	70-130		%REC	10	6/3/2015 5:13:06 AM	R26571
Surr: Toluene-d8	103	70-130		%REC	10	6/3/2015 5:13:06 AM	R26571

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
	J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
	O	RSD is greater than RSDlimit	P	Sample pH Not In Range
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1506059**

16-Jun-15

Client: Western Refining Southwest, Inc.
Project: GAC 6-1-15

Sample ID	**MB-19568**	SampType:	**MBLK**	TestCode:	**EPA Method 8015D: Diesel Range**
Client ID:	**PBW**	Batch ID:	**19568**	RunNo:	**26610**
Prep Date:	**6/4/2015**	Analysis Date:	**6/4/2015**	SeqNo:	**792775** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.58		0.5000		117	69.6	155			

Sample ID	**1506059-001CMS**	SampType:	**MS**	TestCode:	**EPA Method 8015D: Diesel Range**
Client ID:	**Lead**	Batch ID:	**19568**	RunNo:	**26610**
Prep Date:	**6/4/2015**	Analysis Date:	**6/4/2015**	SeqNo:	**792839** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	4.0	0.20	2.500	0.1257	153	67.2	210			
Surr: DNOP	0.33		0.2500		131	69.6	155			

Sample ID	**1506059-001CMSD**	SampType:	**MSD**	TestCode:	**EPA Method 8015D: Diesel Range**
Client ID:	**Lead**	Batch ID:	**19568**	RunNo:	**26610**
Prep Date:	**6/4/2015**	Analysis Date:	**6/4/2015**	SeqNo:	**792840** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	4.0	0.20	2.500	0.1257	154	67.2	210	0.575	33.9	
Surr: DNOP	0.33		0.2500		131	69.6	155	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1506059**

16-Jun-15

Client: Western Refining Southwest, Inc.

Project: GAC 6-1-15

Sample ID **5ML RB**		SampType: **MBLK**		TestCode: **EPA Method 8015D: Gasoline Range**						
Client ID: **PBW**		Batch ID: **R26570**		RunNo: **26570**						
Prep Date:		Analysis Date: **6/2/2015**		SeqNo: **790665**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	16		20.00		79.6	57.8	137			

Sample ID **1506059-002BMS**		SampType: **MS**		TestCode: **EPA Method 8015D: Gasoline Range**						
Client ID: **Inlet**		Batch ID: **R26570**		RunNo: **26570**						
Prep Date:		Analysis Date: **6/2/2015**		SeqNo: **790675**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	7.0	0.50	5.000	1.968	101	51	131			
Surr: BFB	260		200.0		130	57.8	137			

Sample ID **1506059-002BMSD**		SampType: **MSD**		TestCode: **EPA Method 8015D: Gasoline Range**						
Client ID: **Inlet**		Batch ID: **R26570**		RunNo: **26570**						
Prep Date:		Analysis Date: **6/2/2015**		SeqNo: **790676**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	6.6	0.50	5.000	1.968	93.6	51	131	5.07	20	
Surr: BFB	260		200.0		131	57.8	137	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1506059**

16-Jun-15

Client: Western Refining Southwest, Inc.

Project: GAC 6-1-15

Sample ID	**5ml rb**	SampType:	**MBLK**	TestCode:	**EPA Method 8260: Volatiles Short List**
Client ID:	**PBW**	Batch ID:	**R26571**	RunNo:	**26571**
Prep Date:		Analysis Date:	**6/2/2015**	SeqNo:	**790707** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	9.5		10.00		95.0	70	130			
Surr: 4-Bromofluorobenzene	10		10.00		103	70	130			
Surr: Dibromofluoromethane	10		10.00		100	70	130			
Surr: Toluene-d8	9.3		10.00		93.0	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: **Western Refining Southw** Work Order Number: **1506059** RcptNo: **1**

Received by/date: 06/02/15

Logged By: **Ashley Gallegos** **6/2/2015 7:00:00 AM**

Completed By: **Ashley Gallegos** **6/2/2015 9:02:24 AM**

Reviewed By: 06/08/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

\# of preserved bottles checked for pH:

(<2 or >12 unless noted)

Adjusted?

Checked by:

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: Date

By Whom: Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person

Regarding:

Client Instructions:

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.3	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413
Phone #: 505-632-4135
email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC 6-1-15

Project #:

Project Manager:

Sampler: Bob
On Ice: ☒ Yes ☐ No
Sample Temperature: 1.3

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1506059	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted]	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO·EXT, 8015 B				Air Bubbles (Y or N)
-1-15	8:00	H2O	Lead	5-VOA	HCl	-001			X							X						
|	\	|	\	1-500ml	amber													X				
|	8:15	|	inlet	5-VOA	HCl	-002			X							X						
|	\	|	\	1-500ml	amber													X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-1-15	1250	Robert Krakow	Christine Walters	6/1/15	1250
1/15	1834	Christine Walte		06/02/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

July 13, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 3rd QTR 7/1/15 OrderNo.: 1507086

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 7/2/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

CLIENT: Western Refining Southwest, Inc.
Project: GAC 3rd QTR 7/1/15
Lab ID: 1507086-001 **Matrix:** AQUEOUS

Client Sample ID: GAC-Lag
Collection Date: 7/1/2015 7:30:00 AM
Received Date: 7/2/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE							Analyst: **KJH**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	7/2/2015 11:17:08 PM	20075
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	7/2/2015 11:17:08 PM	20075
Surr: DNOP	132	69.6-155		%REC	1	7/2/2015 11:17:08 PM	20075
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **DJF**
Gasoline Range Organics (GRO)	0.15	0.050		mg/L	1	7/6/2015 7:08:39 PM	R27308
Surr: BFB	98.8	70-130		%REC	1	7/6/2015 7:08:39 PM	R27308
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	1.0		µg/L	1	7/6/2015 7:08:39 PM	R27308
Toluene	ND	1.0		µg/L	1	7/6/2015 7:08:39 PM	R27308
Ethylbenzene	ND	1.0		µg/L	1	7/6/2015 7:08:39 PM	R27308
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	7/6/2015 7:08:39 PM	R27308
Xylenes, Total	ND	1.5		µg/L	1	7/6/2015 7:08:39 PM	R27308
Surr: 1,2-Dichloroethane-d4	102	70-130		%REC	1	7/6/2015 7:08:39 PM	R27308
Surr: 4-Bromofluorobenzene	107	70-130		%REC	1	7/6/2015 7:08:39 PM	R27308
Surr: Dibromofluoromethane	107	70-130		%REC	1	7/6/2015 7:08:39 PM	R27308
Surr: Toluene-d8	97.7	70-130		%REC	1	7/6/2015 7:08:39 PM	R27308

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

CLIENT: Western Refining Southwest, Inc.
Project: GAC 3rd QTR 7/1/15
Lab ID: 1507086-002 **Matrix:** AQUEOUS

Client Sample ID: GAC-Lead
Collection Date: 7/1/2015 7:40:00 AM
Received Date: 7/2/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**KJH**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	7/3/2015 12:21:36 AM	20075
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	7/3/2015 12:21:36 AM	20075
Surr: DNOP	126	69.6-155		%REC	1	7/3/2015 12:21:36 AM	20075
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**DJF**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	7/6/2015 8:30:56 PM	R27308
Surr: BFB	97.8	70-130		%REC	1	7/6/2015 8:30:56 PM	R27308
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	7/6/2015 8:30:56 PM	R27308
Toluene	ND	1.0		µg/L	1	7/6/2015 8:30:56 PM	R27308
Ethylbenzene	ND	1.0		µg/L	1	7/6/2015 8:30:56 PM	R27308
Methyl tert-butyl ether (MTBE)	1.5	1.0		µg/L	1	7/6/2015 8:30:56 PM	R27308
Xylenes, Total	ND	1.5		µg/L	1	7/6/2015 8:30:56 PM	R27308
Surr: 1,2-Dichloroethane-d4	95.1	70-130		%REC	1	7/6/2015 8:30:56 PM	R27308
Surr: 4-Bromofluorobenzene	101	70-130		%REC	1	7/6/2015 8:30:56 PM	R27308
Surr: Dibromofluoromethane	101	70-130		%REC	1	7/6/2015 8:30:56 PM	R27308
Surr: Toluene-d8	102	70-130		%REC	1	7/6/2015 8:30:56 PM	R27308

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

Date Reported: **7/13/2015**

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Inlet
Project: GAC 3rd QTR 7/1/15
Collection Date: 7/1/2015 7:50:00 AM
Lab ID: 1507086-003
Matrix: AQUEOUS
Received Date: 7/2/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**KJH**
Diesel Range Organics (DRO)	1.3	0.20		mg/L	1	7/3/2015 12:43:03 AM	20075
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	7/3/2015 12:43:03 AM	20075
Surr: DNOP	136	69.6-155		%REC	1	7/3/2015 12:43:03 AM	20075
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**DJF**
Gasoline Range Organics (GRO)	2.2	0.25		mg/L	5	7/6/2015 8:58:21 PM	R27308
Surr: BFB	101	70-130		%REC	5	7/6/2015 8:58:21 PM	R27308
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	16	5.0		µg/L	5	7/6/2015 8:58:21 PM	R27308
Toluene	ND	5.0		µg/L	5	7/6/2015 8:58:21 PM	R27308
Ethylbenzene	290	5.0		µg/L	5	7/6/2015 8:58:21 PM	R27308
Methyl tert-butyl ether (MTBE)	ND	5.0		µg/L	5	7/6/2015 8:58:21 PM	R27308
Xylenes, Total	100	7.5		µg/L	5	7/6/2015 8:58:21 PM	R27308
Surr: 1,2-Dichloroethane-d4	95.6	70-130		%REC	5	7/6/2015 8:58:21 PM	R27308
Surr: 4-Bromofluorobenzene	105	70-130		%REC	5	7/6/2015 8:58:21 PM	R27308
Surr: Dibromofluoromethane	104	70-130		%REC	5	7/6/2015 8:58:21 PM	R27308
Surr: Toluene-d8	98.9	70-130		%REC	5	7/6/2015 8:58:21 PM	R27308

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1507086**

13-Jul-15

Client: Western Refining Southwest, Inc.

Project: GAC 3rd QTR 7/1/15

Sample ID **MB-20075**	SampType: **MBLK**			TestCode: **EPA Method 8015D: Diesel Range**						
Client ID: **PBW**	Batch ID: **20075**			RunNo: **27254**						
Prep Date: **7/2/2015**	Analysis Date: **7/2/2015**			SeqNo: **817672**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.49		0.5000		97.9	69.6	155			

Sample ID **1507086-001BMS**	SampType: **MS**			TestCode: **EPA Method 8015D: Diesel Range**						
Client ID: **GAC-Lag**	Batch ID: **20075**			RunNo: **27254**						
Prep Date: **7/2/2015**	Analysis Date: **7/2/2015**			SeqNo: **817677**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.1	0.20	2.500	0.1514	119	67.2	210			
Surr: DNOP	0.35		0.2500		138	69.6	155			

Sample ID **1507086-001BMSD**	SampType: **MSD**			TestCode: **EPA Method 8015D: Diesel Range**						
Client ID: **GAC-Lag**	Batch ID: **20075**			RunNo: **27254**						
Prep Date: **7/2/2015**	Analysis Date: **7/3/2015**			SeqNo: **817678**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.0	0.20	2.500	0.1514	115	67.2	210	2.66	33.9	
Surr: DNOP	0.34		0.2500		135	69.6	155	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Client: Western Refining Southwest, Inc.

Project: GAC 3rd QTR 7/1/15

Sample ID **rb** SampType: **MBLK** TestCode: **EPA Method 8260: Volatiles Short List**

Client ID: **PBW** Batch ID: **R27308** RunNo: **27308**

Prep Date: Analysis Date: **7/6/2015** SeqNo: **818546** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	9.9		10.00		99.4	70	130			
Surr: 4-Bromofluorobenzene	10		10.00		104	70	130			
Surr: Dibromofluoromethane	11		10.00		105	70	130			
Surr: Toluene-d8	9.9		10.00		99.0	70	130			

Sample ID **1507086-001a ms** SampType: **MS** TestCode: **EPA Method 8260: Volatiles Short List**

Client ID: **GAC-Lag** Batch ID: **R27308** RunNo: **27308**

Prep Date: Analysis Date: **7/6/2015** SeqNo: **818549** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	20	1.0	20.00	0	102	70	130			
Toluene	21	1.0	20.00	0	107	70	130			
Surr: 1,2-Dichloroethane-d4	10		10.00		103	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		105	70	130			
Surr: Dibromofluoromethane	10		10.00		103	70	130			
Surr: Toluene-d8	10		10.00		101	70	130			

Sample ID **1507086-001a msd** SampType: **MSD** TestCode: **EPA Method 8260: Volatiles Short List**

Client ID: **GAC-Lag** Batch ID: **R27308** RunNo: **27308**

Prep Date: Analysis Date: **7/6/2015** SeqNo: **818550** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	20	1.0	20.00	0	100	70	130	1.56	20	
Toluene	21	1.0	20.00	0	105	70	130	1.44	20	
Surr: 1,2-Dichloroethane-d4	9.8		10.00		98.1	70	130	0	0	
Surr: 4-Bromofluorobenzene	10		10.00		100	70	130	0	0	
Surr: Dibromofluoromethane	11		10.00		108	70	130	0	0	
Surr: Toluene-d8	10		10.00		102	70	130	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

Client: Western Refining Southwest, Inc.

Project: GAC 3rd QTR 7/1/15

Sample ID	**rb**	SampType:	**MBLK**	TestCode:	**EPA Method 8015D: Gasoline Range**
Client ID:	**PBW**	Batch ID:	**R27308**	RunNo:	**27308**
Prep Date:		Analysis Date:	**7/6/2015**	SeqNo:	**818553** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	10		10.00		100	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southw   Work Order Number: 1507086   RcptNo: 1

Received by/date: AT 07/02/15

Logged By: Anne Thorne   7/2/2015 7:00:00 AM   Anne Thorne

Completed By: Anne Thorne   7/2/2015   Anne Thorne

Reviewed By: CS   07/02/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? ~~Yes~~ ☑ No ☑ 07/02/15 No VOA Vials ☐
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

# of preserved bottles checked for pH: ______
(<2 or >12 unless noted)
Adjusted? ______
Checked by: ______

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: Date
By Whom: Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:
Client Instructions:

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.0	Good	Yes			

Chain-of-Custody Record

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Client: Western Refining

Mailing Address: #50 CR 4990

Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:

☐ Standard ☒ Level 4 (Full Validation)

Accreditation

☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:

☒ Standard ☐ Rush

Project Name: GAC 3rd QTR 7-1-15

Project #: PO# 12610954

Project Manager:

Sampler: Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.0

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1507084	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted]	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Ext. 8015B				Air Bubbles (Y or N)
7-1-15	7:30	H2O	GAC - Lag	5-VOA	Hcl	-001			X							X						
				1-500ml	amber	-001												X				
	7:40		GAC - Lead	5-VOA	HCl	-002			X							X						
				1-500ml	amber	-002												X				
	7:50		GAC - inlet	5-VOA		-003			X							X						
						-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
7-1-15	1215	Robert Krakow	Christine Walters	7/1/15	1215
7/1/15	1810	Christine Walters		07/02/15	0700

Remarks:

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

August 18, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 8-3-15 OrderNo.: 1508080

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 8/4/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Inlet
Project: GAC 8-3-15
Collection Date: 8/3/2015 8:00:00 AM
Lab ID: 1508080-001
Matrix: AQUEOUS
Received Date: 8/4/2015 7:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**KJH**
Diesel Range Organics (DRO)	1.2	0.20		mg/L	1	8/7/2015 7:27:18 PM	20613
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	8/7/2015 7:27:18 PM	20613
Surr: DNOP	130	84.6-165		%REC	1	8/7/2015 7:27:18 PM	20613
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**DJF**
Gasoline Range Organics (GRO)	5.2	0.25		mg/L	5	8/5/2015 5:21:11 PM	R27991
Surr: BFB	108	70-130		%REC	5	8/5/2015 5:21:11 PM	R27991
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	5.0		µg/L	5	8/5/2015 5:21:11 PM	R27991
Toluene	ND	5.0		µg/L	5	8/5/2015 5:21:11 PM	R27991
Ethylbenzene	170	5.0		µg/L	5	8/5/2015 5:21:11 PM	R27991
Methyl tert-butyl ether (MTBE)	ND	5.0		µg/L	5	8/5/2015 5:21:11 PM	R27991
Xylenes, Total	850	7.5		µg/L	5	8/5/2015 5:21:11 PM	R27991
Surr: 1,2-Dichloroethane-d4	107	70-130		%REC	5	8/5/2015 5:21:11 PM	R27991
Surr: 4-Bromofluorobenzene	109	70-130		%REC	5	8/5/2015 5:21:11 PM	R27991
Surr: Dibromofluoromethane	113	70-130		%REC	5	8/5/2015 5:21:11 PM	R27991
Surr: Toluene-d8	104	70-130		%REC	5	8/5/2015 5:21:11 PM	R27991

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report

Lab Order **1508080**

Hall Environmental Analysis Laboratory, Inc.

Date Reported: **8/18/2015**

CLIENT: Western Refining Southwest, Inc.		**Client Sample ID:**	GAC-Lead
Project: GAC 8-3-15		**Collection Date:**	8/3/2015 8:10:00 AM
Lab ID: 1508080-002	**Matrix:** AQUEOUS	**Received Date:**	8/4/2015 7:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**KJH**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	8/7/2015 8:49:32 PM	20613
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	8/7/2015 8:49:32 PM	20613
Surr: DNOP	133	84.6-165		%REC	1	8/7/2015 8:49:32 PM	20613
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**DJF**
Gasoline Range Organics (GRO)	0.23	0.050		mg/L	1	8/5/2015 6:44:05 PM	R27991
Surr: BFB	101	70-130		%REC	1	8/5/2015 6:44:05 PM	R27991
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	8/5/2015 6:44:05 PM	R27991
Toluene	ND	1.0		µg/L	1	8/5/2015 6:44:05 PM	R27991
Ethylbenzene	ND	1.0		µg/L	1	8/5/2015 6:44:05 PM	R27991
Methyl tert-butyl ether (MTBE)	1.1	1.0		µg/L	1	8/5/2015 6:44:05 PM	R27991
Xylenes, Total	ND	1.5		µg/L	1	8/5/2015 6:44:05 PM	R27991
Surr: 1,2-Dichloroethane-d4	105	70-130		%REC	1	8/5/2015 6:44:05 PM	R27991
Surr: 4-Bromofluorobenzene	104	70-130		%REC	1	8/5/2015 6:44:05 PM	R27991
Surr: Dibromofluoromethane	115	70-130		%REC	1	8/5/2015 6:44:05 PM	R27991
Surr: Toluene-d8	101	70-130		%REC	1	8/5/2015 6:44:05 PM	R27991

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	D	Sample Diluted Due to Matrix	E	Value above quantitation range
	H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
	ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	% Recovery outside of range due to dilution or matrix		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC 8-3-15
Lab ID: 1508080-003 **Matrix:** AQUEOUS

Client Sample ID: GAC-Outlet
Collection Date: 8/3/2015 8:20:00 AM
Received Date: 8/4/2015 7:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**KJH**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	8/7/2015 9:17:07 PM	20613
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	8/7/2015 9:17:07 PM	20613
Surr: DNOP	134	84.6-165		%REC	1	8/7/2015 9:17:07 PM	20613
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**DJF**
Gasoline Range Organics (GRO)	0.15	0.050		mg/L	1	8/5/2015 8:06:50 PM	R27991
Surr: BFB	97.3	70-130		%REC	1	8/5/2015 8:06:50 PM	R27991
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	8/5/2015 8:06:50 PM	R27991
Toluene	ND	1.0		µg/L	1	8/5/2015 8:06:50 PM	R27991
Ethylbenzene	ND	1.0		µg/L	1	8/5/2015 8:06:50 PM	R27991
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	8/5/2015 8:06:50 PM	R27991
Xylenes, Total	ND	1.5		µg/L	1	8/5/2015 8:06:50 PM	R27991
Surr: 1,2-Dichloroethane-d4	103	70-130		%REC	1	8/5/2015 8:06:50 PM	R27991
Surr: 4-Bromofluorobenzene	102	70-130		%REC	1	8/5/2015 8:06:50 PM	R27991
Surr: Dibromofluoromethane	113	70-130		%REC	1	8/5/2015 8:06:50 PM	R27991
Surr: Toluene-d8	95.8	70-130		%REC	1	8/5/2015 8:06:50 PM	R27991

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1508080**

18-Aug-15

Client: Western Refining Southwest, Inc.

Project: GAC 8-3-15

Sample ID **MB-20613** SampType: **MBLK** TestCode: **EPA Method 8015D: Diesel Range**
Client ID: **PBW** Batch ID: **20613** RunNo: **28026**
Prep Date: **8/5/2015** Analysis Date: **8/7/2015** SeqNo: **844848** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.66		0.5000		132	84.6	165			

Sample ID **LCS-20613** SampType: **LCS** TestCode: **EPA Method 8015D: Diesel Range**
Client ID: **LCSW** Batch ID: **20613** RunNo: **28026**
Prep Date: **8/5/2015** Analysis Date: **8/7/2015** SeqNo: **844849** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.6	0.20	2.500	0	146	67.3	174			
Surr: DNOP	0.35		0.2500		138	84.6	165			

Sample ID **1508080-001BMS** SampType: **MS** TestCode: **EPA Method 8015D: Diesel Range**
Client ID: **GAC-Inlet** Batch ID: **20613** RunNo: **28026**
Prep Date: **8/5/2015** Analysis Date: **8/7/2015** SeqNo: **844905** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	4.6	0.20	2.500	1.166	138	67.2	210			
Surr: DNOP	0.34		0.2500		134	84.6	165			

Sample ID **1508080-001BMSD** SampType: **MSD** TestCode: **EPA Method 8015D: Diesel Range**
Client ID: **GAC-Inlet** Batch ID: **20613** RunNo: **28026**
Prep Date: **8/5/2015** Analysis Date: **8/7/2015** SeqNo: **844906** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	4.5	0.20	2.500	1.166	135	67.2	210	1.46	33.9	
Surr: DNOP	0.34		0.2500		136	84.6	165	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

Client: Western Refining Southwest, Inc.
Project: GAC 8-3-15

Sample ID **RB** SampType: **MBLK** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW** Batch ID: **R27991** RunNo: **27991**
Prep Date: Analysis Date: **8/5/2015** SeqNo: **842706** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	11		10.00		105	70	130			
Surr: 4-Bromofluorobenzene	10		10.00		102	70	130			
Surr: Dibromofluoromethane	12		10.00		116	70	130			
Surr: Toluene-d8	9.7		10.00		97.0	70	130			

Sample ID **100ng lcs** SampType: **LCS** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **LCSW** Batch ID: **R27991** RunNo: **27991**
Prep Date: Analysis Date: **8/5/2015** SeqNo: **842717** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	21	1.0	20.00	0	103	70	130			
Toluene	20	1.0	20.00	0	101	70	130			
Surr: 1,2-Dichloroethane-d4	10		10.00		99.9	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		110	70	130			
Surr: Dibromofluoromethane	10		10.00		105	70	130			
Surr: Toluene-d8	9.8		10.00		98.3	70	130			

Sample ID **1508080-002a ms** SampType: **MS** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **GAC-Lead** Batch ID: **R27991** RunNo: **27991**
Prep Date: Analysis Date: **8/5/2015** SeqNo: **842723** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	21	1.0	20.00	0	107	70	130			
Toluene	21	1.0	20.00	0	104	70	130			
Surr: 1,2-Dichloroethane-d4	10		10.00		101	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		105	70	130			
Surr: Dibromofluoromethane	11		10.00		111	70	130			
Surr: Toluene-d8	10		10.00		100	70	130			

Sample ID **1508080-002a msd** SampType: **MSD** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **GAC-Lead** Batch ID: **R27991** RunNo: **27991**
Prep Date: Analysis Date: **8/5/2015** SeqNo: **842724** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	21	1.0	20.00	0	104	70	130	3.07	20	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.
D	Sample Diluted Due to Matrix
H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits
S	% Recovery outside of range due to dilution or matrix
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
P	Sample pH Not In Range
RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1508080**

18-Aug-15

Client: Western Refining Southwest, Inc.

Project: GAC 8-3-15

Sample ID	**1508080-002a msd**	SampType:	**MSD**	TestCode:	**EPA Method 8260: Volatiles Short List**		
Client ID:	**GAC-Lead**	Batch ID:	**R27991**	RunNo:	**27991**		
Prep Date:		Analysis Date:	**8/5/2015**	SeqNo:	**842724**	Units:	**µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Toluene	20	1.0	20.00	0	99.3	70	130	4.83	20	
Surr: 1,2-Dichloroethane-d4	9.7		10.00		97.4	70	130	0	0	
Surr: 4-Bromofluorobenzene	11		10.00		105	70	130	0	0	
Surr: Dibromofluoromethane	11		10.00		108	70	130	0	0	
Surr: Toluene-d8	9.5		10.00		94.5	70	130	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

Client: Western Refining Southwest, Inc.

Project: GAC 8-3-15

Sample ID **RB** SampType: **MBLK** TestCode: **EPA Method 8015D: Gasoline Range**

Client ID: **PBW** Batch ID: **R27991** RunNo: **27991**

Prep Date: Analysis Date: **8/5/2015** SeqNo: **842759** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	11		10.00		110	70	130			

Sample ID **2.5ug gro lcs** SampType: **LCS** TestCode: **EPA Method 8015D: Gasoline Range**

Client ID: **LCSW** Batch ID: **R27991** RunNo: **27991**

Prep Date: Analysis Date: **8/5/2015** SeqNo: **842760** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.50	0.050	0.5000	0	100	80.6	122			
Surr: BFB	10		10.00		103	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southw   Work Order Number: 1508080   RcptNo: 1

Received by/date: Lm 08/04/15

Logged By: **Ashley Gallegos** 8/4/2015 7:45:00 AM

Completed By: **Ashley Gallegos** 8/4/2015 12:14:54 PM

Reviewed By: Ja 08/04/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

\# of preserved bottles checked for pH: ____
(<2 or >12 unless noted)
Adjusted? ____
Checked by: ____

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: ____ Date ____
By Whom: ____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ____
Client Instructions: ____

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.8	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413
Phone #: 505-632-4135
email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: GAC 8-3-15

Project #: PO # ~~[illegible]~~ 126109~~[illegible]~~ 54

Project Manager:

Sampler: Bob
On Ice: ☒ Yes ☐ No
Sample Temperature: 1.8

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1508080	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / DRO / MRO)	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE on	8270 (Semi-VOA)	DRO-Ext. 8015B				Air Bubbles (Y or N)
-3-15	8:00	H_2O	GAC-inlet	5-VOA	HCl	-001										X						
					amber													X				
	8:10	H_2O	GAC-Lead	5-VOA	HCl	-002										X						
					amber													X				
	8:20	H_2O	GAC-outlet	5-VOA	HCl	-003										X						
					amber													X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-3-15	1040	Robert Krakow	Christine Waelt	8/3/15	1040
8/3/15	1932	Christine Waelt		08/04/15	0745

Remarks:

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

September 15, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 9-1-15 OrderNo.: 1509089

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 9/2/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Hall Environmental Analysis Laboratory, Inc.

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	GAC-Lag
Project:	GAC 9-1-15	**Collection Date:**	9/1/2015 10:45:00 AM
Lab ID:	1509089-001A	**Matrix:**	Aqueous

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **DJF**	
Benzene	ND	1.0		µg/L	1	9/2/2015 8:08:03 PM	A28626
Toluene	ND	1.0		µg/L	1	9/2/2015 8:08:03 PM	A28626
Ethylbenzene	ND	1.0		µg/L	1	9/2/2015 8:08:03 PM	A28626
Xylenes, Total	ND	1.5		µg/L	1	9/2/2015 8:08:03 PM	A28626
Surr: 1,2-Dichloroethane-d4	96.6	70-130		%REC	1	9/2/2015 8:08:03 PM	A28626
Surr: 4-Bromofluorobenzene	99.9	70-130		%REC	1	9/2/2015 8:08:03 PM	A28626
Surr: Dibromofluoromethane	109	70-130		%REC	1	9/2/2015 8:08:03 PM	A28626
Surr: Toluene-d8	98.2	70-130		%REC	1	9/2/2015 8:08:03 PM	A28626

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	GAC-Lag
Project:	GAC 9-1-15	**Collection Date:**	9/1/2015 10:45:00 AM
Lab ID:	1509089-001B	**Matrix:**	Aqueous

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**AG**
Gasoline Range Organics (GRO)	0.46	0.050		mg/L	1	9/4/2015 7:35:34 PM	B28684
Surr: BFB	101	70-130		%REC	1	9/4/2015 7:35:34 PM	B28684

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Hall Environmental Analysis Laboratory, Inc.

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	GAC-Lag
Project:	GAC 9-1-15	**Collection Date:**	9/1/2015 10:45:00 AM
Lab ID:	1509089-001C	**Matrix:**	Aqueous

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 8015D: DIESEL RANGE						Analyst: **JME**	
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	9/3/2015 1:03:45 AM	21109
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	9/3/2015 1:03:45 AM	21109
Surr: DNOP	117	84.6-165		%REC	1	9/3/2015 1:03:45 AM	21109

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Hall Environmental Analysis Laboratory, Inc.

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	GAC-Lead
Project:	GAC 9-1-15	**Collection Date:**	9/1/2015 10:50:00 AM
Lab ID:	1509089-002A	**Matrix:**	Aqueous

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	1.0		µg/L	1	9/2/2015 8:35:31 PM	A28626
Toluene	ND	1.0		µg/L	1	9/2/2015 8:35:31 PM	A28626
Ethylbenzene	ND	1.0		µg/L	1	9/2/2015 8:35:31 PM	A28626
Xylenes, Total	ND	1.5		µg/L	1	9/2/2015 8:35:31 PM	A28626
Surr: 1,2-Dichloroethane-d4	96.6	70-130		%REC	1	9/2/2015 8:35:31 PM	A28626
Surr: 4-Bromofluorobenzene	103	70-130		%REC	1	9/2/2015 8:35:31 PM	A28626
Surr: Dibromofluoromethane	109	70-130		%REC	1	9/2/2015 8:35:31 PM	A28626
Surr: Toluene-d8	98.0	70-130		%REC	1	9/2/2015 8:35:31 PM	A28626

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	D	Sample Diluted Due to Matrix	E	Value above quantitation range
	H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
	ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Hall Environmental Analysis Laboratory, Inc.

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	GAC-Lead
Project:	GAC 9-1-15	**Collection Date:**	9/1/2015 10:50:00 AM
Lab ID:	1509089-002B	**Matrix:**	Aqueous

Analyses	**Result**	**RL**	**Qual**	**Units**	**DF**	**Date Analyzed**	**Batch ID**
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **AG**
Gasoline Range Organics (GRO)	0.28	0.050		mg/L	1	9/4/2015 8:04:17 PM	B28684
Surr: BFB	100	70-130		%REC	1	9/4/2015 8:04:17 PM	B28684

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Hall Environmental Analysis Laboratory, Inc.

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	GAC-Lead
Project:	GAC 9-1-15	**Collection Date:**	9/1/2015 10:50:00 AM
Lab ID:	1509089-002C	**Matrix:**	Aqueous

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**JME**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	9/3/2015 1:25:30 AM	21109
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	9/3/2015 1:25:30 AM	21109
Surr: DNOP	119	84.6-165		%REC	1	9/3/2015 1:25:30 AM	21109

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Hall Environmental Analysis Laboratory, Inc.

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	GAC-Inlet
Project:	GAC 9-1-15	**Collection Date:**	9/1/2015 10:55:00 AM
Lab ID:	1509089-003A	**Matrix:**	Aqueous

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	5.0		µg/L	5	9/2/2015 9:03:01 PM	A28626
Toluene	ND	5.0		µg/L	5	9/2/2015 9:03:01 PM	A28626
Ethylbenzene	180	5.0		µg/L	5	9/2/2015 9:03:01 PM	A28626
Xylenes, Total	850	7.5		µg/L	5	9/2/2015 9:03:01 PM	A28626
Surr: 1,2-Dichloroethane-d4	95.2	70-130		%REC	5	9/2/2015 9:03:01 PM	A28626
Surr: 4-Bromofluorobenzene	96.6	70-130		%REC	5	9/2/2015 9:03:01 PM	A28626
Surr: Dibromofluoromethane	107	70-130		%REC	5	9/2/2015 9:03:01 PM	A28626
Surr: Toluene-d8	95.2	70-130		%REC	5	9/2/2015 9:03:01 PM	A28626

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	GAC-Inlet
Project:	GAC 9-1-15	**Collection Date:**	9/1/2015 10:55:00 AM
Lab ID:	1509089-003B	**Matrix:**	Aqueous

Analyses	**Result**	**RL**	**Qual**	**Units**	**DF**	**Date Analyzed**	**Batch ID**
EPA METHOD 8015D: GASOLINE RANGE						Analyst: **AG**	
Gasoline Range Organics (GRO)	7.1	0.25		mg/L	5	9/4/2015 8:32:56 PM	B28684
Surr: BFB	97.7	70-130		%REC	5	9/4/2015 8:32:56 PM	B28684

CLIENT:	Western Refining Southwest, Inc.	**Client Sample ID:**	GAC-Inlet
Project:	GAC 9-1-15	**Collection Date:**	9/1/2015 10:55:00 AM
Lab ID:	1509089-003C	**Matrix:**	Aqueous

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 8015D: DIESEL RANGE						Analyst: **JME**	
Diesel Range Organics (DRO)	0.35	0.20		mg/L	1	9/3/2015 1:47:05 AM	21109
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	9/3/2015 1:47:05 AM	21109
Surr: DNOP	127	84.6-165		%REC	1	9/3/2015 1:47:05 AM	21109

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

Client: Western Refining Southwest, Inc.
Project: GAC 9-1-15

Sample ID **MB-21109**	SampType: **MBLK**			TestCode: **EPA Method 8015D: Diesel Range**						
Client ID: **PBW**	Batch ID: **21109**			RunNo: **28606**						
Prep Date: **9/2/2015**	Analysis Date: **9/2/2015**			SeqNo: **866351**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.56		0.5000		112	84.6	165			

Sample ID **LCS-21109**	SampType: **LCS**			TestCode: **EPA Method 8015D: Diesel Range**						
Client ID: **LCSW**	Batch ID: **21109**			RunNo: **28606**						
Prep Date: **9/2/2015**	Analysis Date: **9/2/2015**			SeqNo: **866352**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.3	0.20	2.500	0	92.6	67.3	174			
Surr: DNOP	0.28		0.2500		112	84.6	165			

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1509089**

15-Sep-15

Client: Western Refining Southwest, Inc.

Project: GAC 9-1-15

Sample ID	**rb**	SampType:	**MBLK**	TestCode:	**EPA Method 8260: Volatiles Short List**
Client ID:	**PBW**	Batch ID:	**A28626**	RunNo:	**28626**
Prep Date:		Analysis Date:	**9/2/2015**	SeqNo:	**866329** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	9.6		10.00		95.7	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		105	70	130			
Surr: Dibromofluoromethane	11		10.00		108	70	130			
Surr: Toluene-d8	9.8		10.00		98.1	70	130			

Sample ID	**100ng lcs**	SampType:	**LCS**	TestCode:	**EPA Method 8260: Volatiles Short List**
Client ID:	**LCSW**	Batch ID:	**A28626**	RunNo:	**28626**
Prep Date:		Analysis Date:	**9/2/2015**	SeqNo:	**866330** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	20	1.0	20.00	0	98.9	70	130			
Toluene	19	1.0	20.00	0	97.2	70	130			
Surr: 1,2-Dichloroethane-d4	9.7		10.00		97.1	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		105	70	130			
Surr: Dibromofluoromethane	11		10.00		108	70	130			
Surr: Toluene-d8	9.7		10.00		97.2	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

Client: Western Refining Southwest, Inc.
Project: GAC 9-1-15

Sample ID **rb**	SampType: **MBLK**	TestCode: **EPA Method 8015D: Gasoline Range**	
Client ID: **PBW**	Batch ID: **B28684**	RunNo: **28684**	
Prep Date:	Analysis Date: **9/4/2015**	SeqNo: **869169**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	9.9		10.00		98.9	70	130			

Sample ID **2.5ug gro lcs**	SampType: **LCS**	TestCode: **EPA Method 8015D: Gasoline Range**	
Client ID: **LCSW**	Batch ID: **B28684**	RunNo: **28684**	
Prep Date:	Analysis Date: **9/4/2015**	SeqNo: **869170**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.52	0.050	0.5000	0	105	80.6	122			
Surr: BFB	10		10.00		101	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: **Western Refining Southw** Work Order Number: **1509089** RcptNo: **1**

Received by/date: 09/02/15

Logged By: **Lindsay Mangin** **9/2/2015 8:00:00 AM**

Completed By: **Lindsay Mangin** **9/2/2015 9:30:23 AM**

Reviewed By: 09/02/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? <u>Courier</u>

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

\# of preserved bottles checked for pH:
(<2 or >12 unless noted)
Adjusted?
Checked by:

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: Date:
By Whom: Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:
Client Instructions:

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.4	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 5280
Bloomfield, NM 87413

Phone #:

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other ____

☐ EDD (Type) ____

Turn-Around Time:
☒ Standard ☐ Rush ____

Project Name: GAC - 9-1-15

Project #:

Project Manager:

Sampler: Bob + MATT

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.4

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1509089	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted]	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO$_3$,NO$_2$,PO$_4$,SO$_4$)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Ext. 8015B				Air Bubbles (Y or N)
9-1-15	10:45	H$_2$O	GAC-LAg	5-VOA	HCl	-001			X							X						
				1-500 ml	amber	-001												X				
	10:50		GAC-Lead	5-VOA	HCl	-002			X							X						
				1-500ml	amber	-002												X				
	10:55		GAC-iNlet	5-VOA	HCl	-003			X							X						
				1-500ml	amber	-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-1-15	1315	Robert Krakow	Christa Walters	9/1/15	1315
9/1/15	1805	Christa Walters		09/0~~2~~3/15	0800

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

October 13, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 10-1-15 OrderNo.: 1510083

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 10/2/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1510083**

Hall Environmental Analysis Laboratory, Inc.

Date Reported: **10/13/2015**

CLIENT: Western Refining Southwest, Inc.
Project: GAC 10-1-15
Lab ID: 1510083-001
Matrix: AQUEOUS
Client Sample ID: GAC-Lag
Collection Date: 10/1/2015 9:45:00 AM
Received Date: 10/2/2015 8:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**KJH**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	10/6/2015 2:20:11 AM	21644
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	10/6/2015 2:20:11 AM	21644
Surr: DNOP	112	84.6-165		%REC	1	10/6/2015 2:20:11 AM	21644
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**DJF**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	10/5/2015 4:13:03 PM	B29319
Surr: BFB	95.3	70-130		%REC	1	10/5/2015 4:13:03 PM	B29319
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	10/5/2015 4:13:03 PM	A29319
Toluene	ND	1.0		µg/L	1	10/5/2015 4:13:03 PM	A29319
Ethylbenzene	ND	1.0		µg/L	1	10/5/2015 4:13:03 PM	A29319
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	10/5/2015 4:13:03 PM	A29319
Xylenes, Total	ND	1.5		µg/L	1	10/5/2015 4:13:03 PM	A29319
Surr: 1,2-Dichloroethane-d4	97.3	70-130		%REC	1	10/5/2015 4:13:03 PM	A29319
Surr: 4-Bromofluorobenzene	107	70-130		%REC	1	10/5/2015 4:13:03 PM	A29319
Surr: Dibromofluoromethane	107	70-130		%REC	1	10/5/2015 4:13:03 PM	A29319
Surr: Toluene-d8	101	70-130		%REC	1	10/5/2015 4:13:03 PM	A29319

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.
D	Sample Diluted Due to Matrix
H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits
S	% Recovery outside of range due to dilution or matrix
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
P	Sample pH Not In Range
RL	Reporting Detection Limit

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Lead
Project: GAC 10-1-15
Collection Date: 10/1/2015 9:50:00 AM
Lab ID: 1510083-002
Matrix: AQUEOUS
Received Date: 10/2/2015 8:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**KJH**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	10/6/2015 3:41:24 AM	21644
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	10/6/2015 3:41:24 AM	21644
Surr: DNOP	108	84.6-165		%REC	1	10/6/2015 3:41:24 AM	21644
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**DJF**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	10/5/2015 4:40:32 PM	B29319
Surr: BFB	97.8	70-130		%REC	1	10/5/2015 4:40:32 PM	B29319
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	10/5/2015 4:40:32 PM	A29319
Toluene	ND	1.0		µg/L	1	10/5/2015 4:40:32 PM	A29319
Ethylbenzene	ND	1.0		µg/L	1	10/5/2015 4:40:32 PM	A29319
Methyl tert-butyl ether (MTBE)	1.1	1.0		µg/L	1	10/5/2015 4:40:32 PM	A29319
Xylenes, Total	ND	1.5		µg/L	1	10/5/2015 4:40:32 PM	A29319
Surr: 1,2-Dichloroethane-d4	92.2	70-130		%REC	1	10/5/2015 4:40:32 PM	A29319
Surr: 4-Bromofluorobenzene	107	70-130		%REC	1	10/5/2015 4:40:32 PM	A29319
Surr: Dibromofluoromethane	103	70-130		%REC	1	10/5/2015 4:40:32 PM	A29319
Surr: Toluene-d8	101	70-130		%REC	1	10/5/2015 4:40:32 PM	A29319

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	D	Sample Diluted Due to Matrix	E	Value above quantitation range
	H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
	ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	% Recovery outside of range due to dilution or matrix		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Inlet
Project: GAC 10-1-15
Collection Date: 10/1/2015 9:55:00 AM
Lab ID: 1510083-003
Matrix: AQUEOUS
Received Date: 10/2/2015 8:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE							Analyst: **KJH**
Diesel Range Organics (DRO)	0.29	0.20		mg/L	1	10/6/2015 4:08:28 AM	21644
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	10/6/2015 4:08:28 AM	21644
Surr: DNOP	121	84.6-165		%REC	1	10/6/2015 4:08:28 AM	21644
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **DJF**
Gasoline Range Organics (GRO)	0.60	0.25		mg/L	5	10/5/2015 5:08:03 PM	B29319
Surr: BFB	97.7	70-130		%REC	5	10/5/2015 5:08:03 PM	B29319
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	5.0	D	µg/L	5	10/5/2015 5:08:03 PM	A29319
Toluene	ND	5.0	D	µg/L	5	10/5/2015 5:08:03 PM	A29319
Ethylbenzene	ND	5.0	D	µg/L	5	10/5/2015 5:08:03 PM	A29319
Methyl tert-butyl ether (MTBE)	ND	5.0	D	µg/L	5	10/5/2015 5:08:03 PM	A29319
Xylenes, Total	8.6	7.5	D	µg/L	5	10/5/2015 5:08:03 PM	A29319
Surr: 1,2-Dichloroethane-d4	97.1	70-130	D	%REC	5	10/5/2015 5:08:03 PM	A29319
Surr: 4-Bromofluorobenzene	103	70-130	D	%REC	5	10/5/2015 5:08:03 PM	A29319
Surr: Dibromofluoromethane	104	70-130	D	%REC	5	10/5/2015 5:08:03 PM	A29319
Surr: Toluene-d8	99.3	70-130	D	%REC	5	10/5/2015 5:08:03 PM	A29319

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

QC SUMMARY REPORT
Hall Environmental Analysis Laboratory, Inc.

WO#: **1510083**
13-Oct-15

Client: Western Refining Southwest, Inc.
Project: GAC 10-1-15

Sample ID **MB-21644** SampType: **MBLK** TestCode: **EPA Method 8015D: Diesel Range**
Client ID: **PBW** Batch ID: **21644** RunNo: **29273**
Prep Date: **10/2/2015** Analysis Date: **10/6/2015** SeqNo: **890936** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.58		0.5000		116	84.6	165			

Sample ID **LCS-21644** SampType: **LCS** TestCode: **EPA Method 8015D: Diesel Range**
Client ID: **LCSW** Batch ID: **21644** RunNo: **29273**
Prep Date: **10/2/2015** Analysis Date: **10/6/2015** SeqNo: **890939** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.6	0.20	2.500	0	105	67.3	174			
Surr: DNOP	0.28		0.2500		114	84.6	165			

Sample ID **1510083-001BMS** SampType: **MS** TestCode: **EPA Method 8015D: Diesel Range**
Client ID: **GAC-Lag** Batch ID: **21644** RunNo: **29273**
Prep Date: **10/2/2015** Analysis Date: **10/6/2015** SeqNo: **890941** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.4	0.20	2.500	0	94.2	67.2	210			
Surr: DNOP	0.26		0.2500		105	84.6	165			

Sample ID **1510083-001BMSD** SampType: **MSD** TestCode: **EPA Method 8015D: Diesel Range**
Client ID: **GAC-Lag** Batch ID: **21644** RunNo: **29273**
Prep Date: **10/2/2015** Analysis Date: **10/6/2015** SeqNo: **890942** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.7	0.20	2.500	0	107	67.2	210	13.0	33.9	
Surr: DNOP	0.28		0.2500		112	84.6	165	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

Client: Western Refining Southwest, Inc.
Project: GAC 10-1-15

Sample ID **rb1** SampType: **MBLK** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW** Batch ID: **A29319** RunNo: **29319**
Prep Date: Analysis Date: **10/5/2015** SeqNo: **891313** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	9.8		10.00		97.6	70	130			
Surr: 4-Bromofluorobenzene	10		10.00		103	70	130			
Surr: Dibromofluoromethane	11		10.00		112	70	130			
Surr: Toluene-d8	10		10.00		100	70	130			

Sample ID **100ng lcs** SampType: **LCS** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **LCSW** Batch ID: **A29319** RunNo: **29319**
Prep Date: Analysis Date: **10/5/2015** SeqNo: **891314** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	18	1.0	20.00	0	92.1	70	130			
Toluene	19	1.0	20.00	0	97.1	70	130			
Surr: 1,2-Dichloroethane-d4	9.8		10.00		98.5	70	130			
Surr: 4-Bromofluorobenzene	10		10.00		103	70	130			
Surr: Dibromofluoromethane	11		10.00		109	70	130			
Surr: Toluene-d8	10		10.00		101	70	130			

Sample ID **1510083-001a ms** SampType: **MS** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **GAC-Lag** Batch ID: **A29319** RunNo: **29319**
Prep Date: Analysis Date: **10/5/2015** SeqNo: **891316** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	20	1.0	20.00	0	101	70	130			
Toluene	21	1.0	20.00	0	107	70	130			
Surr: 1,2-Dichloroethane-d4	9.8		10.00		98.4	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		107	70	130			
Surr: Dibromofluoromethane	11		10.00		107	70	130			
Surr: Toluene-d8	10		10.00		101	70	130			

Sample ID **1510083-001a msd** SampType: **MSD** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **GAC-Lag** Batch ID: **A29319** RunNo: **29319**
Prep Date: Analysis Date: **10/5/2015** SeqNo: **891317** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	20	1.0	20.00	0	102	70	130	0.746	20	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

Client: Western Refining Southwest, Inc.

Project: GAC 10-1-15

Sample ID **1510083-001a msd** SampType: **MSD** TestCode: **EPA Method 8260: Volatiles Short List**

Client ID: **GAC-Lag** Batch ID: **A29319** RunNo: **29319**

Prep Date: Analysis Date: **10/5/2015** SeqNo: **891317** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Toluene	22	1.0	20.00	0	109	70	130	2.29	20	
Surr: 1,2-Dichloroethane-d4	9.9		10.00		98.6	70	130	0	0	
Surr: 4-Bromofluorobenzene	11		10.00		108	70	130	0	0	
Surr: Dibromofluoromethane	11		10.00		109	70	130	0	0	
Surr: Toluene-d8	10		10.00		104	70	130	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1510083**

13-Oct-15

Client: Western Refining Southwest, Inc.

Project: GAC 10-1-15

Sample ID **rb1** SampType: **MBLK** TestCode: **EPA Method 8015D: Gasoline Range**
Client ID: **PBW** Batch ID: **B29319** RunNo: **29319**
Prep Date: Analysis Date: **10/5/2015** SeqNo: **891329** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	10		10.00		101	70	130			

Sample ID **2.5ug gro lcs** SampType: **LCS** TestCode: **EPA Method 8015D: Gasoline Range**
Client ID: **LCSW** Batch ID: **B29319** RunNo: **29319**
Prep Date: Analysis Date: **10/5/2015** SeqNo: **891330** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.55	0.050	0.5000	0	109	80.6	122			
Surr: BFB	10		10.00		99.8	70	130			

Sample ID **1510083-002a ms** SampType: **MS** TestCode: **EPA Method 8015D: Gasoline Range**
Client ID: **GAC-Lead** Batch ID: **B29319** RunNo: **29319**
Prep Date: Analysis Date: **10/5/2015** SeqNo: **891449** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.53	0.050	0.5000	0	107	53.8	128			
Surr: BFB	9.8		10.00		98.2	70	130			

Sample ID **1510083-002a msd** SampType: **MSD** TestCode: **EPA Method 8015D: Gasoline Range**
Client ID: **GAC-Lead** Batch ID: **B29319** RunNo: **29319**
Prep Date: Analysis Date: **10/5/2015** SeqNo: **891450** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.55	0.050	0.5000	0	110	53.8	128	3.13	20	
Surr: BFB	9.9		10.00		99.4	70	130	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southw   Work Order Number: 1510083   RcptNo: 1

Received by/date: JA 10/02/15

Logged By: **Lindsay Mangin**   10/2/2015 8:00:00 AM

Completed By: **Lindsay Mangin**   10/2/2015 1:18:33 PM

Reviewed By: 10/02/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

# of preserved bottles checked for pH: ______
(<2 or >12 unless noted)
Adjusted? ______
Checked by: ______

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: ______   Date ______
By Whom: ______   Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ______
Client Instructions: ______

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.0	Good	Yes			

Chain-of-Custody Record

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Client: Western Refining

Mailing Address: #50 CR 4990

Bloomfield, NM 87413

Phone #:

email or Fax#:

QA/QC Package:

☐ Standard ☒ Level 4 (Full Validation)

Accreditation

☐ NELAP ☐ Other ______

☐ EDD (Type) ______

Turn-Around Time:

☒ Standard ☐ Rush ______

Project Name: GAC 10-1-15

Project #: PO# 1261124

Project Manager:

Sampler: Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.0

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1510083	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO-Ext 8015B				Air Bubbles (Y or N)
10-1-15	9:45	H2O	GAC-LAG	3-VOA	HCl	-001			X							X						
				1-500ml	amber	-001												X				
	9:50		GAC-Lead	3-VOA	HCl	-002			X							X						
				1-500ml	amber	-002												X				
	9:55		GAC-inlet	3-VOA	HCl	-003			X							X						
				1-500ml	amber	-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
10/1/15	1527	Robert Krakow	Chet Waite	10/1/15	1527
10/1/15	1934	Chet Waite		10/02/15	0800

Remarks:

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

November 23, 2015

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 11-11-15 OrderNo.: 1511519

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 11/12/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC 11-11-15
Lab ID: 1511519-001
Matrix: AQUEOUS
Client Sample ID: GAC-Lag
Collection Date: 11/11/2015 9:50:00 AM
Received Date: 11/12/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE							Analyst: **TOM**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	11/12/2015 11:53:00 AM	22310
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	11/12/2015 11:53:00 AM	22310
Surr: DNOP	96.4	84.6-165		%REC	1	11/12/2015 11:53:00 AM	22310
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	11/12/2015 10:25:31 PM	A30203
Surr: BFB	74.9	57.8-137		%REC	1	11/12/2015 10:25:31 PM	A30203
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **BCN**
Benzene	ND	1.0		µg/L	1	11/14/2015 4:35:05 AM	c30245
Toluene	ND	1.0		µg/L	1	11/14/2015 4:35:05 AM	c30245
Ethylbenzene	ND	1.0		µg/L	1	11/14/2015 4:35:05 AM	c30245
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	11/14/2015 4:35:05 AM	c30245
Xylenes, Total	ND	1.5		µg/L	1	11/14/2015 4:35:05 AM	c30245
Surr: 1,2-Dichloroethane-d4	97.9	70-130		%REC	1	11/14/2015 4:35:05 AM	c30245
Surr: 4-Bromofluorobenzene	89.4	70-130		%REC	1	11/14/2015 4:35:05 AM	c30245
Surr: Dibromofluoromethane	89.2	70-130		%REC	1	11/14/2015 4:35:05 AM	c30245
Surr: Toluene-d8	97.5	70-130		%REC	1	11/14/2015 4:35:05 AM	c30245

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Lead
Project: GAC 11-11-15
Collection Date: 11/11/2015 10:00:00 AM
Lab ID: 1511519-002
Matrix: AQUEOUS
Received Date: 11/12/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst: **TOM**	
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	11/12/2015 12:56:51 PM	22310
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	11/12/2015 12:56:51 PM	22310
Surr: DNOP	87.7	84.6-165		%REC	1	11/12/2015 12:56:51 PM	22310
EPA METHOD 8015D: GASOLINE RANGE						Analyst: **NSB**	
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	11/12/2015 10:50:07 PM	A30203
Surr: BFB	74.8	57.8-137		%REC	1	11/12/2015 10:50:07 PM	A30203
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **BCN**	
Benzene	ND	1.0		µg/L	1	11/16/2015 3:42:06 PM	a30273
Toluene	ND	1.0		µg/L	1	11/16/2015 3:42:06 PM	a30273
Ethylbenzene	ND	1.0		µg/L	1	11/16/2015 3:42:06 PM	a30273
Methyl tert-butyl ether (MTBE)	1.5	1.0		µg/L	1	11/16/2015 3:42:06 PM	a30273
Xylenes, Total	ND	1.5		µg/L	1	11/16/2015 3:42:06 PM	a30273
Surr: 1,2-Dichloroethane-d4	101	70-130		%REC	1	11/16/2015 3:42:06 PM	a30273
Surr: 4-Bromofluorobenzene	86.0	70-130		%REC	1	11/16/2015 3:42:06 PM	a30273
Surr: Dibromofluoromethane	99.8	70-130		%REC	1	11/16/2015 3:42:06 PM	a30273
Surr: Toluene-d8	103	70-130		%REC	1	11/16/2015 3:42:06 PM	a30273

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Inlet
Project: GAC 11-11-15
Collection Date: 11/11/2015 10:10:00 AM
Lab ID: 1511519-003
Matrix: AQUEOUS
Received Date: 11/12/2015 7:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**TOM**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	11/12/2015 1:18:07 PM	22310
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	11/12/2015 1:18:07 PM	22310
Surr: DNOP	92.7	84.6-165		%REC	1	11/12/2015 1:18:07 PM	22310
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	0.38	0.25		mg/L	5	11/12/2015 11:14:40 PM	A30203
Surr: BFB	93.1	57.8-137		%REC	5	11/12/2015 11:14:40 PM	A30203
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**BCN**
Benzene	ND	5.0	D	µg/L	5	11/14/2015 6:05:47 AM	c30245
Toluene	ND	5.0	D	µg/L	5	11/14/2015 6:05:47 AM	c30245
Ethylbenzene	8.0	5.0	D	µg/L	5	11/14/2015 6:05:47 AM	c30245
Methyl tert-butyl ether (MTBE)	ND	5.0	D	µg/L	5	11/14/2015 6:05:47 AM	c30245
Xylenes, Total	ND	7.5	D	µg/L	5	11/14/2015 6:05:47 AM	c30245
Surr: 1,2-Dichloroethane-d4	103	70-130	D	%REC	5	11/14/2015 6:05:47 AM	c30245
Surr: 4-Bromofluorobenzene	107	70-130	D	%REC	5	11/14/2015 6:05:47 AM	c30245
Surr: Dibromofluoromethane	97.1	70-130	D	%REC	5	11/14/2015 6:05:47 AM	c30245
Surr: Toluene-d8	103	70-130	D	%REC	5	11/14/2015 6:05:47 AM	c30245

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:				
	*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
	D	Sample Diluted Due to Matrix	E	Value above quantitation range
	H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
	ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
	R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
	S	% Recovery outside of range due to dilution or matrix		

Client: Western Refining Southwest, Inc.

Project: GAC 11-11-15

Sample ID **MB-22310** SampType: **MBLK** TestCode: **EPA Method 8015D: Diesel Range**

Client ID: **PBW** Batch ID: **22310** RunNo: **30190**

Prep Date: **11/12/2015** Analysis Date: **11/12/2015** SeqNo: **919879** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.45		0.5000		90.6	84.6	165			

Sample ID **LCS-22310** SampType: **LCS** TestCode: **EPA Method 8015D: Diesel Range**

Client ID: **LCSW** Batch ID: **22310** RunNo: **30190**

Prep Date: **11/12/2015** Analysis Date: **11/12/2015** SeqNo: **919880** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.6	0.20	2.500	0	105	67.3	174			
Surr: DNOP	0.22		0.2500		89.7	84.6	165			

Sample ID **1511519-001BMS** SampType: **MS** TestCode: **EPA Method 8015D: Diesel Range**

Client ID: **GAC-Lag** Batch ID: **22310** RunNo: **30190**

Prep Date: **11/12/2015** Analysis Date: **11/12/2015** SeqNo: **919884** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.8	0.20	2.500	0	113	67.2	210			
Surr: DNOP	0.23		0.2500		94.0	84.6	165			

Sample ID **1511519-001BMSD** SampType: **MSD** TestCode: **EPA Method 8015D: Diesel Range**

Client ID: **GAC-Lag** Batch ID: **22310** RunNo: **30190**

Prep Date: **11/12/2015** Analysis Date: **11/12/2015** SeqNo: **919885** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.0	0.20	2.500	0	120	67.2	210	5.49	33.9	
Surr: DNOP	0.24		0.2500		96.1	84.6	165	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1511519**

23-Nov-15

Client: Western Refining Southwest, Inc.

Project: GAC 11-11-15

Sample ID	**5ML RB**	SampType:	**MBLK**	TestCode:	**EPA Method 8015D: Gasoline Range**
Client ID:	**PBW**	Batch ID:	**A30203**	RunNo:	**30203**
Prep Date:		Analysis Date:	**11/12/2015**	SeqNo:	**920301** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	17		20.00		83.0	57.8	137			

Sample ID	**2.5UG GRO LCS**	SampType:	**LCS**	TestCode:	**EPA Method 8015D: Gasoline Range**
Client ID:	**LCSW**	Batch ID:	**A30203**	RunNo:	**30203**
Prep Date:		Analysis Date:	**11/12/2015**	SeqNo:	**920302** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.47	0.050	0.5000	0	93.7	80	120			
Surr: BFB	20		20.00		99.2	57.8	137			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1511519**

23-Nov-15

Client: Western Refining Southwest, Inc.

Project: GAC 11-11-15

Sample ID **100ng lcs**	SampType: **LCS**	TestCode: **EPA Method 8260: Volatiles Short List**	
Client ID: **LCSW**	Batch ID: **c30245**	RunNo: **30245**	
Prep Date:	Analysis Date: **11/14/2015**	SeqNo: **922130**	Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	20	1.0	20.00	0	99.9	70	130			
Toluene	20	1.0	20.00	0	101	70	130			
Surr: 1,2-Dichloroethane-d4	9.7		10.00		96.7	70	130			
Surr: 4-Bromofluorobenzene	8.7		10.00		86.5	70	130			
Surr: Dibromofluoromethane	8.9		10.00		88.5	70	130			
Surr: Toluene-d8	9.6		10.00		96.1	70	130			

Sample ID **rb3**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**	
Client ID: **PBW**	Batch ID: **c30245**	RunNo: **30245**	
Prep Date:	Analysis Date: **11/14/2015**	SeqNo: **922132**	Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	9.7		10.00		96.7	70	130			
Surr: 4-Bromofluorobenzene	8.4		10.00		84.1	70	130			
Surr: Dibromofluoromethane	8.9		10.00		88.5	70	130			
Surr: Toluene-d8	10		10.00		99.8	70	130			

Sample ID **100ng lcs**	SampType: **LCS**	TestCode: **EPA Method 8260: Volatiles Short List**	
Client ID: **LCSW**	Batch ID: **a30273**	RunNo: **30273**	
Prep Date:	Analysis Date: **11/16/2015**	SeqNo: **923205**	Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	20	1.0	20.00	0	98.5	70	130			
Toluene	20	1.0	20.00	0	102	70	130			
Surr: 1,2-Dichloroethane-d4	9.9		10.00		98.6	70	130			
Surr: 4-Bromofluorobenzene	8.4		10.00		83.5	70	130			
Surr: Dibromofluoromethane	10		10.00		103	70	130			
Surr: Toluene-d8	10		10.00		100	70	130			

Sample ID **rb1**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**	
Client ID: **PBW**	Batch ID: **a30273**	RunNo: **30273**	
Prep Date:	Analysis Date: **11/16/2015**	SeqNo: **923206**	Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1511519**

23-Nov-15

Client: Western Refining Southwest, Inc.

Project: GAC 11-11-15

Sample ID **rb1**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**	
Client ID: **PBW**	Batch ID: **a30273**	RunNo: **30273**	
Prep Date:	Analysis Date: **11/16/2015**	SeqNo: **923206**	Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	9.1		10.00		91.0	70	130			
Surr: 4-Bromofluorobenzene	8.6		10.00		86.3	70	130			
Surr: Dibromofluoromethane	9.0		10.00		90.3	70	130			
Surr: Toluene-d8	10		10.00		99.6	70	130			

Sample ID **1511519-003ams**	SampType: **MS**	TestCode: **EPA Method 8260: Volatiles Short List**	
Client ID: **GAC-Inlet**	Batch ID: **a30273**	RunNo: **30273**	
Prep Date:	Analysis Date: **11/16/2015**	SeqNo: **923208**	Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	120	5.0	100.0	0	124	70	130			
Toluene	120	5.0	100.0	0	120	70	130			
Surr: 1,2-Dichloroethane-d4	54		50.00		108	70	130			
Surr: 4-Bromofluorobenzene	55		50.00		110	70	130			
Surr: Dibromofluoromethane	54		50.00		109	70	130			
Surr: Toluene-d8	46		50.00		93.0	70	130			

Sample ID **1511519-003amsd**	SampType: **MSD**	TestCode: **EPA Method 8260: Volatiles Short List**	
Client ID: **GAC-Inlet**	Batch ID: **a30273**	RunNo: **30273**	
Prep Date:	Analysis Date: **11/16/2015**	SeqNo: **923209**	Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	110	5.0	100.0	0	112	70	130	11.0	20	
Toluene	110	5.0	100.0	0	108	70	130	10.2	20	
Surr: 1,2-Dichloroethane-d4	51		50.00		101	70	130	0	0	
Surr: 4-Bromofluorobenzene	50		50.00		99.6	70	130	0	0	
Surr: Dibromofluoromethane	49		50.00		98.4	70	130	0	0	
Surr: Toluene-d8	47		50.00		93.4	70	130	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southw   Work Order Number: 1511519   RcptNo: 1

Received by/date: AT 11/12/15
Logged By: Anne Thorne   11/12/2015 7:00:00 AM
Completed By: Anne Thorne   11/12/2015
Reviewed By: 11/12/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

# of preserved bottles checked for pH: ____
(<2 or >12 unless noted)
Adjusted? ____
Checked by: ____

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: ____   Date ____
By Whom: ____   Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ____
Client Instructions: ____

17. Additional remarks:

18. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.6	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR4990

Bloomfield, NM 87413

Phone #: 505-632-4169

email or Fax#:

QA/QC Package:

☐ Standard ☒ Level 4 (Full Validation)

Accreditation

☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:

☒ Standard ☐ Rush

Project Name: GAC 11-11-15

Project #: PO# 12610954

Project Manager:

Sampler: Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.6

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1511519	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted])	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	8015B DRO Ext.				Air Bubbles (Y or N)
-11-15	9:50	H_2O	GAC - LAq	4-VOA	HCl	-001			X							X						
|	\	|	\	1-500ml	amber	-001												X				
|	10:00	|	GAC - Lead	4-VOA	HCl	-002			X							X						
|	\	|	\	1-500ml	amber	-002												X				
|	10:10	|	GAC - inlet	4-VOA	ACl	-003			X							X						
|	\	|	\	1-500ml	amber	-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
-11-15	1530	Robert Krakow	Christa Waite	11/11/15	1530

Date:	Time:	Relinquished by:	Received by:	Date	Time
11/15	1814	Christa Waite		11/12/15	0700

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

January 11, 2016

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 11/11/15 OrderNo.: 1512C26

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 2 sample(s) on 12/31/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1512C26**
Date Reported: **1/11/2016**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC 11/11/15
Lab ID: 1512C26-001
Matrix: AQUEOUS

Client Sample ID: GAC-Inlet
Collection Date: 12/30/2015 2:15:00 PM
Received Date: 12/31/2015 7:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE							Analyst: **KJH**
Diesel Range Organics (DRO)	1.1	0.20		mg/L	1	1/5/2016 3:04:49 PM	23063
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	1/5/2016 3:04:49 PM	23063
Surr: DNOP	86.8	84.6-165		%REC	1	1/5/2016 3:04:49 PM	23063
EPA METHOD 8015D: GASOLINE RANGE							Analyst: **NSB**
Gasoline Range Organics (GRO)	0.74	0.25		mg/L	5	1/5/2016 12:12:39 PM	R31251
Surr: BFB	109	49.5-130		%REC	5	1/5/2016 12:12:39 PM	R31251
EPA METHOD 8260: VOLATILES SHORT LIST							Analyst: **DJF**
Benzene	ND	5.0		µg/L	5	1/6/2016 1:51:01 AM	A31234
Toluene	ND	5.0		µg/L	5	1/6/2016 1:51:01 AM	A31234
Ethylbenzene	9.7	5.0		µg/L	5	1/6/2016 1:51:01 AM	A31234
Methyl tert-butyl ether (MTBE)	ND	5.0		µg/L	5	1/6/2016 1:51:01 AM	A31234
Xylenes, Total	ND	7.5		µg/L	5	1/6/2016 1:51:01 AM	A31234
Surr: 1,2-Dichloroethane-d4	100	70-130		%REC	5	1/6/2016 1:51:01 AM	A31234
Surr: 4-Bromofluorobenzene	109	70-130		%REC	5	1/6/2016 1:51:01 AM	A31234
Surr: Dibromofluoromethane	98.9	70-130		%REC	5	1/6/2016 1:51:01 AM	A31234
Surr: Toluene-d8	108	70-130		%REC	5	1/6/2016 1:51:01 AM	A31234

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1512C26**
Date Reported: **1/11/2016**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC 11/11/15
Lab ID: 1512C26-002 **Matrix:** AQUEOUS

Client Sample ID: GAC-Lead
Collection Date: 12/30/2015 2:30:00 PM
Received Date: 12/31/2015 7:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: DIESEL RANGE						Analyst:	**KJH**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	1/5/2016 4:09:48 PM	23063
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	1/5/2016 4:09:48 PM	23063
Surr: DNOP	121	84.6-165		%REC	1	1/5/2016 4:09:48 PM	23063
EPA METHOD 8015D: GASOLINE RANGE						Analyst:	**NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	1/5/2016 1:23:39 PM	R31251
Surr: BFB	91.0	49.5-130		%REC	1	1/5/2016 1:23:39 PM	R31251
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst:	**DJF**
Benzene	ND	1.0		µg/L	1	1/6/2016 2:19:24 AM	A31234
Toluene	ND	1.0		µg/L	1	1/6/2016 2:19:24 AM	A31234
Ethylbenzene	ND	1.0		µg/L	1	1/6/2016 2:19:24 AM	A31234
Methyl tert-butyl ether (MTBE)	1.6	1.0		µg/L	1	1/6/2016 2:19:24 AM	A31234
Xylenes, Total	ND	1.5		µg/L	1	1/6/2016 2:19:24 AM	A31234
Surr: 1,2-Dichloroethane-d4	97.4	70-130		%REC	1	1/6/2016 2:19:24 AM	A31234
Surr: 4-Bromofluorobenzene	115	70-130		%REC	1	1/6/2016 2:19:24 AM	A31234
Surr: Dibromofluoromethane	98.5	70-130		%REC	1	1/6/2016 2:19:24 AM	A31234
Surr: Toluene-d8	107	70-130		%REC	1	1/6/2016 2:19:24 AM	A31234

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1512C26**

11-Jan-16

Client: Western Refining Southwest, Inc.

Project: GAC 11/11/15

Sample ID **MB-23063** SampType: **MBLK** TestCode: **EPA Method 8015D: Diesel Range**

Client ID: **PBW** Batch ID: **23063** RunNo: **31230**

Prep Date: **1/5/2016** Analysis Date: **1/5/2016** SeqNo: **957044** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.53		0.5000		107	84.6	165			

Sample ID **LCS-23063** SampType: **LCS** TestCode: **EPA Method 8015D: Diesel Range**

Client ID: **LCSW** Batch ID: **23063** RunNo: **31230**

Prep Date: **1/5/2016** Analysis Date: **1/5/2016** SeqNo: **957050** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.4	0.20	2.500	0	137	65.4	162			
Surr: DNOP	0.27		0.2500		108	84.6	165			

Sample ID **1512C26-001BMS** SampType: **MS** TestCode: **EPA Method 8015D: Diesel Range**

Client ID: **GAC-Inlet** Batch ID: **23063** RunNo: **31230**

Prep Date: **1/5/2016** Analysis Date: **1/5/2016** SeqNo: **957052** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	4.5	0.20	2.500	1.095	138	73.3	174			
Surr: DNOP	0.27		0.2500		109	84.6	165			

Sample ID **1512C26-001BMSD** SampType: **MSD** TestCode: **EPA Method 8015D: Diesel Range**

Client ID: **GAC-Inlet** Batch ID: **23063** RunNo: **31230**

Prep Date: **1/5/2016** Analysis Date: **1/5/2016** SeqNo: **957053** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	4.6	0.20	2.500	1.095	138	73.3	174	0.226	20	
Surr: DNOP	0.28		0.2500		112	84.6	165	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1512C26**

11-Jan-16

Client: Western Refining Southwest, Inc.
Project: GAC 11/11/15

Sample ID	**5ML RB**	SampType:	**MBLK**	TestCode:	**EPA Method 8015D: Gasoline Range**
Client ID:	**PBW**	Batch ID:	**R31251**	RunNo:	**31251**
Prep Date:		Analysis Date:	**1/5/2016**	SeqNo:	**956912** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	17		20.00		86.9	49.5	130			

Sample ID	**2.5UG GRO LCS**	SampType:	**LCS**	TestCode:	**EPA Method 8015D: Gasoline Range**
Client ID:	**LCSW**	Batch ID:	**R31251**	RunNo:	**31251**
Prep Date:		Analysis Date:	**1/5/2016**	SeqNo:	**956913** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.46	0.050	0.5000	0	92.9	80	120			
Surr: BFB	19		20.00		92.6	49.5	130			

Sample ID	**1512C26-001AMS**	SampType:	**MS**	TestCode:	**EPA Method 8015D: Gasoline Range**
Client ID:	**GAC-Inlet**	Batch ID:	**R31251**	RunNo:	**31251**
Prep Date:		Analysis Date:	**1/5/2016**	SeqNo:	**956919** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	3.0	0.25	2.500	0.7400	89.6	70	130			
Surr: BFB	120		100.0		116	49.5	130			

Sample ID	**1512C26-001AMSD**	SampType:	**MSD**	TestCode:	**EPA Method 8015D: Gasoline Range**
Client ID:	**GAC-Inlet**	Batch ID:	**R31251**	RunNo:	**31251**
Prep Date:		Analysis Date:	**1/5/2016**	SeqNo:	**956920** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	3.2	0.25	2.500	0.7400	97.7	70	130	6.56	20	
Surr: BFB	120		100.0		118	49.5	130	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

QC SUMMARY REPORT
Hall Environmental Analysis Laboratory, Inc.

Client: Western Refining Southwest, Inc.
Project: GAC 11/11/15

Sample ID **rb** SampType: **MBLK** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW** Batch ID: **A31234** RunNo: **31234**
Prep Date: Analysis Date: **1/5/2016** SeqNo: **956589** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	10		10.00		99.6	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		109	70	130			
Surr: Dibromofluoromethane	9.8		10.00		97.9	70	130			
Surr: Toluene-d8	10		10.00		104	70	130			

Sample ID **100ng lcsb** SampType: **LCS** TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **LCSW** Batch ID: **A31234** RunNo: **31234**
Prep Date: Analysis Date: **1/5/2016** SeqNo: **956590** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	21	1.0	20.00	0	105	70	130			
Toluene	21	1.0	20.00	0	107	70	130			
Surr: 1,2-Dichloroethane-d4	9.7		10.00		96.9	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		109	70	130			
Surr: Dibromofluoromethane	9.9		10.00		99.0	70	130			
Surr: Toluene-d8	10		10.00		102	70	130			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southw
Work Order Number: 1512C26
RcptNo: 1

Received by/date: Ja 12/31/15
Logged By: **Joe Archuleta** 12/31/2015 7:45:00 AM
Completed By: **Joe Archuleta** 12/31/2015 8:41:15 AM
Reviewed By: JO 01/04/16

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Courier

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? Yes ☐ No ☐ No VOA Vials ☑
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
(Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
(If no, notify customer for authorization.)

\# of preserved bottles checked for pH:
(<2 or >12 unless noted)
Adjusted?
Checked by:

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified:
Date
By Whom:
Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:
Client Instructions:

17. Additional remarks:

18. Cooler Information

Cooler No	Temp ºC	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.0	Good	Yes			

Chain-of-Custody Record

lient: Western Refining

ailing Address: #50 CR4990
Bloomfield NM 87413
hone #: 505-632-4169
mail or Fax#:
A/QC Package:
 Standard ☒ Level 4 (Full Validation)
ccreditation
 NELAP ☐ Other
 EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC 11-11-15

Project #:
PO# 12610954

Project Manager:

Sampler: Matt
On Ice: ☒ Yes ☐ No
Sample Temperature: 1.0

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1512C26	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / [redacted]	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	8015B DRO Ext.				Air Bubbles (Y or N)
0/15	2:15	H_2O	GAC-Inlet	4-VOA	HCL	-001			X							X						
\	\	\	\	1-500mL	amber	-001												X				
0/15	2:30	H_2O	GAC-lead	4-VOA	HCL	-002			X							X						
\	\	\	\	1-500mL	amber	-002												X				

ate:	Time:	Relinquished by:	Received by:	Date	Time
30/15	4:00 PM	Matt Krakow		12/30/15	1650
ate:	Time:	Relinquished by:	Received by:	Date	Time
30/15	1710			12/31/15	0745

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.