PREDICTIVE ECOLOGICAL RISK ASSESSMENT

UNOCAL SAN LUIS OBISPO TANK FARM SAN LUIS OBISPO, CALIFORNIA

Version 2.0

Prepared for

San Luis Obispo Tank Farm Surface Evaluation, Remediation, and Restoration Team

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BBL Sciences®

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Respectfully submitted,

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Acronyms

AE	Assessment endpoint
AGS	Applied Geochemical Strategies, Inc.
ARCS	Assessment and Remediation of Contaminated Sediments
AST	Aboveground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient water quality criteria
BAF	Bioaccumulation factor
BBL	Blasland, Bouck & Lee, Inc.
BTAG	Biological Technical Assistance Group
BTEX	Benzene, toluene, ethyl benzene and total xylenes
BW	Body Weight
CAM	California Administrative Manual
CCME	Canadian Council Ministries of the Environment
CDFG	California Department of Fish and Game
CNPS	California Native Plant Society
COC	Chain of custody
COPEC	Constituent of potential ecological concern
CSM	Conceptual site model
DMS	Data management system
DO	Dissolved oxygen
DQA	Data quality assessment
DQO	Data quality objective
DTSC	California Department of Toxic Substances Control
EC	Effect concentration
EPC	Exposure point concentration
ERA	Ecological risk assessment
ERWG	Ecological risk working group
HERD	Human and Ecological Risk Division
HQ	Hazard quotient
LC	Lethal concentration
LNAPL	Light non-aqueous phase liquid
LOAEL	Lowest observable adverse effects level

LOEC	Lowest observed effect concentration
ME	Measurement endpoint
MRP	Monitoring and reporting program
NOAA	National Oceanic & Atmospheric Administration
NOAEL	No observable adverse effects level
NOEC	No observed effect concentration
ORNL	Oakridge National Laboratory
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
pERA	Predictive ecological risk assessment
PEC	Probable effect concentration
ROC	Receptor of concern
RWQCB	California Regional Water Quality Control Board
SAV	Secondary acute value
SCV	Secondary chronic value
SERA	Scoping Ecological Risk Assessment
SERR T	Surface Evaluation, Remediation and Restoration Team
SLO	San Luis Obispo
SQG	Sediment Quality Guideline
SUF	Site use factor
SVOC	Semi-volatile organic compound
TEC	Threshold effect concentration
TPH	Total petroleum hydrocarbons
TRV	Toxicity reference value
95% UCL	95 % upper confidence limit on the arithmetic mean
UET	Upper effects threshold
UF	Uncertainty factor
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOC	Volatile organic compound

Executive Summary

The primary objective of this predictive ecological risk assessment (pERA) is to provide a screening-level evaluation of potential ecological risks associated with the SLO Tank Farm site using the existing site data and site characterization reports. It is anticipated that the results of this risk assessment will be used either to support remedial decisions or to focus additional assessment.

Unocal's approximately 340 acre San Luis Obispo (SLO) Tank Farm site (the site) is located at 276 Tank Farm Road in unincorporated San Luis Obispo County, California. For a period of approximately 70 years (i.e., from 1910 until the early 1980s), most of the site was used for the storage and distribution of unrefined crude oil. In 1926, a lightning strike ignited a major fire at the SLO Tank Farm site. Residual hydrocarbons present at the site are associated with crude oil released during the fire, spills and leaks that occurred during the facility's historical operation, and use of the site as a fire training school.

Predictive ERA Framework and Process

Unocal has entered a voluntary cooperative process to evaluate potential ecological risks at the site. To facilitate the process, Unocal and the stakeholders formed a Surface Evaluation, Remediation, and Restoration Team (SERRT). The SERRT was established to oversee and direct the risk assessment and risk management activities for the site with a subgroup, the ecological risk working group (ERWG), being formed to specifically focus on the pERA. The pERA generally follows the California Department of Toxic Substances Control (DTSC) "Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities Part A: Overview" (DTSC, 1996). The pERA consists of four basic components: problem formulation, exposure assessment, effects assessment, and risk characterization. Due to the conservatism of the evaluation, any determinations of Level 1 or Level 2 risk should not be considered definitive conclusions, but, rather, should be interpreted as conservative estimates of potential risk. The outcome of this pERA will be used to assess the next steps. These could include a Validation Study if the collection of site-specific data is warranted to ground-truth and/or refine the risk estimates of the pERA, or if risk managers determine that the information in the pERA is sufficient for risk management purposes, the results could be used as the basis for remedial objectives.

Key Elements

- **pERA consists of Tier 1 and Tier 2 assessment.**
- **Tier 2 evaluates 2 risk scenarios**
  - **Site-wide**
  - **Site minus the former operations area**
- **Important habitats evaluated include both terrestrial and wetland.**
- **COPECs selected include arsenic, lead, PAHs, and TPH.**
- **CSM identified complete exposure pathways between impacted site media and plant, invertebrate, and wildlife receptors.**
- **8 terrestrial and 8 wetland receptors evaluated.**

A number of specific decisions regarding the spatial scope of the pERA were made as a part of the cooperative process with the ERWG. The most significant include exclusion of Reservoirs 5 and 7 and all surface hydrocarbon expressions (solid, pliable or liquid oil on the surface) from the pERA. These areas were excluded because it was generally agreed that the tar would likely exceed toxicity thresholds and that many of these areas are physical hazards to the ecological receptors. As such it was acknowledged that evaluation of risk from these areas would not add resolution to the risk assessment and management process and that these areas will be addressed separately by Unocal.

The pERA includes a two tier analysis. Tier 1 includes a site assessment using the most conservative exposure and effects assumptions. The results are used to focus the Tier 2 assessment. The Tier 2 assessment uses refined exposure estimates and a range of effects criteria to evaluate site-wide risks. Those compounds that demonstrate Level 1 site-wide risk are evaluated spatially (i.e., on an individual sample-specific location basis). In addition, the Tier 2 assessment includes evaluation of two different risk scenarios. Scenario 1 evaluates what will be referred to as "the whole site" for the rest of the document, but which actually is composed of the whole site minus Reservoirs 5 and 7 and all surface hydrocarbon expressions. Scenario 2 is a “possible post-remediation” scenario and excludes the former operations area from the exposure estimates, as well as Reservoirs 5 and 7 and surface hydrocarbon expressions.

Data Quality Assessment

The first step in the pERA process, a data quality assessment of the existing site data, concluded that data were sufficient to conduct the pERA except for three data gaps: (1) surface-water inorganics data and surface-water polycyclic aromatic hydrocarbon (PAH) and total petroleum hydrocarbon (TPH) data with adequate detection limits, (2) biological surveys for special-status species, and (3) biological characterization of the aquatic habitat. Data were collected to fill these data gaps and are included in the pERA.

Once data quality was assessed and data gaps addressed, the four components of the pERA (problem formulation, exposure assessment, effects assessment, and risk characterization) were conducted.

Problem Formulation

The problem formulation defined the goals and objectives of the risk assessment and included an overview of ecological setting of the site, selection of constituents of potential ecological concern (COPECs), the conceptual site model (CSM), selection of assessment and measurement endpoints (AEs and MEs), and selection of representative receptors (including the identification of special-status species). For purposes of the pERA, two primary habitat types were evaluated: terrestrial (includes grasslands, ruderal, disturbed/industrial), and wetland (seasonally ponded wetlands, freshwater emergent wetlands, riparian and aquatic). The COPEC screening process for the pERA included three steps: (1) sample coverage and detection limits, (2) comparison of site metals data to background concentrations; and (3) evaluation of frequency of detection. Based on the screening process outlined above, the primary COPECs evaluated through Tier 2 included arsenic, lead, PAHs, and TPH.

The CSM for the site was developed based on historical and current site activities and the biological surveys conducted at the site. For the purposes of the pERA, it was assumed that all of the site area could remain undeveloped (i.e., land reuses in the Airport Plan will not be considered). Complete pathways for terrestrial receptors include: terrestrial plants and soil invertebrates and site soil through direct contact; and, herbivorous, insectivorous, and carnivorous birds and mammals through ingestion of impacted plant or prey tissue. Complete pathways for wetland receptors include: wetland plants, riparian plants and sediment invertebrates and site sediments through direct contact; aquatic invertebrates and amphibians and site surface water through direct contact; and, aquatic-feeding herbivorous, insectivorous, and carnivorous birds and aquatic-feeding omnivorous mammals through ingestion of impacted plant or prey tissue. Figures ES-1 and ES-2 summarize the CSM developed for the pERA for terrestrial and wetland habitats respectively.

Based on the ecological guilds and complete exposure pathways identified in CSM, AEs were developed to identify the ecological values at the site that should be protected. Eight AEs were identified for the terrestrial habitat at the site (AE: T1 – T8) and eight AEs for the wetland habitat (AE: W1- W8). The measurement endpoints (MEs) were developed as a means of measuring potential ecological effects and to determine whether any potential risk is associated with the COPEC concentrations in each media. Each of these AEs has between one and three associated MEs.

The final step of the problem formulation was to identify receptors of concern (ROCs) that are representative species for each AE. Receptors of concern were selected to be conservative representatives based on their life history characteristics, such that estimates of potential exposure are maximized. Additionally, special-status species were included as ROCs for specific AEs in cases where these species have been observed on site.

Exposure and Effects Assessment

For the exposure assessment, exposure point concentrations (EPCs) in soil, sediment and water were developed for the Tier 1 (maximum detected concentration) and Tier 2 assessment (95%UCL of the mean) for each of the exposure scenarios (Scenarios 1 and 2). In addition to the site-wide exposure estimates, individual sample points were used to evaluate the spatial extent of potential risk. A food-chain dose model was used to model a daily dose to wildlife receptors (birds and mammals) from ingestion of impacted prey. This dose was modeled using both site-wide media EPCs and individual sample concentrations.

In the effects assessment, toxicological effects data (e.g., sediment quality guidelines, water quality criteria, and toxicity reference values [TRVs]) were used as benchmarks to compare to site COPEC EPCs and modeled daily doses. For the pERA, both low and high benchmarks were identified from the peer-reviewed literature. Benchmarks were selected to be conservative estimators of potential toxic effects and were selected to minimize the possibility of reaching a finding of no risk when risk actually exists. The low values represent a toxicological threshold below which there is high confidence in a finding of no risk. The high values represent a value above which risk may be probable or further evaluation is needed. In between these two benchmarks, it is uncertain as to the exact concentration at which toxicological effects might be observed. In Tier 1, low benchmarks were used as an initial screen. For the Tier 2 assessment, both low and high benchmarks were used to help put any identified risk into context.

Risk Characterization

The risk characterization integrated the results of the exposure and effects assessments to characterize risk to the ROCs and the AEs identified in the problem formulation. The measurement endpoints used in this assessment to evaluate potential risk through direct exposure and food-chain exposure utilize a hazard quotient (HQ) approach. For direct exposure, the HQ represents the ratio of estimated exposure to a media-based toxicity benchmark. For food-chain assessment, the HQ represents the ratio of an estimated daily dose to a wildlife TRV. Proper interpretation of hazard quotients is critical to the risk assessment process, as well as to risk management decision making. Consistent with a screening-level assessment, the pERA HQs are categorized as follows:

- When the HQ is less than 1 for the low benchmark comparison, there is high confidence in a finding of *de minimus* risk.

- When the HQ is greater than 1 for the low benchmark comparison but less than 1 for the high benchmark comparison, risk is categorized as Level 1. Within this category the exact threshold of risk is unknown and to ensure conservatism, risk is considered possible.
- When the HQ is greater than 1 for the high benchmark comparison, risk is categorized as Level 2. Within this category, risks may be probable and/or further evaluation may be required.

Key Elements

Tier 1

- **HQs = site-wide maximum detected media COPEC concentrations/low toxicity benchmarks.**

Tier 2

- **Scenario 1 – HQs = site-wide 95% UCL media COPEC concentrations/low and high toxicity benchmarks.**
- **Scenario 2 – HQs = 95% UCL media COPEC concentrations for site excluding former operations area/low and high toxicity benchmarks.**
- **Spatial Evaluation of Risk – Individual sample point concentrations/low and high toxicity benchmarks.**

In a screening-level assessment such as this pERA, the interpretation of results in the context of uncertainties and conservatism of the analysis (i.e., the exposure and effects assessment) is the final step. In this assessment, when the available exposure and effects information was uncertain, conservative assumptions were made to ensure that risks were not underestimated. Consideration of this conservatism is important in understanding risk findings as categorized above. For example, a Level 2 risk based on a benchmark that was selected in a highly conservative fashion to mitigate underlying uncertainties, may be interpreted as less critical than a Level 2 risk identified for a compound for which the benchmark is more certain. These factors should be considered along with the magnitude of the HQs, the spatial distribution of the exceedances, and the presence/absence of special-status species. Based on these results, risk managers may decide that the pERA provides sufficient information for making risk management decisions or that further evaluation is warranted (e.g., a Validation Study).

Predictive ERA Tier 1 Results

The Tier 1 assessment evaluated each AE using the maximum detected concentration in soil, sediment and water as the EPC. For terrestrial AEs, arsenic and lead HQs were greater than 1 and these compounds were evaluated further in Tier 2. The PAH HQs for 10 of the 16 measured PAHs for terrestrial plants were greater than 1, and these PAHs were evaluated further in Tier 2 for potential plant toxicity. All PAH HQs for terrestrial invertebrates and wildlife were less than 1; thus, PAHs were not evaluated further in Tier 2 for these receptors. TPH HQs were greater than 1 for plants, invertebrates, and most of the terrestrial wildlife receptors; therefore, TPH was evaluated further in Tier 2 for potential risk to these receptors.

For the Tier 1 wetland AEs, arsenic HQs were greater than 1 for plants, sediment invertebrates, and two wildlife receptors (western sandpiper and raccoon). Lead HQs were greater than 1 for plants, sediment invertebrates, and all wildlife receptors. These metals were evaluated further for these receptors in Tier 2. HQs for eight of 16 PAHs for plants and HQs for 11 of the 16 PAHs for sediment invertebrates were greater than 1. These PAHs were evaluated further in Tier 2 for potential risk to sediment invertebrates and wetland plants. As with the terrestrial evaluation, HQs for PAHs for wildlife do not exceed 1, and PAHs were not evaluated further for these receptors. HQs for TPH for plants and sediment invertebrates

were greater than 1, as was the HQ for one of the wildlife receptors (the western sandpiper). TPH was evaluated in Tier 2 for potential risk to these receptors.

HQs for all COPECs for plants in the riparian area were less than 1. Thus, riparian plants were not carried forward for further assessment in Tier 2. Additionally, the Tier 1 evaluation of surface water exposure to aquatic invertebrates and amphibians resulted in no COPECs being carried forward for evaluation in Tier 2.

Predictive ERA Tier 2 Results

The Tier 2 assessment used a refined exposure estimate (i.e., the 95% UCL of the mean) and compared this value to both a low and a high toxicity benchmark for each receptor to calculate a HQ. Additionally, two exposure scenarios were evaluated: Scenario 1, the entire site; and Scenario 2, the whole site excluding the former operations area. For those AEs where the Tier 2 HQ exceeded 1, a spatial analysis was conducted on a point-by-point basis. Tables ES-1 and ES-2 summarize the Tier 2 evaluation for the terrestrial and wetland AEs respectively.

Arsenic

The former operations area of the site is the primary location of background arsenic exceedances. Based on a comparison of the 95% UCL to benchmarks, arsenic risks are categorized as Level 1 for terrestrial plants and for two of the eight terrestrial wildlife receptors: the California vole (AE: T4) and the ornate shrew (AE: T6). Risk from arsenic to the remaining 6 terrestrial wildlife receptors (AEs: T3 and T5-T8), terrestrial invertebrates (AE: T2) and all wetland receptors (AEs: W1-W8) is considered *de minimus*.

While risk within the former operations area cannot be ruled out, the likelihood that the spatial extent and magnitude of the elevated concentrations would adversely affect plant or mammal populations (vole and shrew) is unlikely for the following reasons. First, the vast majority of elevated arsenic concentrations are located within the operations area which currently represents low quality habitat since the majority of the area contains parking lots and buildings. Second, higher quality habitat represented by the rest of the site (excluding the operations area) is within background for arsenic. Third, for these AEs, protection is at the level of the population; thus, given the small area of elevated arsenic concentrations, arsenic is not likely to pose significant risk to the populations of these species at the SLO Tank Farm site. However, based on the uncertainties associated with the risk estimates in the pERA, hot spot analysis may be necessary, especially if future reuse might result in habitat restoration.

Lead

The majority of lead concentrations on-site are within background. For those samples that exceed background, the Tier 2 assessment indicates that lead does not pose risk to soil invertebrates (AE: T2). Lead risk falls into the Level 1 category for terrestrial plants (AE: T1). However, the Level 1 risk to terrestrial plants is low in magnitude (low benchmark HQ = 1.4) and not likely to affect plant populations or special-status terrestrial plant species (the SLO morning glory). For wetlands, lead risks are categorized as Level 1 for plants (AE: W1) but two individual locations are characterized as Level 2 (Table ES-2). Risk to sediment invertebrates (AE: W3 and W4) is characterized as Level 2, with only four locations in the tank bottoms in the northwest portion of the site exceeding high benchmarks. While these limited lead benchmark exceedances are not likely to adversely affect wetland plant or invertebrate populations, risks cannot be ruled out. Moreover, because the special-status Congdon's tar plant and the

cysts of the special-status fairy shrimp have been observed in the wetland areas where elevated lead concentrations occur, risks to these species may require further evaluation.

For wildlife, the Tier 2 assessment indicates that lead risks are *de minimus* for the coyote (AE: T8). Risk is categorized as Level 1 for the California vole (AEs: T4), ornate shrew (AE: T6), American kestrel and northern harrier (AE: T7), mallard (AE: W5), great blue heron (AE: W7), and raccoon (AE: W8) and as Level 2 for the song sparrow (AE: T3), western meadowlark and loggerhead shrike (AE: T5), and western sandpiper (AE: W6). Site use was assumed to be 100% for each exposure estimate. For special-status species such as the loggerhead shrike and northern harrier that require a higher level of protection, this assumption may be appropriately conservative. However, given the small area of elevated lead concentrations relative to the home ranges of the identified receptors and the conservatism of the lead food-chain model (which assumes 100% bioavailability and assimilation efficiency), lead is not likely to pose risk to wildlife populations in general. However, since uncertainty remains regarding the potential bioavailability of lead at the Site, additional hot spot assessment may be necessary to refine estimates of potential impacts to birds. Figures ES-3 and ES-4 present the risk results for lead to terrestrial and wetland receptors respectively.

PAHs

PAHs risk is *de minimus* for terrestrial plants (AE: T1), invertebrates (AE: T2) and wildlife receptors (AEs: T3-T8). Risk from one sample location within the wetlands can be categorized as Level 2 from PAHs for wetland plants (AE: W1) and sediment invertebrates, and Level 1 in two locations for sediment invertebrates (AEs: W3 and W4). Each of these locations is on or near a surface hydrocarbon expression. These limited exceedances of conservative benchmarks are not expected to adversely affect wetland plant or invertebrate populations.

TPH

For TPH, Tier 2 HQs for terrestrial and wetland plants (AEs: T1 and W1) and invertebrates (AEs: T2, W3 and W4) indicate Level 2 risk to these AEs. Wildlife receptors were assessed for exposure to TPH based on incidental soil ingestion. Of the eight terrestrial wildlife receptors, risk for the song sparrow (AE: T3) and western meadowlark (AE: T5) is characterized as Level 1 for TPH. The HQs for TPH for the low benchmarks for the song sparrow and western meadowlark are only slightly greater than 1 (2.2 and 1.7, respectively). When the conservatism of the site use assumption (i.e., site use = 100%) is considered, this small magnitude of estimated risk is not likely to adversely impact avian populations. TPH risk to the remaining terrestrial wildlife receptors via incidental soil ingestion is *de minimus*.

For the wetland wildlife receptors, TPH risks are characterized as Level 2 (low benchmark HQ of 11 and high benchmark HQ of 1.1) to the western sandpiper (AE: W6). As with the terrestrial wildlife receptors, when the conservatism of the site use assumptions is considered for this receptor, the likelihood of a population-level impact on insectivorous, wetland birds is small. TPH risk for the remaining wetland wildlife receptors via incidental ingestion of soil is *de minimus*. The spatial evaluation of TPH benchmark exceedances shows that the majority of the exceedances are on or near identified surface hydrocarbon expressions. A few notable exceptions include several samples within reservoir 4 (i.e., northeast corner of the site). Risk associated with two samples in the wetland areas in the southwest corner of the site (B-52 in Tank 6 and S-59) was also categorized as Level 2 and these two locations are not associated with known surface hydrocarbon expressions. Therefore, while TPH is the main risk driver at the SLO Tank Farm site, areas of potential risk are limited, and the majority of the site presents either *de minimus* or Level 1 risk to plants and invertebrates. Figures ES-5 and ES-6 present the risk results for TPH to terrestrial and wetland receptors respectively.

Predictive ERA Results - Scenario 2

Scenario 2 evaluated the site excluding the former operations area. This area has been identified as a potential area of commercial industrial use in the future. Under this scenario, ecological habitat within the former operations area would be negligible; thus, exposure pathways to ecological receptors would be incomplete. Because all wetland samples fall outside of the former operations area, no separate Scenario 2 evaluation was necessary for the wetland assessment endpoints. The results of the Scenario 2 terrestrial risk evaluation are described below.

Arsenic

Arsenic was not evaluated in Scenario 2 because concentrations outside the former operations area are generally below background concentrations and it was not carried forward as a Scenario 2 COPEC.

Lead

For scenario 2, risk is characterized as Level 2 for herbivorous (AE: T3) and insectivorous birds (AE: T5); as Level 1 for terrestrial plants (AE: T1), herbivorous (AE: T4) and insectivorous mammals (AE: T6) and to carnivorous birds (AE: T7); and as *de minimus* for soil invertebrates (AE: T2) and carnivorous mammals (AE: T8). The results of the Scenario 2 are not significantly different from the findings of Scenario 1. The spatial distribution of elevated lead concentrations outside the former operations area is localized in several tank bottoms within the northwest portion of the site.

PAHs

PAHs were not evaluated for Scenario 2 because risk to terrestrial receptors is considered *de minimus* based on the site-wide 95% UCL screen.

TPH

For Scenario 2, risk to birds (AE: T3, T5, and T7) and mammals (AE: T4, T6 and T8) from TPH is *de minimus*, and Level 2 risk is indicated for plants (AE: T1) and soil invertebrates (AE: T2). The overall risk analysis for Scenario 2 is similar to Scenario 1, with only the song sparrow and western meadowlark having different results (both show *de minimus* risk in Scenario 2). The areas of Level 1 or Level 2 risk identified in Scenario 2 are generally associated with on-site surface hydrocarbon expressions or subsurface plumes.

Uncertainties

The understanding of the underlying uncertainties inherent in the data and models used in the pERA is a critical aspect of the risk-based decision-making process. Identifying the sources and potential magnitude of the major uncertainties is crucial to the appropriate interpretation of risk assessment results. The nature of the pERA as a screening-level assessment mandates that the uncertainties are largely mitigated by making conservative assumptions to ensure that no risk is overlooked or under estimated. Thus, a significant portion of the uncertainty relates to conservative assumptions used in the screening-level pERA. These conservative assumptions, when taken together, result in predicted risk levels that are likely higher than those actually present at the site. However, wherever possible, factors that may have resulted in underestimation of risk were also identified.

Conclusions

In general terms, terrestrial/wetland plants and terrestrial/sediment invertebrates are the most sensitive receptors evaluated in the pERA, especially in terms of risk due to petroleum exposure. Potential risk to wildlife (i.e., birds and mammals) from exposure to petroleum (either as TPH or PAHs) is generally *de minimus*. Spatially the majority of TPH benchmark exceedances are on or near identified surface hydrocarbon expressions. A few notable exceptions include several samples within Reservoir 4 and two samples in the wetland areas in the southwest corner of the site (B-52 in Reservoir 6 and S-59). The main potential risks to wildlife identified in the pERA are from exposure to lead and to a lesser extent arsenic. Elevated concentrations of both compounds are localized and limited to the former operations area (arsenic and lead) and tank bottoms in the northeastern portion of the site (lead).

While the pERA has identified the potential for risk, as described above, the screening-level framework resulted in conservative estimates of risk. A validation study focused on the most significant sources of uncertainty would further refine the evaluation and could corroborate these initial findings or result in a finding of *de minimus* risk. Risk managers will need to evaluate the findings presented herein and decide whether or not sufficient information exists to manage identified risks at the site, or whether a focused validation study is needed to help reduce uncertainty and to refine the estimate of potential risk.

Table ES-1. Tier 2 Terrestrial Risk Summary of Site-Wide and Individual Sample Point Risk Estimates
San Luis Obispo Tank Farm

	Plants AE: T1.	Invertebrates AE: T2.	Song Sparrow AE: T3.	California Vole AE: T4.	Western Meadowlark AE: T5.	Loggerhead Shrike AE: T5.	Ornate Shrew AE: T6.	American Kestrel AE: T7.	Northern Harrier AE: T7.	Coyote AE: T8.
Arsenic[1,2]	**(12/12 - 1/12)**	***de minimus***	***de minimus***	**(12/12 - 6/12)**	***de minimus***	***de minimus***	**(12/12 - 4/12)**	***de minimus***	***de minimus***	***de minimus***
Lead: Scenario 1[2,5]	**(19/21 - 3/21)**	***de minimus***	**(21/21 - 18/21)**	**(21/21 - 0/21)**	**(21/21 - 20/21)**	**(21/21 - 21/21)**	**(21/21 - 3/21)**	**(21/21 - 16/21)**	**(21/21 - 4/21)**	***de minimus***
Lead: Scenario 2[2,6]	**(8/9 - 2/9)**	***de minimus***	**(9/9 - 7/9)**	**(9/9 - 0/9)**	**(9/9 - 9/9)**	**(9/9 - 9/9)**	**(9/9 - 2/9)**	**(9/9 - 6/9)**	**(9/9 - 3/9)**	***de minimus***
PAHs[3,4]	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***
Sum PAH[3,4]	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
TPH: Scenario 1[4,5]	**(66/237 - 33/237)**	**(66/237 - 62/237)**	**(24/237 - 2/237)**	***de minimus***	**(14/237 - 1/237)**	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***
TPH: Scenario 2[4,6]	**(43/151 - 27/151)**	**(43/151 - 42/151)**	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***

NA = Analyte not assessed because no benchmark available.

[1] Arsenic was not identified as a COPEC for Scenario 2 as concentrations outside of the former operations area are generally below background.

[2] Risk summaries represent only stations with concentrations greater than background.

[3] PAHs were not evaluated for Scenario 2 because Scenario 1 indicated *de minimus* risk for all terrestrial receptors.

[4] Risk summaries represent all stations where COPEC was measured.

[5]Scenario 1 = Exposure estimated using data from the whole site

[6]Scenario 2 = Exposure estimated using data from the whole site minus the former operations area

Site-Wide Risk Estimates

*** Risk category (i.e., color) determination is based on the site-wide hazard quotients as listed in Table 6-6, calculated by dividing the 95% UCL on the mean (or maximum if lower) by the low toxicity reference value.**

	de minimus (Low Benchmark HQ < 1)
	Risk is categorized as Level 1 (Low benchmark site-wide HQ > 1 < High benchmark site-wide HQ)
	Risk is Categorized as Level 2 (High benchmark site-wide HQ > 1)

Individual Sample Point - Spatial Assessment of Risk

*** Numbers in boxes (12/12 - 1/12) =** (first set of numbers indicates the number of individual sample HQs >1 for the low benchmark **/** total number of sample locations above background concentrations; the second set of numbers indicates the number of individual point exceedances of the high benchmark **/** total number of sample locations above background concentrations.

For example: The site-wide risk from arsenic to plants is identified as Level 1 as indicated by the green color. The numbers in the box indicate that 12 samples had concentrations greater than background concentrations and of those, 12 exceeded the low benchmark and 1 exceeded the high benchmark.

Table ES-2. Tier 2 Wetland Risk Summary of Site-Wide and Individual Sample Point Risk Estimates[1]
San Luis Obispo Tank Farm

	Plants AE: W1.	Invertebrates AE: W3, W4.	Mallard AE: W5.	Western Sandpiper AE: W6.	Great Blue Heron AE: W7.	Raccoon AE: W8.
Arsenic[2]	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***
Lead[2]	**(5/5 - 2/5)**	**(5/5 - 4/5)**	**(5/5 - 3/5)**	**(5/5 - 5/5)**	**(5/5 - 3/5)**	**(4/5 - 0/5)**
PAHs[3,4]	**(1/13 - 1/13)**	**(3/13 - 1/13)**	***de minimus***	***de minimus***	***de minimus***	***de minimus***
Sum PAH[3]	**NA**	**(3/13 - 1/13)**	**NA**	**NA**	**NA**	**NA**
Sum TPH[3]	**(7/29 - 3/29)**	**(7/29 - 6/29)**	***de minimus***	**(3/29 - 1/29)**	***de minimus***	***de minimus***

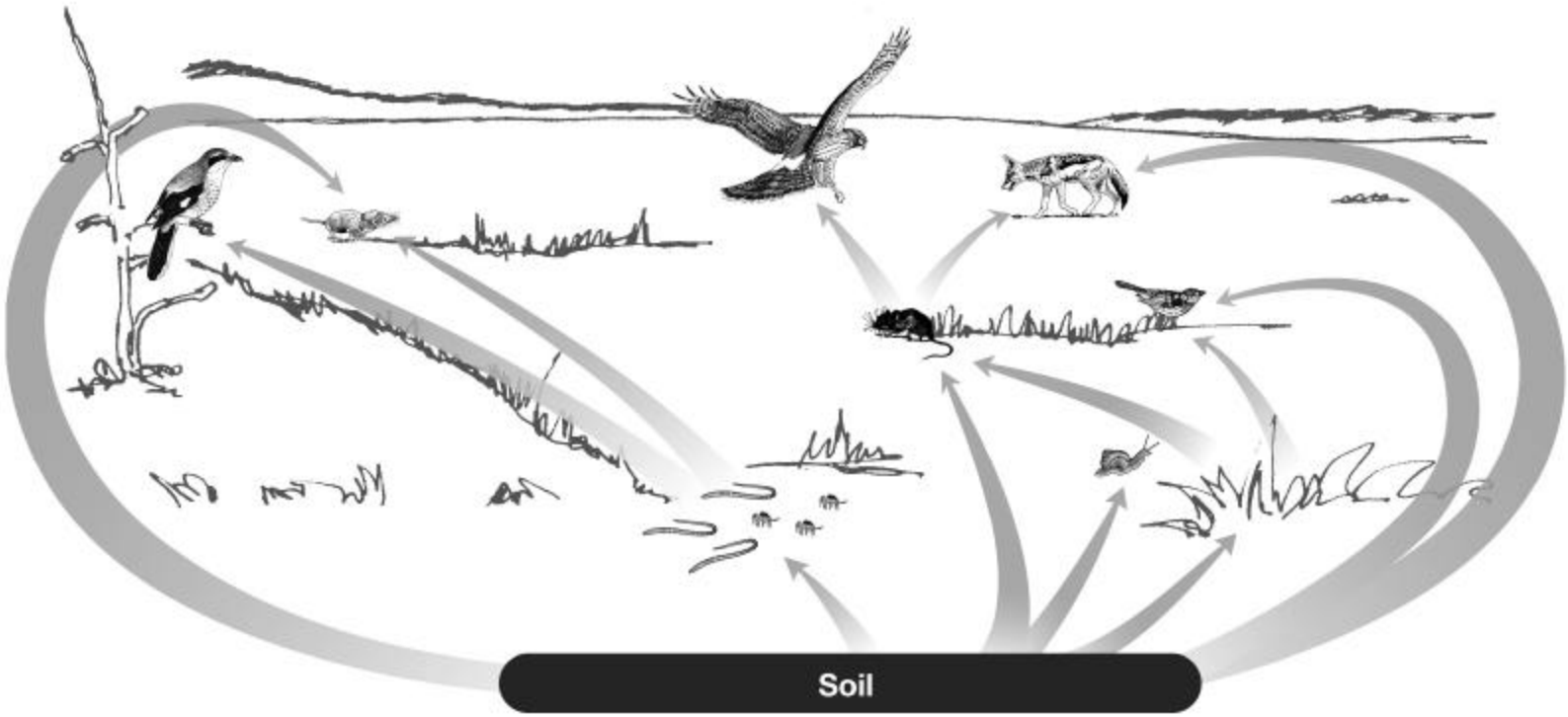
NA = Analyte not assessed because no benchmark available.
[1] Summarizes Scenario 1 results as majority of wetlands are outside of the former operations area.
[2] Risk summaries represent only stations with concentrations greater than background.
[3] Risk summaries represent all stations where COPEC was measured.
[4]Benzo(a)pyrene exceedances presented for PAHs.

Site-wide Risk Summary
*** Risk category (i.e., color) determination is based on the hazard quotients as listed in Table 6-11, calculated by dividing the 95% UCL on the mean (or maximum if lower) by the low and high toxicity reference values.**

	de minimus (Low Benchmark HQ < 1)
	Risk is categorized as Level 1 (Low benchmark site-wide HQ > 1 < High benchmark site-wide HQ)
	Risk is Categorized as Level 2 (High benchmark site-wide HQ > 1)

Individual Sample Point - Spatial Assessment of Risk
*** Numbers in boxes (5/5 - 2/5) =** (first set of numbers indicates the number of individual sample HQs >1 for the low benchmark **/** total number of sample locations above background concentrations; the second set of numbers indicates the number of individual point exceedances of the high benchmark **/** total number of sample locations above background concentrations.

For example: The site-wide risk from lead to plants is identified as Level 1 as indicated by the green color. The numbers in the box indicate that 5 samples within site wetlands had concentrations greater than background concentrations and of those, 5 exceeded the low benchmark and 2 exceeded the high benchmark.



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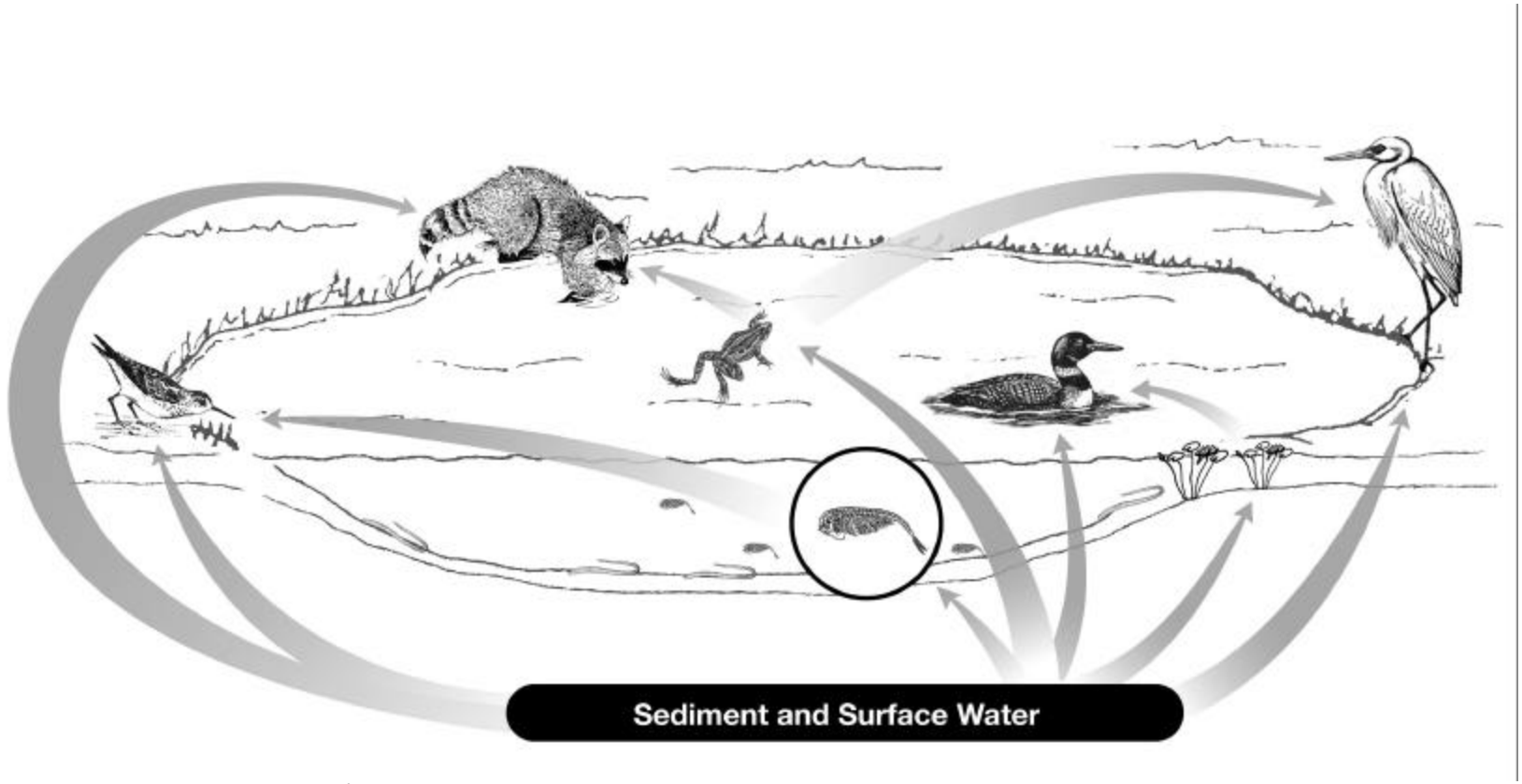
AE-T1: Survival and reproduction of terrestrial plant populations conducive to maintenance of the terrestrial plant community and maintenance of the SLO morning glory population
AE-T2: Survival and reproduction of terrestrial invertebrate populations conducive to the maintenance of the terrestrial invertebrate community
AE-T3: Survival, growth and reproduction of herbivorous bird populations*
AE-T4: Survival, growth and reproduction of herbivorous mammal populations
AE-T5: Survival, growth and reproduction of insectivorous bird species*
AE-T6: Survival, growth and reproduction of insectivorous mammal species
AE-T7: Survival, growth and reproduction of carnivorous bird species*
AE-T8: Survival, growth and reproduction of omnivorous mammal species
* Assessment endpoint may include protection of individual threatened, endangered or special status species as appropriate

Figure ES-1: Conceptual Model and Assessment Endpoints (AEs) for Terrestrial Habitat at the San Luis Obispo Tank Farm Site



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AE-W1: Survival and reproduction of wetland plant populations conducive to maintenance of the wetland plant community and maintenance of the Congdon's tarplant population.
AE-W2: Survival and reproduction of aquatic invertebrate and vertebrate populations conducive to maintenance of the aquatic community
AE-W3: Survival, growth and reproduction of individual special-status fairy shrimp
AE-W4: Survival and reproduction of sediment invertebrate populations conducive to maintenance of the sediment invertebrate community
AE-W5: Survival, growth and reproduction of herbivorous bird populations.
AE-W6: Survival, growth and reproduction of insectivorous bird species*
AE-W7: Survival, growth and reproduction of carnivorous bird species*
AE-W8: Survival, growth and reproduction of omnivorous mammal species
* Assessment endpoint may include protection of individual threatened, endangered or special status species as appropriate

Figure ES-2: Conceptual Model and Assessment Endpoints (AEs) for Wetland Habitat at the San Luis Obispo Tank Farm

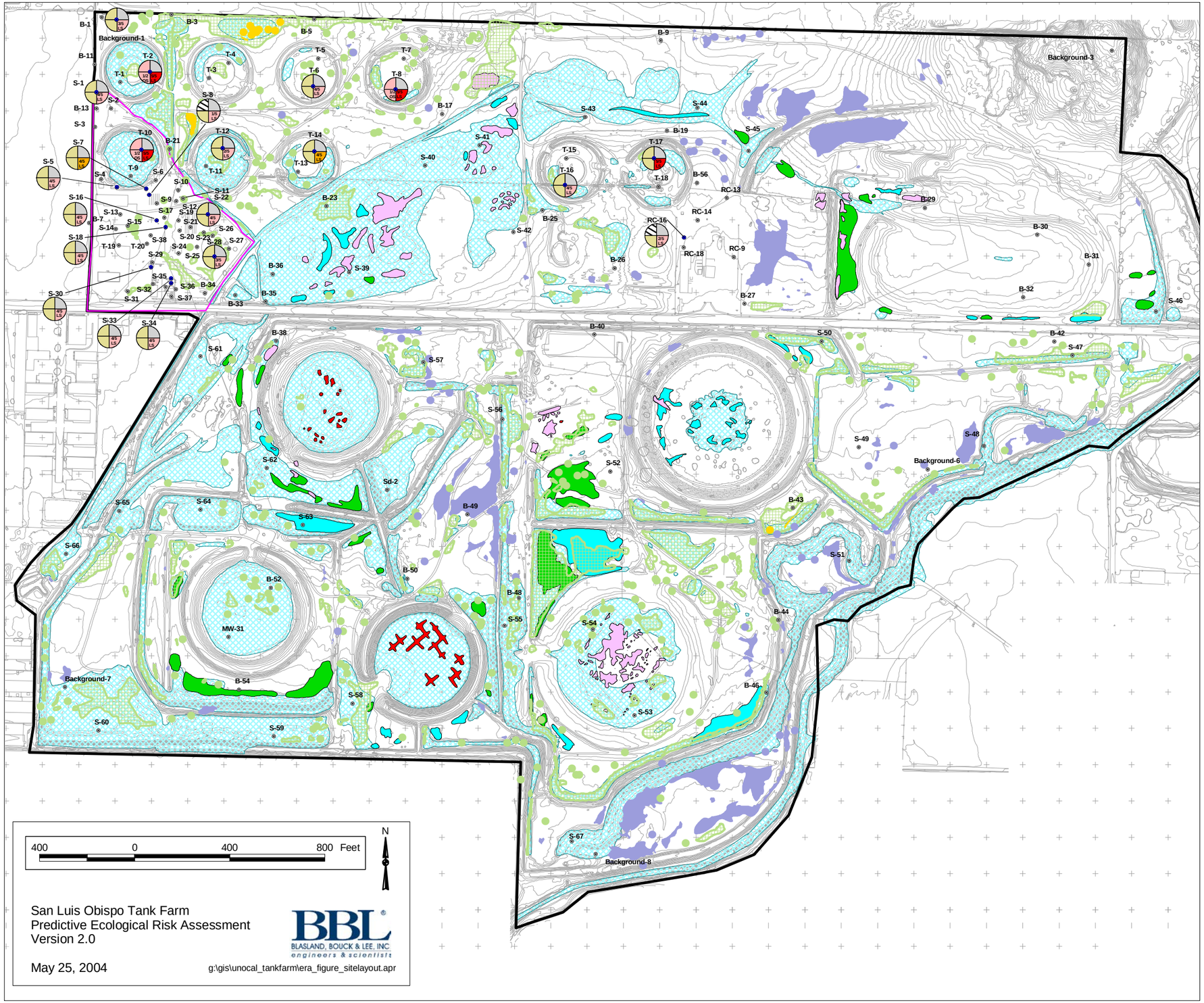


Figure ES-3

Lead Hazard Quotient Summary
for Terrestrial Receptors

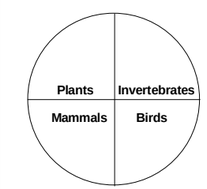
Legend

- Soil samples
- Concentration <= background
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- 95% UCL low benchmark HQ less than or equal to 1
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed



2/5 - number of species exceeding LOAEL out of number assessed

Species with highest HQ identified when LOAEL exceeeded
Birds: SS - Song Sparrow
WM - Western Meadowlark
LS - Loggerhead Shrike
AK - American Kestrel
NH - Northern Harrier
WS - Western Sandpiper

Mammals: CV - California Vole
OS - Ornate Shrew

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

Plant communities with < 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Plant communities with > 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

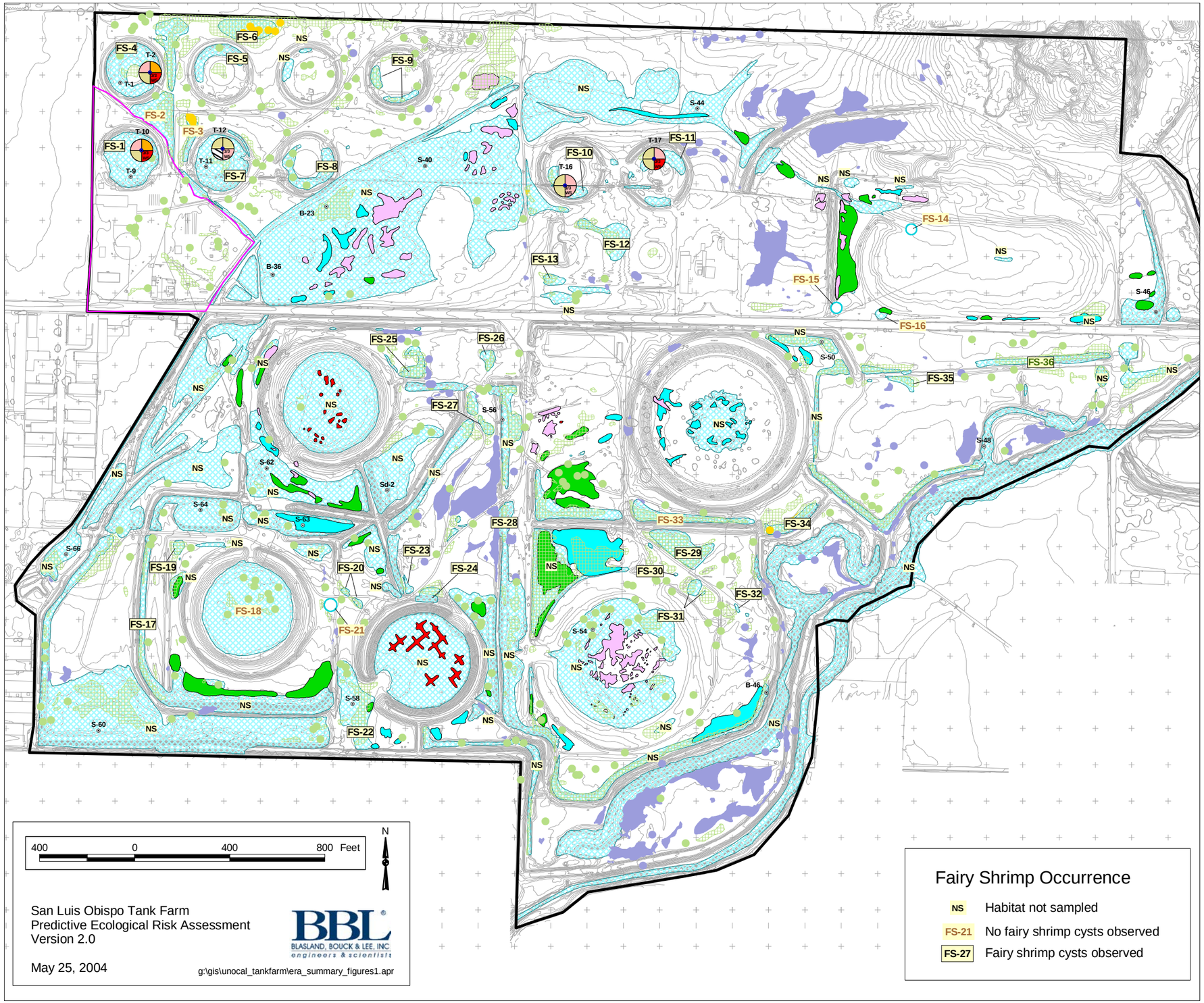


Figure ES-4

Lead Hazard Quotient Summary
for Wetland Receptors

San Luis Obispo Tank Farm

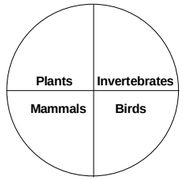
Legend

- Soil samples
- Concentration <= background
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- 95% UCL low benchmark HQ less than or equal to 1
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed



2/5 - number of species exceeding LOAEL out of number assessed

Species with highest HQ identified when LOAEL exceeeded
Birds: SS - Song Sparrow
WM - Western Meadowlark
LS - Loggerhead Shrike
AK - American Kestrel
NH - Northern Harrier
WS - Western Sandpiper

Mammals: CV - California Vole
OS - Ornate Shrew

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

Plant communities with < 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Plant communities with > 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

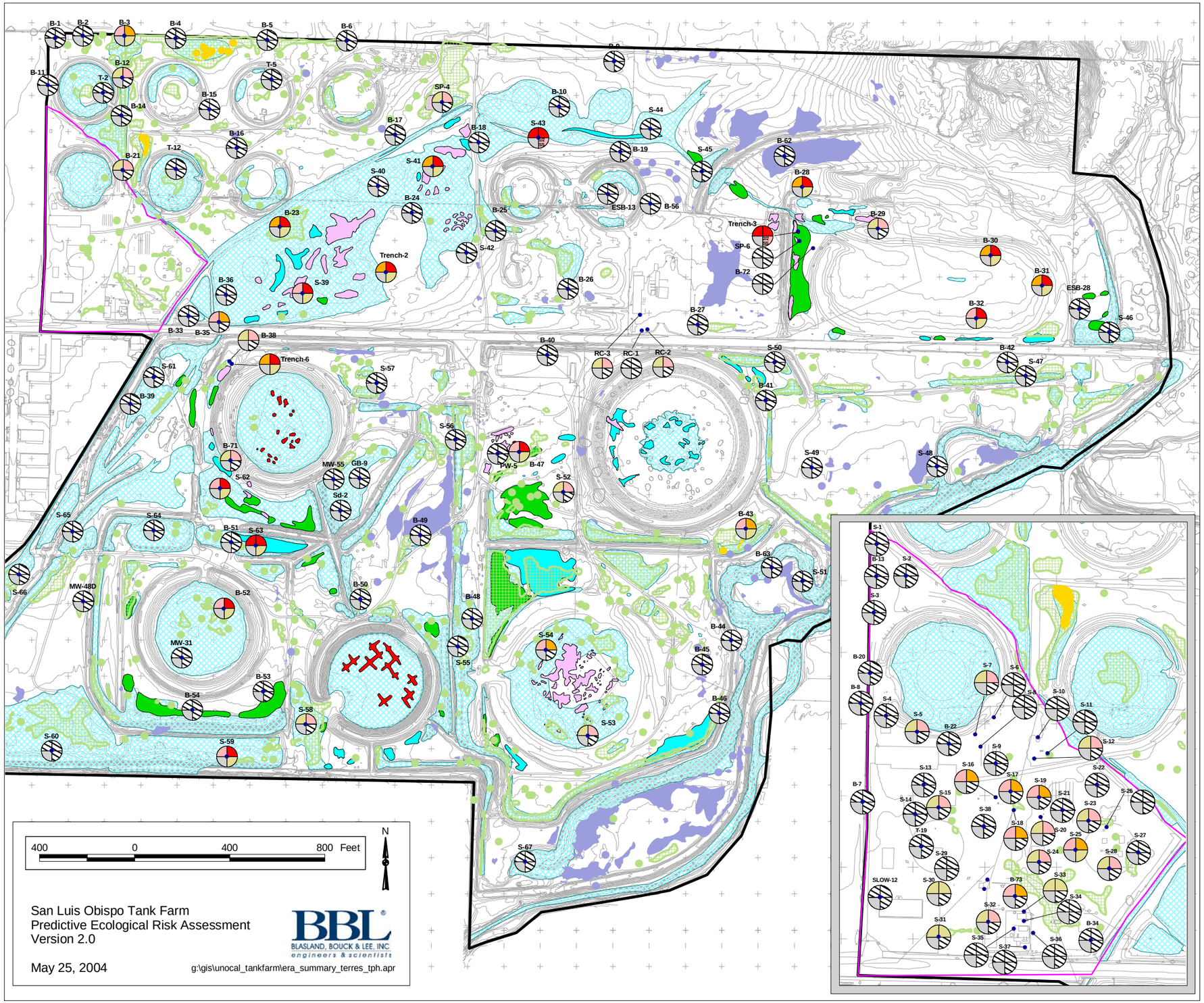


Figure ES-5

Sum TPH Hazard Quotient Summary
for Terrestrial Receptors

San Luis Obispo Tank Farm

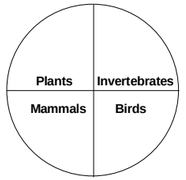
Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- 95% UCL low benchmark HQ less than or equal to 1
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed



2/5 - number of species exceeding LOAEL out of number assessed

Species with highest HQ identified when LOAEL exceeeded
Birds: SS - Song Sparrow
WM - Western Meadowlark
LS - Loggerhead Shrike
AK - American Kestrel
NH - Northern Harrier
WS - Western Sandpiper

Mammals: CV - California Vole
OS - Ornate Shrew

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

Plant communities with < 100 individuals

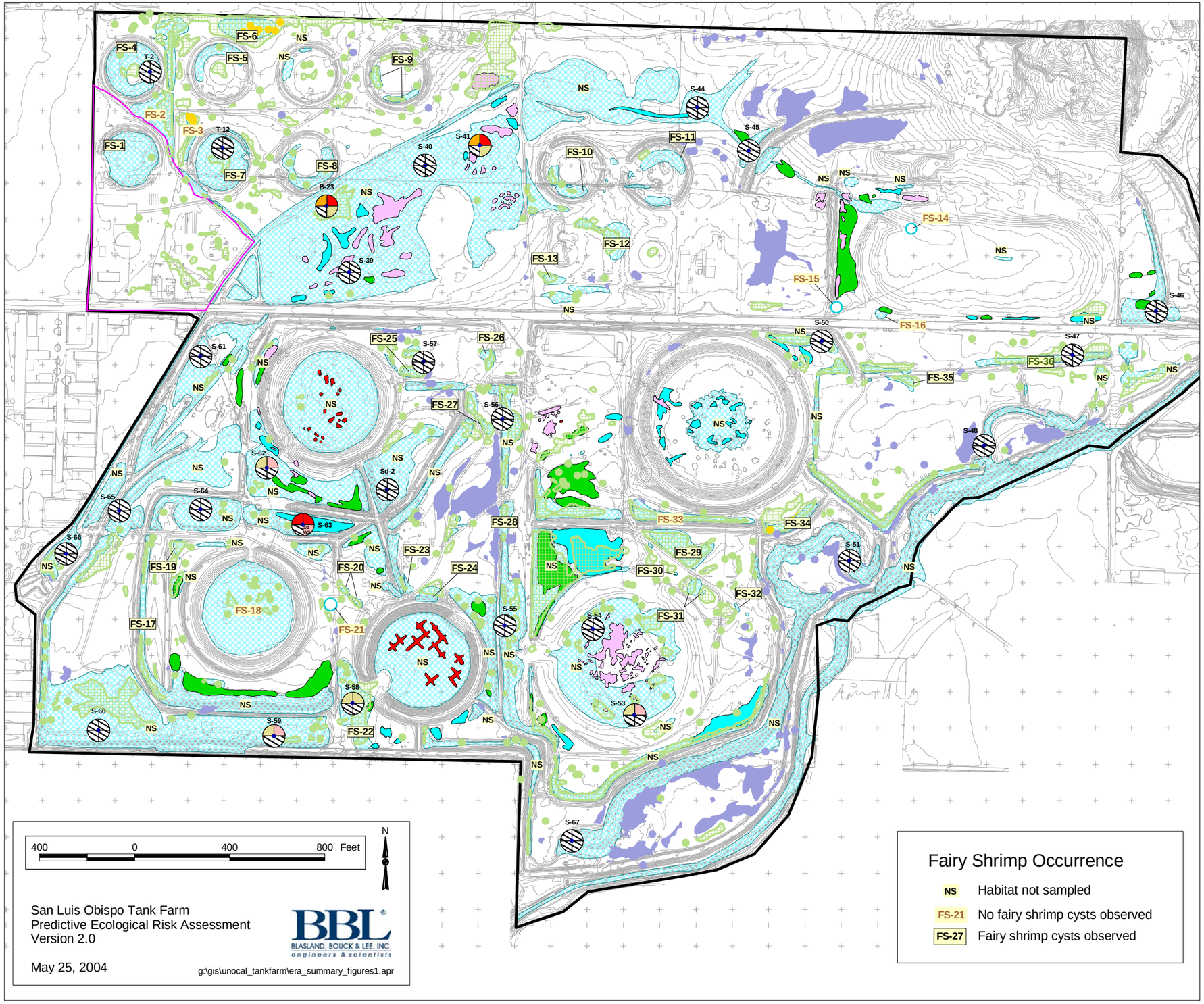
- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Plant communities with > 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Figure ES-6

Sum TPH Hazard Quotient Summary
for Wetland Receptors



Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- 95% UCL low benchmark HQ less than or equal to 1
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Plants | Invertebrates
Mammals | Birds

2/5 - number of species exceeding LOAEL out of number assessed

Species with highest HQ identified when LOAEL exceeeded
Birds: SS - Song Sparrow
WM - Western Meadowlark
LS - Loggerhead Shrike
AK - American Kestrel
NH - Northern Harrier
WS - Western Sandpiper

Mammals: CV - California Vole
OS - Ornate Shrew

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

Plant communities with < 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Plant communities with > 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

1. Introduction

Unocal's 325-acre San Luis Obispo (SLO) Tank Farm Road site (the site) is located at 276 Tank Farm Road in unincorporated San Luis Obispo County, California (Figure 1-1). For a period of approximately 70 years (i.e., from 1910 until the early 1980s), most of the site was used for the storage and distribution of unrefined crude oil. The six large earthen "tanks" or reservoirs and 20 of the 21 stainless steel storage tanks have been removed from the site. The remaining stainless steel tank is used to store water.

In 1926, a lightning strike ignited a major fire at the SLO Tank Farm site. It has been estimated that approximately six million barrels of crude oil were either burned or released resulting in the formation of a hard, asphaltic slag material, pliable oil, and liquid oil over portions of the site and in the release of crude oil to subsurface soils. Residual hydrocarbons present at the site are associated with crude oil released during the fire, spills and leaks that occurred during the facility's historical operation, and use of the site as a fire training school.

1.1 Objectives

The primary objective of this ecological risk assessment (ERA) is to provide a screening-level evaluation of potential ecological risks associated with the SLO Tank Farm site using the existing site data and site characterization reports. It is anticipated that the results of this risk assessment will be used either to support remedial decisions or to focus additional assessment.

1.2 Regulatory Framework

Unocal has entered a voluntary cooperative process to evaluate potential ecological risks with a number of the stakeholders with interest in the environmental resources at the SLO Tank Farm site. All potential stakeholders were invited to participate in the process, and the Regional Water Quality Control Board (RWQCB), the City of San Luis Obispo, and the California Department of Fish and Game (CDFG) chose to actively participate. To facilitate the process, Unocal and the stakeholders formed a Surface Evaluation, Remediation, and Restoration Team (SERRT). The SERRT was established to oversee and direct the risk assessment and risk management activities for the site. From the SERRT, an ecological risk working group (ERWG) was formed, composed of Unocal and its representatives; the RWQCB; the CDFG; the City of San Luis Obispo; and Blasland Bouck and Lee (BBL), the consultants conducting the ecological risk assessment on behalf of the SERRT.

The ERWG began meeting in January 2003 and met on eight occasions over the next 9 months to discuss and work through the technical issues associated with conducting the ERA. Consensus was reached on the primary technical aspects of the ERA and is documented in a series of meeting summaries that were ratified for each meeting (Appendix A). The quantitative and qualitative analyses in this ERA reflect these consensus decisions.

1.3 Approach Overview

As a part of the cooperative process discussed above, it was decided that this risk assessment would generally follow the California Department of Toxic Substances Control (DTSC) "Guidance for

Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities Part A: Overview" (DTSC, 1996). According to the DTSC risk assessment guidance (DTSC, 1996), the initial step in the risk assessment process is a scoping ecological risk assessment (SERA) to identify potentially complete exposure pathways. If complete pathways are identified, the process proceeds to a predictive ecological risk assessment (pERA). In the pERA, the toxicity criteria are identified and/or developed for receptors and contaminants of concern, exposure is assessed, and risk to aquatic and/or terrestrial biota is estimated. If the results of the pERA are not sufficient to make risk management decisions, the process may proceed to a Validation Study. In the Validation Study, exposure and effects parameters used in the pERA are refined and validated by collecting site-specific data.

A SERA was conducted, and complete exposure pathways were identified (ENTRIX, Inc., 1998); thus, further evaluation was warranted. The scope of this document is to conduct the next phase of the risk assessment process, the pERA (Box 2 of Figure 1-2). This SERA and the pERA together generally constitute a screening-level risk assessment, as described in Steps 1 and 2 of the U.S. Environmental Protection Agency's (USEPA's) Ecological Risk Assessment Guidance (USEPA, 1997). In the absence of site-specific data, a screening-level assessment uses conservative assumptions to estimate exposure and effects to potential ecological receptors. This ensures high confidence in any determinations of no or *de minimus* risk. On the contrary, findings of potential risk are not intended to be definitive indications of risk but, rather, indications of a possibility of risk that may require verification.

The pERA consists of four basic components: problem formulation, exposure assessment, effects assessment, and risk characterization. Problem formulation defines the goals and objectives of the risk assessment. This is a formal process to develop and evaluate preliminary hypotheses concerning the likelihood and causes of ecological effects that may have occurred, or may occur, from human activities (USEPA, 1998). The exposure assessment assesses the potential for exposure to chemical stressors (i.e., site-related chemicals) by evaluating the co-occurrence of the stressors and the ecological receptors (USEPA, 1998). The effects assessment identifies toxicological effects data (e.g., sediment quality guidelines [SQGs], federal ambient water quality criteria [AWQC], and toxicity reference values [TRVs]) that are used as benchmarks to compare to site constituent of potential ecological concern (COPEC) concentrations. In the risk characterization phase of the assessment, the results of the exposure and effects assessments are combined to estimate risk to the receptors and the assessment endpoints (AEs) identified in problem formulation. An uncertainty analysis is also provided to identify any inputs to the risk assessment that might over- or under estimate risk. Finally, risks are interpreted, and conclusions are reported (USEPA, 1997).

The risk conclusions of the pERA are estimated based on modeled exposure and non-site-specific, literature-based toxicity benchmarks, and, as discussed previously, are screening level in nature. Thus, any determinations of Level 1 or Level 2 risk should not be considered definitive conclusions, but, rather, they should be interpreted as conservative estimates of potential risk. The outcome of this pERA will be used to assess the next steps (i.e., no further assessment, Validation Study or remedial actions [Figure 1-2]). If deemed necessary, a Validation Study would involve the collection of site-specific data to ground-truth and/or refine some or all of the risk estimates of the pERA. In contrast, if risk managers determine that the information in the pERA is sufficient for risk management purposes, the results will be used as the basis for the determination of remedial objectives.

In addition to the general components discussed above, the pERA includes an evaluation of both the terrestrial and wetland environments on-site in two tiers of analysis. Tier 1 provides a highly conservative screen (i.e., maximum exposure estimates compared to low toxicity benchmarks) to help focus the Tier 2 analysis. Those compounds that fail this initial screen are carried forward to the Tier 2

assessment. Tier 2 consists of a refined evaluation of risk based on site-wide exposure estimates and a range of low and high toxicity benchmarks. For those compounds that demonstrate Level 1 or 2 site-wide risk, the pERA includes an individual point analysis.

Within the Tier 2 assessment, two different risk scenarios are evaluated. Scenario 1 is the scenario described above for Tier 2 that evaluates the whole site[1]. Scenario 2 is a "possible post-remediation" scenario and excludes the former operations area (shown on Figure 1-3) from the exposure estimates. This area has been identified for likely commercial industrial reuse and would, therefore, not support ecological receptors in the future. Thus, Scenario 2 assumes that the operations area would be cleaned up to specified remedial goals that would be developed based on land use identified at a later date and does not include the operations area in the assessment. Figure 1-2 summarizes the approach and the components included in this pERA.

In addition to the overall assessment approach discussed above, a number of specific decisions regarding the spatial scope of the pERA were discussed, ratified and incorporated as a part of the cooperative process with the ERWG. These include:

1) The pERA addresses terrestrial and wetland environments using soil, sediment, and surface water samples collected within the site boundary. This was agreed to by the ERWG based on a review of historical site activities and site topography showing that no site impacts have likely occurred on adjacent lands in the ecologically relevant zone (i.e., up to 5 feet below ground surface [bgs] in soil).

2) The terrestrial dataset includes all soil or sediment samples from 0 to 5 feet below ground surface (bgs). The wetland dataset includes all soil or sediment samples from 0 to 0.5 feet bgs that fall within the federal- or state-delineated wetlands. The riparian dataset includes all soil or sediment samples from 0 to 10 feet bgs that fall within the identified riparian areas on-site (Figure 1-3). Soil horizons were generally selected as the most likely soil area to which an ecological receptor might be exposed. Additional rationale for selection of these soil horizons is provided in the Exposure Assessment in Section 4.1.

3) Reservoirs 5 and 7 (shown on Figure 1-3) are excluded from this risk evaluation. These former tank bottoms have a visible sheen of petroleum on their surfaces, and the chemical composition of the petroleum constituents in these areas would likely indicate risk to ecological receptors based on toxicological benchmarks. Thus, it is acknowledged that evaluation of risk from these areas would not add resolution to the risk assessment and management process, and quantitative risk evaluation of these areas is not included in this pERA.

4) All surface hydrocarbon expressions (shown on Figure 1-3) are excluded from the risk evaluation. While bioavailability is likely to be limited based on the physical nature of the petroleum, the chemical composition of the petroleum constituents in these areas would likely indicate risk to ecological receptors based on toxicological benchmarks. Thus, it is acknowledged that evaluation of risk from these areas would not add resolution to the risk assessment and management process, and quantitative risk evaluation of these areas is not included in this pERA. Areas of surface

[1] Scenario 1 evaluates what will be referred to as "the whole site" for the rest of this document, but which actually is composed of the whole site minus Reservoirs 5 and 7 and all surface tar expressions. Scenario 2 is a "possible post-remediation" scenario and excludes the former operations area from the exposure estimates, as well as Reservoirs 5 and 7 and surface tar expressions.

hydrocarbon expression and Reservoirs 5 and 7 will be addressed separately by Unocal. Figure 1-3 shows all samples included in the pERA.

1.4 Report Organization

This pERA consists of the following chapters:

Section 2 – Site Setting. The site setting includes a description of the site history and physical setting of the SLO Tank Farm site, a summary of the previous environmental investigation and recent data collection activities, a data quality assessment, and a discussion of data use.

Section 3 – Problem Formulation. The problem formulation includes a description of the site ecological setting, COPEC selection, the site conceptual site model (CSM), the assessment and measurement endpoints, and the selection of receptors of concern.

Section 4 – Exposure Assessment. The exposure assessment includes a description of exposure estimates for Tier 1 and Tier 2 - Scenario 1, and Tier 2 - Scenario 2. Exposure estimates are presented for both direct toxicity (i.e., media concentrations) and for food-chain exposures (i.e., modeled daily doses).

Section 5 – Effects Assessment. The effects assessment includes a summary of both the low- and high toxicity benchmarks selected for each AE and the underlying rationale for their selection.

Section 6 – Risk Characterization. The risk characterization integrates the exposure and effects assessment and presents risk estimates for each AE. This section includes risk estimates for Tier 1, Tier 2 - Scenario 1, and Tier 2 - Scenario 2.

Section 7 – Uncertainty Analysis. The uncertainty analysis addresses the uncertainties associated with each section of the pERA and assesses how these uncertainties might over- or under estimate potential risk in the pERA.

Section 8 – Conclusions. The summary and conclusions section presents a final interpretation of the risk characterization in the context of the uncertainties discussed in Section 7.

2. Site Setting

The site setting includes a description of the site history and physical setting of the SLO Tank Farm site, a summary of the previous environmental investigations, a data quality assessment, a summary of recent data collection activities and a summary of the data use for the pERA.

Key Elements

- **Site was historically a petroleum storage and distribution facility.**
- **A subsurface weathered petroleum plume is present.**
- **Previous investigations evaluated groundwater, surface water, soil, sediment, and ecological resources.**
- **Data Quality Assessment found that data are adequate for the purposes of screening-level assessment .**
- **Recent data collection to address data gaps included:**
  - **surface water metals, PAHs, and TPH**
  - **biological surveys for aquatic life, birds, and plants (including special-status species)**

2.1 Site History

The site was an operational petroleum storage and distribution facility for petroleum produced in the San Joaquin Valley from 1910 to the early 1980s. In 1926, a lightening strike ignited a fire that destroyed many of the storage tanks and reservoirs on the site and released an estimated 6 million barrels of petroleum. This release, along with a number or spills and leaks throughout the history of site operations, has resulted in the presence of a highly weathered layer of mostly crude oil-derived petroleum in a large portion of the subsurface of the site (Figure 2-1).

In addition to the six reservoirs and 21 above-ground storage tanks (ASTs) utilized for crude oil storage, the facility included a series of pipelines for oil movement to and from the site and for movement between the on-site tanks. Unocal conducted its regional pipeline operations at the site, primarily from the northwest area of the site. Facilities to support pipeline operations included a pumphouse, boilers (for heating crude oil to reduce viscosity) and associated blow-down area, a small petroleum physical properties testing laboratory, and an electrical equipment house. The northwest operations area also included areas for general equipment storage and maintenance, as well as underground storage tanks (USTs) that contained diesel fuel and gasoline (England & Associates, 1999b).

Other historical activities at the site include the operation of a fire training school in the area east of the operations area. Operation of the fire school included the use of off-specification gasoline and diesel fuel (stored in three ASTs) for training exercises. In the past, Unocal leased several acres near the center of the site to a recycling company that maintained a transfer station for glass, plastic, aluminum, and paper (England & Associates, 1999b).

Current land use for the site is primarily open space with cattle grazing as a fire control measure. The northwest area of the site, where the office buildings and parking lot are located, is currently used by Unocal as commercial office space. A proposed land reuse plan has been developed by the City of San Luis Obispo, as outlined in the Airport Area Specific Plan (City of San Luis Obispo, 2002). According to this plan, the majority of the SLO Tank Farm site would remain open space. The northeast and northwest corners of the site (including the former operations area) are proposed as a business park. This plan is in the review draft stage and has not been approved.

2.2 Physical Site Setting

The Unocal SLO Tank Farm site is located in western San Luis Obispo County, south of the city of San Luis Obispo and west of the municipal airport (Figure 1-1). The site is divided into a north and south section by Tank Farm Road, and is bordered by light industrial development, the San Luis Obispo County airport and adjacent pasture lands, and residential neighborhoods to the east and west, south, and north, respectively. The existing buildings in the northwest part of the site currently serve as Unocal's headquarters for a variety of environmental and remediation functions.

The local and regional geology have been extensively characterized in the *Additional Site Characterization Report* (England & Associates, 1999b) and are briefly summarized here. The major portion of the SLO Tank Farm site is situated in the flat terrain of the San Luis Valley, which is a narrow, northwest-trending alluvium-filled basin. The alluvial deposits filling the valley comprise the primary groundwater reservoir serving the San Luis Obispo area and reach a maximum thickness of approximately 150 feet south of the site. The upper 20 feet of the alluvium generally consists of silty and lean clays with moderate to high plasticity. Below 20 feet, the alluvium consists of lenticular interbeds of fine-grained silty sand and poorly graded and well-graded sands and gravels. Groundwater is typically found at depths ranging from 5 to 27 feet, and the regional gradient and flow direction is toward the southwest.

San Luis Obispo County experiences distinct wet and dry seasons. According to the California Department of Water Resources, average annual rainfall for the region is approximately 22.5 inches (www.cdec.water.ca.gov). Almost 22 inches (or 97%) of this rainfall occurs between the months of October and April, and only approximately 0.2 inch occurs during the summer months of June, July, and August (see Figure 2-2).

2.3 Previous Investigations

Since June 1988, a number of environmental investigations have been conducted at the site to determine the nature and extent of soil and groundwater impacts by petroleum and to describe the ecological resources found there. The information (including chemical data) in several of these reports provides the basis for this pERA. These reports are briefly summarized below, and the site samples considered in pERA are shown on Figure 1-3.

2.3.1 Nature and Extent

Investigations of the nature and extent of groundwater and soil contamination at the site began in 1988. As summarized in the *Additional Site Characterization* (England & Associates, 1999b), approximately 10 investigations between 1988 and 1999 resulted in the drilling of over 120 soil borings and the installation of 60 groundwater monitoring wells at the site.[2] Summaries of these investigations, as well as the associated data, are provided by England & Associates (1999b). Overall, these investigations identified three principal subsurface crude oil plumes (Figure 2-1):

[2] Investigators included Brown & Caldwell, Dames & Moore, Earth Systems Environmental, England & Associates, Ground water Technology, and Unocal.

1. northwest plume – underlying the former pipeline operations area in the northwest corner of the property. This area includes several smaller, separate occurrences that underlie former pipelines and steel ASTs located north and northeast of the field offices. Vertically, petroleum in this area is limited to a depth of approximately 25 feet, but mostly occurs in the 10- to 15-foot depth range.
2. northeast plume – beneath former Reservoir 4. Petroleum-impacted soil and bedrock were found to extend from the ground surface to depths of up to 50 feet in the eastern part of the former reservoir.
3. southern plume – large occurrence that underlies much of the property south of Tank Farm Road. Borings drilled within the area indicate that impacted soil occurs primarily in the 5- to 25-foot depth range. Locally, impacted soil extends as deep as 50 feet below Reservoirs 2 and 3.

Studies conducted following those summarized by England and Associates (1999b) that characterized the nature and extent of the contamination at the site are summarized below.

Additional Site Characterization, England & Associates, April 1999. Based on the findings to date, England & Associates conducted its Additional Site Characterization in 1999(b). This investigation focused on refining the delineation of crude oil in the subsurface, characterizing the physiochemical nature of crude oil in surface soils and at depth, and examining areas of the site not used exclusively for petroleum storage (e.g., boiler blow-down pond, fire school area, cutting shed, pump house) for other potential contaminants of concern. Specific work included drilling 16 borings to better delineate the subsurface plumes relative to site property lines, 42 borings to better delineate the extent of crude oil plumes, five borings to examine contamination in the area of the boiler blow-down pond, and 58 shallow soil samples (0.5 to 2.5 feet bgs) to determine concentrations of benzene, toluene, ethylbenzene, and xylene (BTEX) and total petroleum hydrocarbon (TPH), as well as other COPECs, such as metals, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) in the vicinity of the operations area. Sampling also focused on wetland and riparian areas, including surface tars, soils, sediments, and surface waters, to examine the nature and extent of contamination in habitat areas of likely ecological interest.

Findings included:

- hydrocarbons detected below 5 feet are dominated by compounds in the C10-C25 range (60%; the remaining 40% composed of C25-C40 hydrocarbons);
- there is a limited contribution of BTEX constituents to the crude oil (i.e., $\leq$0.5 mg/kg wet weight in 3 of 17 samples);
- there are no significant concentrations of VOCs ($\leq$0.092 mg/kg wet weight in 7 of 39 samples) or PCBs ($\leq$ 0.09 mg/kg wet weight Aroclor 1254 in 6 of 38 samples) in soil or tar samples;
- PAH concentrations generally below 1 milligram per kilogram (mg/kg wet weight);
- of the 17 CAM (California Administrative Manual) metals, only arsenic and lead were detected in concentrations significantly above background concentrations; and
- movement of crude oil in the subsurface has reached its maximum limit of travel.

In addition, this report characterized the surface hydrocarbon expressions at the site. The expressions are defined as remnants of the crude oil deposited on the land surface as a result of the 1926 fire and are present in the form of surficial crude oil. These expressions occur in a variety of forms including: (1) solid, vesicular material similar in appearance and consistency to volcanic rock (green areas on Figure 1-3); (2) pliable no flowing weathered crude (blue areas on Figure 1-3); (3) pliable with evidence of recent

plastic flow (purple areas on figure 1-3); and (4) liquid petroleum which is capable of creating sheen in surface water (red areas on Figure 1-3). Detailed results are provided in the April 1999 report.

Former Boiler Blow-Down Area Investigation. England & Associates, January 1999. In conjunction with the Additional Site Characterization, England & Associates investigated the former boiler blow-down area and documented the findings in a separate report (1999a). The primary objective of the investigation was to determine whether discharges of the boiler blow-down water adversely impacted groundwater quality. Boiler-related operations were conducted in the operations area of the site, and cooled blow-down water discharged to a small pond 250 feet east of the boiler in the southwest corner of the northwest marsh (in the vicinity of B-33, see Figure 1-3). The investigation involved drilling five borings, collecting soil samples from a variety of depths (including 0.5, 2.5, and 5 feet), and completing the borings as ether temporary piezometers or permanent groundwater wells. Soil samples contained detectable concentrations of TPH, primarily at depths less than 15 feet, but contained no detectable BTEX or PAHs. The authors determined that the only metal exceeding background was zinc, and that this occurred in only one sample. In groundwater, TPH but not PAHs or BTEX was detected. A variety of metals were detected in groundwater. Overall, the report concluded that soil and groundwater beneath the boiler blow-down pond may have been impacted by discharged boiler water, but that the area of impact is generally limited to the former pond area itself.

Supplemental Site Characterization. England Geosystem Inc., October 2001. England Geosystem, Inc. (formerly England & Associates) performed a Supplemental Site Characterization (England Geosystem, Inc., 2001) to address data gaps at the site. Specifically, the investigation was designed to:

- characterize the vertical and localized horizontal direction of groundwater flow in areas of hydrocarbon seepage (such as Reservoir 7 and adjacent to Reservoir 2);
- measure chemical and physical properties of light non-aqueous phase liquid (LNAPL) in wells;
- assess vertical variations in the occurrence and chemistry of residual liquid-phase petroleum hydrocarbons in soil;
- characterize the composition and flux of soil gas in petroleum-impacted areas of the site under consideration for future development;
- assess the potential mobility of the liquid-phase petroleum; and
- measure the activity of natural attenuation processes.

England Geosystem, Inc.'s 2001 report details the findings of this investigation. Briefly, it was determined that, while it was unlikely that vertical groundwater gradients were responsible for seepage observed in the vicinity of Reservoir 2, the vertical groundwater gradient contribution to seepages in Reservoir 7 could not be determined. LNAPL detected in wells at the site exhibited low density and high viscosity, and had chemical and physical properties consistent with San Joaquin Valley crude oil. England Geosystem, Inc observed no apparent relationships between TPH composition, BTEX composition, or PAH composition with sample depth. Finally, the low density and high viscosity of average LNAPL at the site makes it 750 times less mobile than water; in addition, the low permeabilities/transmissivities measured in the subsurface soils impede the lateral movement of LNAPL.

Reservoir Bottom Hydrocarbon Seepage Study Report. England Geosystem Inc., November 2002. In 2002, England Geosystem, Inc. performed a study to identify the processes responsible for the production of hydrocarbon sheen in Reservoirs 5 and 7 at the site. Hypotheses evaluated included (1) the

development of sheen when water contacted oil residue present in reservoir bottoms, and (2) rising groundwater or density inversion forcing LNAPL to the surface. Based on observed surface water/groundwater relationships and the accumulation of LNAPL, it was concluded that rising groundwater is a significant contributor to the hydrocarbon seeps in Reservoirs 5 and 7 and that seepage appears to be related to shallow seasonally fluctuating groundwater and NAPL, as well as discontinuities in the formation underlying the reservoirs (England Geosystem, Inc, 2002).

Analysis for Pesticides and Herbicides, Unocal San Luis Obispo Tank Farm. Earth Systems Pacific, July 2002. Earth Systems Pacific conducted surface sampling at the site in May 2002 to evaluate the presence of pesticides and herbicides in soils. Twenty-three surface soil samples, from locations scattered over the entire site, were analyzed for organochlorine pesticides and chlorinated/phenoxy acid herbicides. No organochlorine pesticides or chlorinated/phenoxy acid herbicides were detected, with detection limits ranging from 0.002 to 1.5 mg/kg wet weight and 0.02 to 20 mg/kg wet weight, respectively (Earth Systems Pacific, 2002a).

Groundwater Monitoring Results, September 2002, Monitoring and Reporting Program 93-120 – Unocal Tank Farm. Earth Systems Pacific, October 2002. Ongoing groundwater and surface water monitoring is conducted at the site, pursuant to the RWQCB Monitoring and Reporting Program (MRP) 93-120 (Earth Systems Pacific, 2002b). The MRP (initiated in 1993), calls for semi-annual groundwater monitoring and currently includes 26 groundwater monitoring wells, five off-site supply wells, and 10 surface water locations analyzed for TPH (purgeable [C4-C10 compounds] and extractable [>C10 compounds]) and BTEX.[3] When the pERA activities were initiated, the most recent semi-annual groundwater monitoring had occurred in September 2002. At that time, only the groundwater and off-site supply wells were sampled. The groundwater gradient was determined to be to the west-southwest, at an average slope of 0.007. Purgeable TPH was detected in only one of the four monitoring wells analyzed. Extractable TPH was detected in 16 of 24 wells sampled and in two of the five supply wells. However, following silica gel cleanup, extractable TPH was detected in only two monitoring wells and in no off-site supply wells. BTEX constituents were detected in only one monitoring well and in no off-site supply wells (Earth Systems Pacific, 2002b).

2.3.2 Ecological Resource Evaluations

A number of studies have been conducted to support ecological risk assessment and permitting activities at the site. As a part of these studies, the biological resources (i.e., habitats and receptors) at the site have been surveyed and characterized. A list of species observed or expected at the site based on the combined results of these surveys is included in Appendix B. The following paragraphs summarize the biological surveys and wetland delineations that have been conducted at the site.

Biological Surveys
Two historical biological surveys were conducted at the site. The first was conducted by ENTRIX as a part of a scoping ecological risk assessment. The second was conducted by EDAW to identify key resources that might be impacted by site closure activities.

Scoping Ecological Risk Assessment and Biological Characterization for Unocal Tank Farm Road Site. ENTRIX, Inc., February 1998. ENTRIX, Inc. (ENTRIX) prepared a Scoping Ecological Risk Assessment and Biological Site Characterization for Unocal SLO Tank Farm site (1998). The objective of

[3] Historically (January 1998 through September 2003), the MRP also called for the analysis of PAHs.

the scoping assessment was to develop a conceptual site model that identified species and contaminants of concern and potentially complete exposure pathways based on existing chemical and ecological data. ENTRIX identified seven major habitats (grasslands, ruderal, disturbed/industrial, seasonally ponded wetlands, freshwater emergent wetlands, aquatic, and valley riparian) based on reconnaissance-level surveys conducted during 1996. ENTRIX identified 61 plant species and observed 108 wildlife species (invertebrates, fish, amphibians and reptiles, birds, and mammals) on-site. Eleven special-status wildlife species were observed during the surveys. ENTRIX indicated that an additional 93 wildlife species could occur at the site. Petroleum-associated PAHs were identified as the major COPECs at the site. Potentially complete exposure pathways that were identified included the following:

- terrestrial wildlife and plant exposure to surface soils and tar and oil surface hydrocarbon expressions (including entrapment of wildlife in surface expressions);
- terrestrial wildlife exposure to contaminated biota;
- terrestrial wildlife exposure to fugitive dust;
- wetland wildlife and plant exposure to surface water, groundwater, sediments, and surface hydrocarbon expressions (including entrapment of wildlife in surface hydrocarbon expressions); and
- wetland wildlife exposure to contaminated biota.

ENTRIX concluded that potential exposure to contamination in the riparian habitat was likely to be minimal given its location on the periphery of the site away from the main areas of known contamination.

Key Biological Resource Issues and Preliminary Restoration Concepts for the Proposed Unocal Tank Farm Development and Ecological Preserve. EDAW, Inc., July 1999. In July 1999, EDAW examined biological resource issues at the site (EDAW, 1999b). One of the objectives of the report was to examine key issues related to biological resources at the site that may be affected by closure activities. As such, the report provides a review of conditions existing in 1999. This includes a summary of the site's biological resources, as well as a listing of sensitive species and habitats potentially present on-site. The investigation of plant communities and wildlife habitats included a review of historical site investigation such as the ENTRIX 1998 SERA and other sources, as well as field surveys of the site. The report provides a comprehensive review of plants and wildlife species observed or commonly occurring in the 10 plant habitats EDAW identified (non-native grasslands, valley needle grasslands, seasonal wet meadow, freshwater marsh, mixed riparian, coyote brush-California sagebrush scrub, seasonal wet meadow/tar flat, agriculture, developed/industrial). In addition, it provides a list of special-status species for which potentially suitable or marginally suitable habitat exists on-site based on historical site documents, reports of flora and fauna in the area, and species identified in the California Natural Diversity Database.

Wetland Delineation

The southern portion San Luis Obispo Tank Farm wetlands were delineated by the U.S. Army Corps of Engineers, Los Angeles District in June of 1994. Jurisdictional wetlands were identified in 39.15 acres. This delineation expired in June 1999 and an updated delineation of jurisdiction waters of the United States was conducted for the entire site by EDAW, Inc as described below. The findings of this report were verified in a September 10, 1999 letter from the USDA Natural Resource Conservation Service in conjunction with the U.S. Army Corps of Engineers (USACE).

Wetland Delineation for Unocal Tank Farm. EDAW, Inc., July 1999. EDAW, Inc.'s (EDAW's) 1999 *Wetland Delineation for Unocal Tank Farm* identified U.S. Army Corps of Engineers (USACE) jurisdictional wetlands at the site. Methods included mapping based on aerial photographs, with subsequent surveys of the site during May 1999. During the survey, wetland indicators examined included hydric soils, hydrophytic vegetation, and field indicators for surficial hydrology such as inundation, soil saturation in the upper 12 inches, water marks, drift lines, sediment deposits, and/or drainage patterns. EDAW (1999a) reported a total of 57.2 acres of USACE jurisdiction on the site, with 55.8 acres classified as jurisdictional wetlands and 1.4 acres of "Other Waters of the U.S." EDAW (1999a) reported that the quality of wetlands varied from highly valuable (wetlands with a dominant percentage of native species and good habitat value) to very disturbed (wetlands with no hydric soil characteristics, evidence of oil and/or tar, and dominated by non-native species).

Final State Wetland Delineation Report, Unocal's San Luis Obispo Tank Farm. JENESIS 2003. In addition to the federal wetland delineation conducted by EDAW, a state wetland delineation was conducted according to the CDFG definition of wetlands (adopted form USFWS). Using the state wetland definition caused, in some cases, expansion of the wetland boundaries. The state delineation identified all of the jurisdictional areas identified by the federal delineation and identified an additional 18.75 acres for a total of 75.95 of state delineated wetlands.

Both the federal and state delineated wetlands are considered a part of the wetland footprint for the purposes of this pERA.

2.4 Data Quality Assessment

The USEPA's *Guidance for Data Quality Assessment* (2000a) provides general guidance on assessing data quality criteria and performance specifications for decision making. As described by the USEPA, "Data Quality Assessment (DQA) is the scientific and statistical evaluation of data to determine if data obtained from environmental data operations are of the right type, quality, and quantity to support their intended use." The guidance specifies that DQA is built on the fundamental premise that data *quality*, as a concept, is meaningful only when it relates to the intended use of the data. As such, one of the questions the DQA is designed to address is: "Can the decision (or estimate) be made with the desired confidence, given the quality of the data set?" To assess the adequacy of the data available for the Unocal SLO Tank Farm site to support the pERA, four primary questions were addressed.

1) Are the available data of adequate quality?

2) Have all the potential contaminants at the site been assessed?

3) Is the spatial coverage of the available data in each media adequate to assess all identified receptors at the site?

4) Are the detection limits of the available data adequate to evaluate potential risk to ecological receptors?

2.4.1 Data Quality

To support various project needs, the environmental monitoring data for the site and vicinity were formally assembled and are maintained in a primary electronic database by England Geosystem. A number of tasks have been undertaken by England Geosystem, Inc. to compile and verify the accuracy of the primary environmental monitoring database. Establishing and using a consistent, verified data source ensures the use of the same information for all data analyses and reports. As with any long-running environmental project, the compilation of the Unocal SLO Tank Farm data management system (DMS) has been an evolving process. Therefore, the data, especially the historical data, come from a variety of sources with varying levels of data quality. To establish confidence in the completeness and quality of the data in the primary database, England Geosystem compiled all available data sources and subsequently performed verification of the Unocal SLO Tank Farm site DMS.

In order to promote the completeness and accuracy of the primary database for use in site risk assessments, England Geosystem, Inc. identified all known sources of original data and reviewed chains of custody (COCs) and analytical laboratory reports from the original source reports, then uploaded the data electronically or entered it manually, depending on the source. Once data were compiled, a number of steps were taken to verify that the data were entered into the database correctly and that the information contained in the data fields was uniform. Specific details of the data compilation and verification conducted are provided in the Data Verification and Analysis Technical Memo (Appendix C).

2.4.2 Adequacy of Constituents Assessed

Petroleum-associated compounds are known contaminants at the site and have been assessed in a number of site investigations (Section 2.3.1). Other minor sources of non-petroleum compounds have been identified at the site and assessed. Solvents, lubricating and/or hydraulic fluids, and/or solvent-based additives may have been used in the petroleum properties testing laboratory and pipeline pumping activities. To address potential contamination from these materials, VOCs and semi-volatile organic compounds (SVOCs) other than PAHs have been measured. SVOCs were not detected in site soils. Non-BTEX constituents were detected at low levels ($\leq$ 0.115 mg/kg dry weight) at 7 of 55 locations and BTEX constituents were detected in only 5 of 219 locations. The electrical equipment house may have housed transformers containing PCBs, but these compounds also have rarely been detected in site soils. PCBs were detected at low levels ($\leq$ 0.11 mg/kg dry weight) in 6 of 55 samples – none of which were located adjacent to the electrical equipment house (England & Associates, 1999b). Agricultural activities and/or weed control could have been potential sources of herbicides or pesticides at the site, but these compounds have been measured, and none have been detected in site soils (Earth Systems Pacific, 2002a).

Dioxin has not been measured at the site and was considered for the pERA based on the possibility that it may have been formed as a result of the petroleum burn in the 1926 fire. It was discussed and agreed to by the ERWG that while it could be possible that dioxin compounds could have been produced and deposited onto soil during the burning of crude oil in the 1926 event fire at the site, the lack of atmospheric chlorine and the very low crude oil chlorine concentration would limit the amount of dioxin compound formation. Concentrations of dioxin compounds in soil are expected to be within the range of ambient background concentrations, which have not been found to be a significant risk to human health or the environment. Thus, analytical measurements of dioxin were not conducted. Details of the rationale

for this determination are provided in Appendix D, *Dioxin Compounds in Soil at Unocal's San Luis Obispo Tank Farm*.

Based on the historical knowledge of site activities and the site assessments that have been conducted, the suite of compounds analyzed for in soils at the SLO Tank Farm site was considered adequate for the pERA by the ERWG.

However, measurements of inorganic compounds in surface water were identified as a data gap. In addition, two seasonally inundated locations of known surface soil contamination (the Cow Pond and Reservoir 3) were identified that had not previously been sampled for petroleum constituents in surface water. To address this, surface water data quality objectives (DQOs) were developed, and sampling was conducted at 10 locations (England Geosystem, 2003c). Samples were analyzed for water quality parameters, metals, and the organic constituents regularly analyzed as part of the ongoing Monitoring and Reporting Program 93-120. With the addition of this data, the ERWG considered analytical coverage in surface water to be adequate for the pERA.

2.4.3 Spatial and Temporal Coverage

Data have been collected at the SLO Tank Farm site during both the dry and the wet seasons, and from a variety of habitats and depths. Most of the sampling that has been conducted at the site has been in areas of known or suspected contamination. As shown on Figure 1-3, soil/sediment sample coverage is densest in the former operations area and in the recycling area. Samples outside these two areas are more dispersed but, as described in the Section 2.2, have been collected with the purpose of evaluating potential source areas and are thus likely to capture the majority of the potentially contaminated site areas. The soil data set[4] includes 237 TPH samples, 120 metals samples, and 68 PAH samples collected from 1988 through 2003 in summer (dry) and winter (wet) months from the top 5 feet. The sediment data set, as defined by the federal and state delineated wetlands, includes 29 TPH samples, 19 metals samples, and 13 PAH samples collected in October and November of 1998 from the top 6 inches. The specific rationale for the selection of soil and sediment depth horizons is provided in the Exposure Assessment in Section 4.0. The available soil and sediment data are considered adequate for the screening-level purposes of identifying potential areas or compounds requiring further evaluation in this pERA.

Surface water data have been collected during 12 sampling events conducted at various times of the November to March wet season over the past nine years. Much of this sampling was conducted as a part of the ongoing Monitoring and Reporting Program 93-120. As discussed above, metals in surface water were identified as a data gap and were, analyzed in March 2003. The surface water data set includes TPH and/or PAHs from 21 sample locations and metals from 11 sample locations (Figure 1-3). The review of the available surface water data indicates that coverage is adequate for the purposes of the pERA.

2.4.4 Detection Limits

For inorganics, the adequacy of detection limits was evaluated by comparing detection limits to the identified background inflection point, when available. For those inorganics that were never or rarely detected and therefore a background inflection point could not be determined, and for all organic

[4] Because the sediment samples within the wetlands are dry for a significant portion of the year, they are included in both the terrestrial and wetland evaluations.

compounds analyzed, detection limits for each compound was evaluated by comparing one-half of the detection limits to ecologically relevant benchmarks. When benchmarks were not available for a compound, a surrogate value (e.g., the most conservative benchmark available for a class of compounds) was used. Detection limits for most compounds were adequate. Background for selenium and thallium could not be determined and both compounds had detection limits greater than their respective screening values. Detection limits for petroleum compounds (TPH and PAHs), PCBs, non-petroleum SVOCs, and VOCs were adequate. No screening values were available for herbicides, but, based on discussions with the ERWG (Appendix A), it was agreed that these detection limits were adequate. Pesticide detection limits were adequate for the majority of the samples (i.e., 70% to 100%). As with herbicides, the ERWG agreed that these detection limits were generally adequate.

For surface water, only detection limits for the most recent data collected were evaluated. These data represent the most relevant and highest-quality data and were used selectively over historical data. The detection limits for this sampling event were prescribed by the DQOs and were adequate for ecological assessment purposes. Thus, all surface water detection limits were considered adequate for the pERA.

The detection limit evaluation is summarized in Table 3-1 and discussed in the context of the COPEC screening process is discussed in Section 3.2.

2.5 Data Collection Activities

During the pERA DQA process, three primary data gaps were identified that were critical to the completion of the pERA. These are:

- surface water metals data and surface water PAH and TPH data with adequate detection limits;
- biological surveys for special-status species at the site; and
- biological characterization of the aquatic habitat at the site.

Data were collected to address each of these data gaps, as discussed below.

2.5.1 Surface water Data Collection

To address the data gaps identified for site surface water, England Geosystem conducted a wet season sampling of 10 surface water sample locations. Figure 1-3 shows the sample locations for this sampling event, as well as historical surface water sampling locations. Sample locations were selected based on the results of previous analyses and on identified spatial data gaps. Prior to the collection of samples, each surface water body was photographed, the condition described (e.g., type [pond or creek], approximate size, depth, water movement [e.g., flowing, stagnant], evidence of disturbance, water color, clarity, odor). Samples were analyzed for TPH-purgeable (C_4-C_{10}); BTEX; TPH extractable (C_8-C_{40}) both before and after silica gel treatment[5]; PAHs; CAM metals; general minerals; dissolved organic carbon; and ammonia-nitrogen. In situ water parameters (i.e., dissolved oxygen [DO], specific conductivity, water temperature, turbidity, and pH) were measured in the field prior to sampling for contaminants. The

[5] Samples containing greater than or equal to 1 milligram per liter (mg/L) of extractable-range TPH (SW-1 and SW-4) were also subjected to TPH fraction analysis (aliphatic and aromatic) in four carbon ranges.

results of this sampling event are presented in the *Supplemental Evaluation of Surface Water Report* (England Geosystem, Inc., 2003c and 2003d).

2.5.2 Biological Surveys

To address the need for special-status species surveys and for characterization of the aquatic habitat, Rincon Consultants was contracted to conduct biological surveys. Special-status species include federally and/or state listed threatened or endangered species or species of special concern and, in addition, for plants, species on the California Native Plant Society's (CNPS') 1B list of rare plants. The following species were surveyed at the site:

- water-column and benthic (i.e., sediment) invertebrates;
- aquatic vertebrates (i.e., fish and amphibians);
- California red-legged frog;
- California tiger salamander;
- Black rail (breeding season);
- rare plants;
- vernal pool branchiopods (fairy shrimp) (dry season); and
- Morro shoulderband snail.

Data quality objectives were developed and followed for surveys of aquatic invertebrates, benthic invertebrates and special-status species and are included as an attachment to the final *Phase 1 Biological Studies Report* (Rincon Consultants, 2003a). The surveys conducted in May 2003 characterized the aquatic and benthic community as "typical of non-flowing seasonally-ponded habitat". The species found consisted primarily of facultative invertebrates that use the bottom surface and water column interactively and, in some cases, during different life stages.

The aquatic vertebrate surveys found mostly Pacific tree frog larvae and adults and bullfrog adults. A number of young common carp were also found in the western marsh. The California red-legged frog was not found on-site and would generally not be expected given the predominance of bullfrogs as predators and competitors. Likewise, the California tiger salamander was not observed on site and is not likely to be present given the habitat disturbance and introduction of non-native predator species. The threespine stickleback and southwestern pond turtle were observed in the east fork San Luis Obispo Creek that runs along the south east border of the site (Rincon Consultants, 2003a).

The black rail was not found on site and would not be expected based on the marginal habitat suitability. Three special-status plants, the Congdon's tar plant, San Luis Obispo morning glory, and Hoover's button celery were found at the site. These species are not federal- or state-listed threatened or endangered species but are included on the CNPS 1B list. Purple needle grass was also mapped as a part of the rare plant survey. While not a special status species, it is considered a rare plant community by CDFG if found in high enough density. Its occurrence at the site was limited with only one small stand occurring in high density (i.e., 80% cover) (Rincon Consultants 2003a). The distributions of all four rare or special

status plant species are mapped on Figure 2-3. The detailed results, species lists, and rare plant maps are presented in the *Phase I Biological Resources Studies* (Rincon Consultants 2003a).

While the May surveys were too late in the season to detect fairy shrimp using the wet-season protocol, the dry-season protocol was conducted in September 2003 (Rincon Consultants, 2003b). Cysts of the federally threatened fairy shrimp, *Branchinecta lynchi*, were identified at 27 of the 36 locations sampled (Figure 2-3) and cysts of the non-listed species, *Linderiella occidentalis*, were observed in 11 of 36 location. Some of the potentially suitable fairy shrimp habitat was not sampled due to observed or presumed hydrocarbon contamination within the pool. The detailed results of the Phase II biological surveys can be found in the *Phase II Biological Resources Studies* (Rincon 2003b). Wet season protocols for the fairy shrimp will be conducted in 2004.

The Morro shoulderband snail was not observed on site during the Phase II dry season survey but potential habitat was identified. Subsequent wet season surveys were conducted for the Morro shoulderband snail between December of 2003 and March of 2004. This species was observed at several locations[6]. The final results of these surveys are not available at this time, but are expected to be released in 2004.

2.6 Data Use

This section describes how the dataset for this pERA was compiled from the larger primary database assembled and maintained by England Geosystem, Inc. Details of the process used to compile and verify the data in the primary database for the SLO Tank Farm are provided in Appendix C. Data compilation included identification of ecologically relevant data and modification of data to make it suitable for use in the pERA. The complete dataset used in the pERA for each habitat type is included on a CD in Appendix I.

Because the pERA is only concerned with media to which ecological receptors may be exposed, many of the data collected for the site and included in the primary database are not relevant for the purposes of the risk assessment (e.g., groundwater or deep soil data). For this reason, specific data were selected for use in the pERA based on agreements with the ERWG (Appendix A: 1/28/03 summary). As described in Section 1.3, soil, sediment, and surface water data from ecologically relevant depths were selected for the pERA risk analysis. It was also decided that only on-site data be included in the pERA, and Reservoirs 5 and 7 and all surface hydrocarbon expressions be excluded.

Because the majority of the site data were not collected specifically for the purpose of risk assessment, some data modifications were necessary to finalize the dataset for the pERA. These included the conversion of soil and sediment results from wet weight to dry weight and creating “Sum” analytes for TPH and PAHs. All soil and sediment analytical data in the primary database were reported in wet weight. Therefore all soil and sediment results in the pERA dataset were converted from wet-to-dry weight using a conversion factor of 0.799 because ecological toxicity benchmarks are based on dry weight values. This value was developed in 2001 by England Geosystem based on moisture data available from nearby the site (Tank Farm Road) locations, and its use agreed upon by the ERWG (Appendix A: 3/11/03 summary).

[6] It is currently uncertain whether the Morro Shoulderband snail found in inland clay-based substrate such as that found at the SLO Tank Farm is considered the listed species.

Ecotoxicological benchmarks available for ecological risk assessment of petroleum contamination are often based on a total or combined measure of the various constituents of petroleum. Thus, for the purposes of the pERA, it was necessary to combine some of the available site data to define two new analytes, Sum TPH and Sum PAH, so that the data could be compared to available benchmarks. The "Sum TPH (C10-C40)" analyte was created by summing the C10-C25 and C25-C40 analytes for all samples in which they were reported. Any non-detected values were summed at half the detection limit. Summing the C10-C25 and C25-C40 results allows for comparison with the measured C10-C40 results and other whole TPH benchmarks. Because the C4 – C10 carbon range was generally not detected in early soil samples, the majority of the samples collected for the site were not analyzed for this fraction. Of the soil samples collected on-site from depths less than or equal to five feet (i.e., pERA relevant), C4-C10 TPH results are reported for only 47 samples, while Sum TPH C10-C40 and measured C10-C40 results are available for 237 samples. Moreover, TPH in the C4-C10 range was detected in only five of the 47 samples, with concentration ranging from 22.5 to 538 mg/kg dry weight. The highest concentration was detected in the Trench 6 sample from 4 feet; however it comprises only 1.56% of the total TPH (C4-C40) detected at that location. For these reasons, the C4-C10 carbon range was excluded from the sum TPH calculation. Sum TPH is referred to in the remainder of this report as simply TPH.

The secondary database "Sum PAH" analyte was created by summing the following 16 analytes: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. Any non-detected values were summed at half the detection limit. Summing these individual PAHs into Sum PAH in this manner allows for consistency with available literature-based PAH toxicity benchmarks. Additional details on specific data modifications for the pERA are provided in Appendix C.

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3. Problem Formulation

Problem formulation defines the goals and objectives of the risk assessment. This is a formal process to develop and evaluate preliminary hypotheses concerning the likelihood and causes of ecological effects that may have occurred, or may occur, from human activities (USEPA, 1998). The problem formulation for this pERA includes an overview of ecological setting of the site, selection of COPECs, the CSM, the selection of assessment and measurement endpoints, and the selection of representative receptors (including the identification of special-status species). The following sections provide details of each step in the problem formulation.

Key Elements

- **Important habitats evaluated include both terrestrial and wetland.**
- **Site-specific surveys conducted and used to characterize site ecology.**
- **COPECs selected include arsenic, lead, PAHs, and TPH.**
- **CSM identified complete exposure pathways between impacted site media and plant, invertebrate, and wildlife receptors.**
- **Assessment endpoints: 8 terrestrial and 8 wetland.**
- **Receptors of concern selected to maximize exposure. Special status species selected as appropriate.**

3.1 Ecological Setting

The majority of the site lies within the flat terrain of the San Luis Valley. While some low-lying areas are inundated for extended periods, other more shallow depressions in the valley bottom are dry for most of the year (ENTRIX, 1998). Tributaries of the San Luis Obispo Creek likely flowed through portions of the site, but water drainage projects have modified most natural drainages. Remnants of historical riverine and adjacent riparian corridor remain along the southeastern site border (ENTRIX, 1998).

Historical site operations also have substantially reconfigured the surface of the property. For example, the extensive network of berms constructed around the petroleum storage tanks to prevent a release in the event of reservoir or tank failure has resulted in the creation of closed depressions, many of which have been designated wetlands (see state and federally delineated wetlands presented on Figure 1-3). Remnants of large oil reservoirs constructed at the site include the concrete that once lined the basins. Construction of operating facilities in the northwest corner of the site has resulted in very little natural habitat remaining in this area. In addition, grazing of cattle as a means of fire suppression likely impacts surface features and vegetation at the site.

Previous investigations have identified seven different habitat types at the site: grasslands (non-native and valley needle), ruderal, disturbed/industrial, seasonally ponded wetlands, freshwater emergent wetlands, aquatic, and valley riparian (ENTRIX, 1998; EDAW, 1999b). For purposes of the pERA, these seven habitat types have been reduced to two primary types: terrestrial (includes grasslands, ruderal, disturbed/industrial) and wetland (seasonally ponded wetlands, freshwater emergent wetlands, riparian and aquatic).

The three surveys conducted at the site (ENTRIX, 1998; EDAW, 1999b; and Rincon Consultants Inc. [Rincon], 2003a) included surveys of plant, invertebrate, amphibian, avian and mammalian species (including notation of special-status species) observed or expected to be observed on-site. The dominant species observed on-site (as described in these surveys) are summarized below. Sections 2.3.2 and 2.5.2 provide additional detail of these three reports, and Appendix B provides a detailed list of species

identified as occurring, or potentially occurring on site. Overall, vegetation in terrestrial areas of the site is dominated by non-native grasses interspersed with native meadow barley and valley needle grasses, and native and non-native forbs (broad-leaf species). Common non-native grasses at the site include Italian ryegrass, soft chess, rip gut grass, and wild oat; forbs include bird's-foot trefoil, English plantain, bur-clover, and filaree. Ruderal portions of the site are also dominated by non-native species such as a variety of thistle, fennel, and mustard, as well as the native shrubs coyote brush and California sagebrush. Common avian species in the terrestrial habitat at the site include, but are not limited to mourning dove, western meadowlark, red-winged blackbird, black phoebe, and cliff swallow. Of these, western meadowlark, red-winged blackbird, and black phoebe were observed nesting on-site. Several raptors have been observed hunting over the site, including American kestrel, white-tailed kites, red-tailed hawks, and turkey vultures. Common terrestrial wildlife species observed on-site include western fence lizard, striped skunk, California ground squirrel, California vole, Botta's pocket gopher, and black-tailed hare.

As indicated above, wetland habitats at the site include the seasonally ponded wetlands located predominantly within the berms originally constructed around petroleum storage tanks at the site, freshwater marsh such as the large marsh area located in the northwestern portion of the site, and the open water areas often associated with these two habitats. Vegetative species commonly found in seasonally wet habitats (depending on level of inundation) on-site include wild rye, meadow barley, saltgrass, hedge-nettle, cinquefoil, spikebrush and a variety of other rush, smartweed, and woolly marbles. Common wildlife species observed in these seasonally wet areas include amphibians such as Pacific tree frogs and bullfrogs, and a variety of passerines, mallard, cinnamon teal, western sandpiper, and wading birds such as the a variety of egret and heron, and greater yellow legs. Mammals observed in these areas included harvest mice, California vole, and black-tailed deer, as well as tracks of coyote, muskrat and skunk. The second habitat classified as wetland in the pERA is the freshwater marsh areas. Dominant emergent wetland species at the site are bulrush, water plantain, spikebrush, and cattail. Wildlife species expected in these habitats are the same as those in the seasonally ponded wetlands. Aquatic habitats at the site occur in the seasonal wetlands and the freshwater marsh areas. Carp have been observed in waters on-site. Waterbirds observed on-site include mallard, American coot, and cinnamon teal; mammals observed in aquatic habitats include muskrat, bats, raccoon, and striped skunk.

Riparian habitat at the site is predominantly limited to the eastern and southern boundaries of the property and includes the following vegetation: willow, cottonwood, sycamore, and coast live oak, as well as understory species including but not limited to monkey flower, poison oak, mustard, and radish. Riparian habitat may provide roosting or nesting areas for a variety of avian species observed on-site such as screech owl, Cooper's hawk, sharp-shinned and red-tailed hawk, bushtit, chestnut-backed chickadee, downy woodpecker, ash-throated flycatcher, song sparrow, Bewick's wren, and California and spotted towhee. Black-tailed deer, Virginia possum, and harvest mice have been observed in riparian habitat at the site. While not observed on-site, the southwestern pond turtle has been observed in off-site riparian areas.

Special-status plant species found in the surveys included one terrestrial species, the San Luis Obispo morning glory, and two wetland species: Congdon's tar plant, and Hoover's button celery (see Figure 2-3). One special-status aquatic invertebrate species, vernal pool fairy shrimp, and one special- status terrestrial invertebrate, the Morro shoulderband snail were observed on-site. Special-status reptiles, the southwestern pond turtle and sagebrush lizard, were also observed, though of the two, only the sagebrush lizard was observed on-site. Special-status avian species observed on-site included golden eagle, white-tailed kite, sharp-shinned hawk, Cooper's hawk, northern harrier, California horned lark, loggerhead shrike, the double-crested cormorant, and the California gull. None of the three surveys have identified

special-status amphibians or mammals on-site. Appendix B identifies the species observed or expected to be present on-site based on these surveys and provides scientific names.

3.2 COPEC Selection

The next step in the problem formulation process is the identification of COPECs. The COPEC screening process for the pERA involved three primary steps (Figure 3-1):

1. assessment sample coverage and detection limits;
2. comparison of site metals data to background concentrations; and
3. evaluation of frequency of detection.

As discussed in Section 1.3, the pERA includes a Tier 1 and a Tier 2 assessment and two exposure scenarios within the Tier 2 assessment (Scenario 1 and Scenario 2). Because the Tier 1 assessment and the Tier 2-Scenario 1 assessment include the same data set (i.e. all on-site soil and sediment data and 2003 surface water data), the COPEC screening process for these two steps in the pERA is the same. Tier 2-Scenario 2 is an evaluation of a separate exposure scenario (i.e., on-site soil and sediment data outside the former operations area), and a separate COPEC screen was conducted for this scenario. The results of the COPEC screens for each scenario are described below and are summarized by media in Tables 3-1, 3-2 and 3-3.

3.2.1 Assessment of Sample Coverage and Detection Limits

In general, sample coverage and detection limits were determined to be adequate. The specific details of the assessment of sample coverage and detection limits are presented in the data quality assessment in Section 2.4.

3.2.2 Assessment of Inorganic Background

Inorganic background concentrations were determined by England Geosystem (2003b) in the report *Background Metals Evaluation, Unocal San Luis Obispo Tank Farm*. In this report, England Geosystem developed background concentrations based on the distribution of CAM 17 metals detected in soil and bedrock at the SLO Tank Farm site and in the vicinity of the property. The data were evaluated using cumulative probability plots to determine whether separate populations were present. When an inflection point in the data was not observed, the data were considered to be a part of one background population (i.e., all data within the range of background). An inflection point on the plot was considered indicative of multiple populations and was used to bound the background population. In other words, concentrations falling below the inflection point were considered within the background population and concentrations above the inflection point were considered anomalous, or outside the background population. Table 3-4 summarizes the inflection points as outlined by England Geosystem (2003b).

As indicated previously, antimony, selenium, silver, and thallium were never or rarely (selenium in 2 of 123 samples) detected on or in the vicinity of the site; therefore, background concentrations of these metals were not developed by England Geosystem. Based on the evaluation of the background inflection point, beryllium, chromium, copper, and nickel were found to occur on-site at background concentrations

by England Geosystem (no anomalous populations were identified). Thus, of the 17 CAM metals, eight were eliminated as COPECs based on infrequent detects or the absence of an inflection point that would signal an anomalous concentration (antimony, beryllium, chromium, copper, nickel, selenium, silver and thallium). While the remaining nine metals may have had a small number of samples that were greater than the identified inflection point (see COPEC selection rationale in Table 3-1), England Geosystem (2003b) concluded that, overall, only arsenic and lead occur on-site with anomalous concentrations with more than moderate frequency that might indicate another population. No specific site sources of these metals have been identified and the sporadic nature of the distribution of the few anomalous concentrations does not indicate a site source. Figures 3 – 15 in the Background Evaluation Report by England (England Geosystem 2003b) shows the spatial distribution of these metals on site. Through ERWG review and discussion, it was agreed that arsenic and lead are the only inorganic soil compounds identified as COPECs for the pERA.

Due to the ephemeral nature of the wetlands, this background evaluation applied to both terrestrial and wetland soils and sediment. Background was not determined for surface water, but the soil background assessment is considered in interpreting surface water data.

3.2.3 Assessment of the Frequency of Detection

In general, if a constituent was not detected in its respective media more than 5% of the time, it was excluded as a COPEC. This step in the COPEC selection process also includes a professional judgment step to evaluate any compounds that are eliminated based on low frequency of detection to prevent potential hot spots from being overlooked and to allow for compounds that were infrequently detected that may be laboratory contaminants.

Surface water: Metals were analyzed in 10 surface water samples, making even one detect a frequency greater than 5%. Thus, only compounds that were not detected were eliminated as COPECs. Because the most recent sampling event represents the most relevant and highest-quality data for the site, it was used selectively over historical data as the basis for the COPEC screen for organic constituents. Thus, as with metals, only organic compounds that were not detected were eliminated as COPECs. Compounds analyzed during March 2003 included BTEX, PAHs, and TPH (C10-C40). Historical results for these constituents were compared to the results from the latest sampling event and were found to be comparable. For BTEX and PAHs, only toluene was detected at a few locations and is carried forward as a COPEC.

TPH (C10-C40) was detected in surface water in all but two locations, with detected concentrations ranging from 0.13 to 1.9 milligram per liter (mg/L). Concentrations exceeding 1 mg/L were observed in water collected from SW-4 and SW-1; all remaining detections were below 0.4 mg/L. As reported in the *Characterization of TPH Detected in Surface Water* Technical Memorandum prepared by Applied Geochemical Strategies, Inc. (AGS), these detections of TPH do not appear to be related to the known sources of petroleum at the site. Moreover, silica gel cleanup, which removes polar compounds, resulted in the removal of detectable TPH from all the samples. Potential sources of polar material include biological derivation from plant materials, biological degradation of petroleum compounds, or polar compounds derived directly from petroleum in the soils, although the last source is unlikely given the long time that the petroleum-contaminated soils have been exposed to the environment. Mass spectral analyses were conducted on the three surface water samples with the highest TPH concentrations (SW-4, SW-1, and SW-2) to identify the specific compounds in the TPH mixture detected in these samples.

Overall, AGS concluded that petroleum is unlikely to be a major source of the organic material found in the surface water from the site because: 1) neither aliphatic/aromatic material nor PAHs were detected in surface water; 2) the detected TPH was removed by silica gel, 3) the particular compounds identified in the mass spectral analysis are not indicative of petroleum, and 4) field observations of vegetation and water color and clarity suggest a naturally occurring, biologically-derived source; however, conclusive determination the sources of TPH detected at SW-1 and SW-2 cannot be made without further analytical investigations. Details of the TPH surface water analysis can be found in the AGS technical memorandum which is included in Appendix E. While some uncertainty remains regarding the specific composition of TPH detected in surface water, TPH is not carried forward as a surface water COPEC and will be discussed further in the Uncertainty Analysis (Section 7).

Soil/Sediment Inorganic COPECs: As indicated previously, arsenic and lead are the only inorganic COPECs carried forward as COPECs based on the background analysis.

Soil/Sediment Organic COPECs: Non-petroleum organics (i.e., other than TPH and PAHs) in soil/sediment less than or equal to 5 feet bgs were evaluated, and most compounds were not detected at a frequency greater than 5%. Three VOCs were detected in more than 5% of samples, including isopropylbenzene (6 of 55), n-propylbenzene (6 of 55), and sec-butylbenzene (5 of 55). All detects but one were within a limited spatial area of the operations area at a depth of 2.5 feet and were two orders of magnitude lower than the lowest available screening criteria for VOCs (5 mg/kg for xylenes[7]) (Figure 3-2). In addition to these VOCs, Aroclor 1254 was detected in more than 5% of samples (6 of 55). The highest detection of Aroclor 1254 (0.1126 mg/kg) is lower than the lowest available benchmark for plants or invertebrates (0.81) and was detected only in terrestrial habitat. While PCBs can bioaccumulate, the limited spatial area of the detections would indicate that this compound would not pose food-chain risks. Because the number, magnitude, and spatial area of detections were generally minimal, and the range of detections was below available screening values, these compounds are not carried forward as COPECs.

Thus, it was determined that TPH (defined as C10-C40) and PAHs are the organic COPECs requiring further evaluation in the pERA.

3.2.4 COPECs Identified for the pERA

Based on the screening process outlined above, and through review and discussion with the ERWG, it was agreed that the following COPECs would be evaluated in the pERA in each of the following media:

Tier 1:

- soil/sediment: arsenic, lead, PAHs, TPH; and
- surface water: arsenic, barium, nickel, thallium, vanadium, zinc and toluene.

Tier 2 – Scenario 1:

- soil/sediment: arsenic, lead, PAHs, TPH.

Tier 2 – Scenario 2:

- soil: lead, PAHs, TPH; and

[7] Lowest screening value based of phytotoxicity (CCME 1999d).

- arsenic is not included as a COPEC in Scenario 2 because all concentrations outside the former operations area are below the identified background inflection point.

3.3 CSM and Exposure Pathway Analysis

The CSM considers the site setting in an ecological context and identifies important site receptors, ecological exposure pathways, and potential pathways of chemical transport (USEPA, 1992). The CSM is then used to aid in the selection of assessment and measurement endpoints. The CSM schematically presents the relationship between chemical sources and classes of receptors at the site (Figure 3-3), and identifies potentially complete and significant pathways through which ecological receptors may be exposed to the identified COPECs.

The CSM for the site was developed based on historical and current site activities and the biological surveys conducted at the site. For the purposes of the CSM, it is assumed that all of the site area could remain undeveloped (i.e., land reuses in the Airport Plan will not be considered).

3.3.1 Site Sources

Potential sources of petroleum-associated compounds at the site include the nearly 6 million barrels of crude oil released as a result of the 1926 lightning strike and subsequent fire. While much of the crude oil is believed to have been consumed by the fire, previous site investigations have demonstrated that a substantial amount of the crude oil was released into the soils at the site and is present as soil associated TPH and tar material (England & Associates, 1999b). Other sources of potential hydrocarbon releases to the surface soils at the site are primarily associated with lighter petroleum products (gasoline, diesel fuel, etc.) used at a fire-fighting training facility located immediately east of the current office/operations area (England & Associates, 1999b), and/or leakage from the various crude oil pipelines and former underground storage tank located near the field offices (ENTRIX, 1998). Maintenance of above ground storage tanks is a potential source of lead at the site.

3.3.2 Chemical Migration Pathways

COPECs released to surface soils may percolate into groundwater or run off into surface water bodies and associated sediments. These COPECs may also volatilize or become airborne due to wind erosion. COPECs within the subsurface plume may seep into upper soils via rising groundwater levels or through fractures in the subsurface strata.

3.3.3 Identification of Complete Exposure Pathways

To identify complete exposure pathways, ecological guilds (i.e. groups of species that use the same set of resources in a similar manner) were identified based on the potential for organisms in these guilds to either reside in or obtain a significant portion of their diet from the site. Simplified food webs for terrestrial and wetland environments are shown on Figures 3-4 and 3-5. Ecological guilds that have been identified as including organisms potentially occurring in the terrestrial environment are plants; soil invertebrates; and herbivorous, insectivorous, omnivorous, and carnivorous birds and mammals. Ecological guilds identified in the wetland areas include aquatic plants; aquatic and sediment

invertebrates; amphibians and reptiles; and herbivorous, insectivorous, omnivorous and carnivorous birds and mammals. The complete exposure pathways identified at the site for terrestrial, wetland, and riparian areas are summarized in the CSM on Figure 3-3.

A number of pathways identified as potentially complete in the CSM (Figure 3-3) were not quantitatively evaluated due to the absence of elevated contaminant exposure concentrations. For example, a complete pathway is identified for inhalation of volatile compounds by burrowing animals. Site soil gas data for the primary volatile components of petroleum (BTEX) have been collected on two occasions at eight sample locations at depths ranging from 2.5 to 17.5 feet bgs. These data indicate that BTEX components were detected in 63 of 80 samples at low concentrations (England Geosystem, 2003a). Concentrations of BTEX components within the top five feet of soil ranged from nondetect (< 0.01 parts per million vapor [ppmv]) to 0.42 ppmv. This is consistent with the fact that the subsurface contamination is characterized as weathered hydrocarbons consisting primarily of heavier molecular weight compounds. Thus, this pathway is not quantitatively evaluated. In addition to pathways eliminated based on minimal media contamination, the pathway for dermal contact of birds and mammals with petroleum sheen or free product is not quantitatively evaluated. As discussed in Section 1.3, specific site areas with petroleum sheen (Reservoirs 5 and 7) and surface hydrocarbon expressions are excluded from the pERA because a finding of potential risk to receptors in these areas is likely and as such these areas will be addressed separately by Unocal. A summary of pathways that are quantitatively evaluated in this pERA is provided below.

Complete pathways for terrestrial receptors include:

- terrestrial plants and site soil – direct contact;
- soil invertebrates and site soil – direct contact;
- herbivorous, insectivorous[8], and carnivorous mammals and site soil and impacted plant or prey tissue – ingestion; and
- herbivorous, insectivorous[7], and carnivorous birds and site soil and impacted plant or prey tissue – ingestion.

Complete pathways for wetland receptors include:

- wetland plants and site sediments – direct contact;
- riparian plants and site sediments – direct contact;
- sediment invertebrates and site sediments – direct contact;
- aquatic invertebrates and amphibians and site surface water – direct contact;
- aquatic-feeding omnivorous mammals and site sediment and impacted plant or prey tissue – ingestion; and
- aquatic-feeding herbivorous, insectivorous[7], and carnivorous birds and site sediments and impacted aquatic plant or prey tissue – ingestion.

[8] Insectivores such as the meadowlark and sandpiper are considered protective of omnivores (i.e., higher potential exposure).

3.4 Assessment and Measurement Endpoints

Based on the ecological guilds and complete exposure pathways identified in the previous sections, assessment endpoints (AEs) were developed to identify the ecological values at the site that should be protected. The measurement endpoints (MEs) were developed as a means of measuring potential ecological effects and determining whether any potential risk is associated with the COPEC concentrations in each media.

In general, AE selection must consider the ecosystem, communities, and species relevant to a specific site. As defined by the USEPA (1997), AEs are formal expressions of the actual environmental values that are to be protected at a site. AEs are defined based on technical considerations, including the significance of exposure pathways, the presence of receptors, and a COPEC's biotic transfer pathway.
The selection of AEs depends on:

- the chemicals present and their concentration;
- mechanisms of toxicity of the chemicals to different groups of organisms;
- ecologically relevant receptor groups that are potentially sensitive or highly exposed to the chemicals; and
- potentially complete exposure pathways.

A ME is defined as a "measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint" and is a measure of biological effects (e.g., mortality, reproduction, growth) (USEPA, 1997). The AEs and associated MEs selected for the terrestrial (T) and wetland (W) areas of the site are summarized in Tables 3-5 and 3-6 and are identified below.

Terrestrial Assessment Endpoints[9]

AE: T1. Survival and reproduction of terrestrial plant populations[10]:

- ME1: Compare soil concentrations to low and high phytotoxicity benchmarks.
- ME2: Overlay SLO morning glory population map to evaluate risk to this species of special concern.

AE: T2. Survival and reproduction of terrestrial invertebrate populations and individual Morro shoulderband snails:

- ME1: Compare soil concentrations to low and high terrestrial soil invertebrate toxicity benchmarks.

AE: T3. Survival, growth and reproduction of herbivorous bird populations[11]:

[9] For terrestrial assessment, soil was assessed from all sediment and soil samples of depth 0-5 feet bgs. This approach was used to account for the ephemeral nature of the wetland habitat at the site.
[10] Assessment endpoint also includes protection of special-status species.
[11] Note that for selected AEs where endpoints include survival, growth and reproduction as the attributes to be protected at the level of the population, effects on these endpoints may not constitute a take under the CDFG Code Section 3005, Title 14, California Code of Regulations, Section 475 as take is generally considered to be mortality and these endpoints are all sub-lethal.

- ME1: estimate average daily dose by modeling COPEC concentrations in plant tissue and soil from the site and compare the modeled dose to low and high avian TRVs.

AE: T4. Survival, growth and reproduction of herbivorous mammal populations[11]:

- ME1: Estimate average daily dose by modeling COPEC concentrations in plant tissue and soil from the site and compare the modeled dose to low and high mammalian TRVs.

AE: T5. Survival, growth and reproduction of insectivorous bird populations[9, 11]:

- ME1: Estimate average daily dose by modeling COPEC body burdens in invertebrate tissue and soil from the site and compare the modeled dose to low and high avian TRVs.

AE: T6. Survival, growth and reproduction of insectivorous mammal populations[11]:

- ME1: Estimate average daily dose by modeling COPEC body burdens in invertebrate tissue and soil from the site and compare the modeled dose to low and high mammalian TRVs.

AE: T7. Survival, growth and reproduction of carnivorous bird populations[9,11]:

- ME1: Estimate average daily dose by modeling COPEC body burdens in vertebrate tissue and soil from the site and compare the modeled dose to low and high avian TRVs.

AE: T8. Survival, growth and reproduction of carnivorous mammal populations[11]:

- ME1: Estimate average daily dose by modeling COPEC body burdens in vertebrate tissue and soil from the site and compare the modeled dose to low and high mammalian TRVs.

Wetland Assessment Endpoints

AE: W1. Survival and reproduction of wetland plant populations[9]:

- ME1: Compare wetland sediment concentrations[12] to low and high phytotoxicity benchmarks.
- ME2: Overlay Congdon's tarplant population map to evaluate risk to this species of special concern.
- ME3: Compare riparian sediment concentrations[13] within the riparian footprint to low and high phytotoxicity benchmarks.

AE: W2. Survival and reproduction of aquatic invertebrate and amphibian populations:

- ME1: Compare water concentrations to low and high aquatic toxicity benchmarks (e.g., ambient water quality criteria, AWQC).

AE: W3. Survival, growth and reproduction of individual special-status fairy shrimp:

- ME1: Compare water concentrations to low and high aquatic toxicity benchmarks (e.g., AWQC).
- ME2: Compare wetland sediment concentrations to low and high sediment invertebrate toxicity benchmarks.
- ME3: Overlay map of suitable habitat for the fairy shrimp to evaluate risk to the fairy shrimp.

[12] Wetland sediment concentrations defined as soil or sediment from 0-0.5 feet bgs within the federal or state delineated wetlands.
[13] Riparian sediment concentrations defined as soil or sediment from 0-10 feet bgs within the riparian footprint.

AE: W4. Survival and reproduction of sediment invertebrate populations:

- ME1: Compare wetland sediment concentrations to low and high sediment invertebrate toxicity benchmarks.

AE: W5. Survival, growth and reproduction of herbivorous bird populations[11]:

- ME1: Estimate average daily dose by modeling COPEC concentrations in plant tissue from wetland sediment concentrations and compare the modeled dose to low and high avian TRVs.

AE: W6. Survival, growth and reproduction of insectivorous bird populations[12]:

- ME1: Estimate average daily dose by modeling COPEC body burdens in invertebrate tissue from wetland sediment concentrations and compare the modeled dose to low and high avian TRVs.

AE: W7. Survival, growth and reproduction of carnivorous bird populations[11]:

- ME1: Estimate average daily dose by modeling COPEC body burdens in vertebrate tissue from wetland sediment concentrations and compare the modeled dose to low and high avian TRVs.

AE: W8. Survival, growth and reproduction of omnivorous mammal populations[12]:

- ME1: Estimate average daily dose by modeling COPEC body burdens in prey tissues from wetland sediment concentrations and compare modeled dose to low and high mammalian TRVs.

3.4.1 Receptor of Concern Selection

Because it impractical to assess the toxic effects of COPECs to all potentially exposed ecological receptors, a subset of potential receptors was chosen to act as a "surrogate species" for each AE. These "receptors of concern" (ROCs) are analogous to the "representative species" defined by DTSC (1996) as follows:

- species that represent a functional group of organisms at the site for the evaluation of AEs; and
- species that are chosen based primarily on their function in the ecosystem and secondarily on taxonomic relatedness and known or presumed similarities in physiology and life history.

As detailed in the SLO Tank Farm Selection of Receptors of Concern Technical Memorandum (Appendix F), because they represent a larger group, ROCs were selected so that they maximize exposure, thus producing conservative estimates of risk. For those AEs that are generic in nature (e.g., AEs: T1, T2, W1, W2, W3 and W4), selection of representative receptors was not necessary. These AEs are evaluated using benchmarks that are not specific to a particular species. For example, the phytotoxicity benchmarks used to evaluate terrestrial plants (AE T1: ME1) are developed based on observed toxicity to a variety of plant species and are thus considered protective of a variety of species. Therefore, it is not necessary to select a specific representative species for these AEs. The selection of ROCs included all AEs that focus on upper trophic-level groups.

The first step in the ROC selection process was to develop a list of species that have been observed on-site and are common visitors. Avian and mammalian species that have been observed at the SLO Tank Farm site are summarized in Appendix B. For each AE where special-status species were identified as inhabiting or potentially inhabiting the site, both standard and special-status ROCs were selected. In

general, ROCs were selected for each AE from this subset of species based on one or more of the following criteria:

- Receptor observed breeding on-site – Species breeding on-site are likely to experience greater exposure and have life history stages (young) that may be more sensitive to site-associated contaminants.
- Receptor has feeding strategy likely to maximize exposure to site-associated contaminants and has diet preferences that are representative of the guild in question.
- Receptor has a small relative body size – Smaller species have larger chemical absorbing surfaces per unit volume than larger species (Suter, 1993).
- Receptor has a small relative home range – Animals with smaller home ranges are likely to spend more time foraging on the site than animals with larger home ranges.
- Receptor-specific life history data (exposure parameters) are readily available.

The overall rationale for the selection of each terrestrial and wetland ROC is described below. Full details of the selection process are included in Appendix F.

Terrestrial Assessment Endpoints

AE: T3. Survival, growth, and reproduction of herbivorous bird populations

Of the terrestrial herbivorous bird species observed breeding on-site, the song sparrow was selected as the ROC because it is a ground feeder and has a small relative body size, and exposure parameters are readily available. No special-status terrestrial herbivorous birds were identified as inhabiting or potentially inhabiting the site.

AE: T4. Survival, growth, and reproduction of herbivorous mammal populations

Of the terrestrial herbivorous mammals observed breeding on-site, the California vole was selected as the ROC because it has the smallest relative body size and home range. No special-status terrestrial herbivorous mammals were identified inhabiting or potentially inhabiting the site.

AE: T5. Survival, growth, and reproduction of insectivorous bird populations

Two special-status terrestrial insectivorous birds have been observed on-site: California horned lark and loggerhead shrike. Neither of these birds has been observed breeding on-site, and they have similar body sizes and feeding strategies. Because life history data are readily available for only the loggerhead shrike, it was selected as the special-status ROC. Of the non-special-status species observed breeding on-site, the western meadowlark was selected as the ROC for this AE. Although the western meadowlark has a relatively larger body size than other terrestrial insectivorous birds, it was selected as the ROC because it forages from the ground (and therefore is likely to have greater exposure to site-related contaminants than birds that catch their prey in the air), and life history data are readily available.

AE: T6. Survival, growth, and reproduction of insectivorous mammal populations

The only terrestrial insectivorous mammal species observed on-site are bats. However, because bats generally catch their prey on the fly, they are not likely to experience significant exposure to site-related

contaminants. Ground-feeding insectivorous mammals that are likely to inhabit the site include the ornate shrew and broad-footed mole. The ornate shrew was selected as the ROC for terrestrial insectivorous mammals because it has a small relative body size and home range. No special-status terrestrial insectivorous mammals have been identified inhabiting or potentially inhabiting the site.

AE: T7. Survival, growth, and reproduction of carnivorous bird populations

No carnivorous birds have been observed breeding on-site. Five special-status terrestrial carnivorous birds have been observed on-site: Cooper's hawk, sharp-shinned hawk, white-tailed hawk, golden eagle, and northern harrier. The northern harrier was selected as the special-status terrestrial carnivorous bird ROC because it has among the smallest relative body size, and exposure parameters are available. Of the non special-status terrestrial carnivorous birds, the American kestrel was selected as the ROC because it has a relatively small body size, and exposure parameters are readily available.

AE: T8. Survival, growth, and reproduction of carnivorous mammal populations

The only carnivorous mammals observed on the site are the striped skunk and coyote. Neither has been observed breeding on-site. While the skunk has a smaller relative body size and home range, its diet is not likely to include as great a proportion of higher trophic-level animals as the coyote. Because mammals whose diets are composed of non-vertebrate organisms are already assessed (AE: T4 and T6), the coyote, as the species with the greatest proportion of vertebrates in its diet, was selected as the ROC. No special-status terrestrial carnivorous mammals have been identified inhabiting or potentially inhabiting the site.

Wetland Assessment Endpoints

AE: W5. Survival, growth, and reproduction of herbivorous bird populations

The only wetland herbivorous birds identified breeding on-site are the mallard and the red-winged black bird. Although it has a larger relative body size than the red-winged black bird, the mallard likely spends more time feeding in the wetland habitat, and was selected as the ROC for herbivorous birds. No special-status wetland herbivorous birds have been identified inhabiting or potentially inhabiting the site.

AE: W6. Survival, growth, and reproduction of insectivorous birds populations

Insectivorous birds that probe the sediments are likely to have the greatest exposure to site-related contaminants due to the relatively high incidental sediment ingestion associated with this feeding strategy. Of the insectivorous birds identified breeding on-site, the killdeer is expected to have the highest rate of exposure based on body size and the potential for incidental sediment ingestion based on its feeding strategy. However, limited life history information is available for this species. Of the remaining sediment-probing birds observed breeding on-site, the western sandpiper was selected as the ROC, as it is expected to provide the most conservative estimate of exposure for this AE. No special-status wetland insectivorous birds have been identified inhabiting or potentially inhabiting the site.

AE: W7. Survival, growth, and reproduction of carnivorous bird populations

No wetland carnivorous birds have been observed breeding on-site. The only special-status species observed on-site are the double-crested cormorant and California gull. The cormorant was not selected as a special-status ROC because the wetland habitat at the site does not have water deep enough or does not

contain sufficient fish to provide quality foraging habitat for cormorant. Although the California gull has been observed in ruderal and aquatic areas of the site, it was not selected as a special-status ROC for wetland carnivorous birds because its feeds primarily on garbage and carrion and is, therefore, unlikely to have significant exposure to wetland-associated contaminants. Therefore, no special-status ROC was selected for this AE.

Of the non special-status wetland carnivorous birds observed on-site, the belted kingfisher has a relatively small body size, and exposure parameters are available. However, based on its feeding strategy, it is unlikely to forage significantly within the wetlands found on-site due to the lack of trees next to open water, and, therefore, was not proposed as the ROC for carnivorous birds. While the great blue heron has a larger body size than other wetland carnivorous birds, it was selected as the ROC for this AE because it is the only other carnivorous bird that is a standard risk assessment ROC for which life history data are readily available.

AE: W8. Survival, growth, and reproduction of omnivorous mammal populations

The raccoon is the only omnivorous mammal that has been identified inhabiting wetland areas on-site and, therefore, it was selected as the ROC for this AE. No special-status wetland omnivorous mammals have been identified inhabiting or potentially inhabiting the site.

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4. Exposure Assessment

The exposure assessment assesses the potential for exposure to chemical stressors (i.e., site-related COPECs) by evaluating the co-occurrence of the stressors and the ecological receptors (USEPA, 1998). Three media types were identified in the CSM (Section 3.3) for use in the pERA: soil, sediment, and surface water. The following bullets summarize how each data type is defined and used to develop exposure point concentrations (EPCs) for evaluation of the terrestrial and wetland AEs identified for the pERA:

- All on-site soil and sediment samples collected from depths less than or equal to 5 feet were used to assess exposure to terrestrial receptors (AEs: T1 – T8).
- All on-site soil and sediment samples collected from depths less than or equal to 0.5 feet that fall within the footprint of federal and state-delineated wetlands (Figure 1-3) were used to assess exposure to wetland receptors (AE: W1, AEs: W3-W8).
- All on-site soil and sediment samples collected from depths less than or equal to 10 feet and located within riparian habitat were used to assess exposure to riparian plants (AE: W1).
- All on-site surface water samples collected from all depths were used to assess exposure to aquatic receptors (AE: W2, W3, and W4).

Exposure Point Concentrations

Tier 1
- **Maximum detected concentrations in site media**
- **Modeled food web daily dose based on maximum concentration**

Tier 2
- **Scenario 1**
  - **95% UCLs in site media – whole site**
  - **Modeled food web daily dose based on 95% UCL media concentration – whole site**
- **Scenario 2**
  - **95% UCL in site soil – whole site, excluding former operations area**
  - **Modeled food web daily dose based on 95% UCL media concentration – whole site excluding former operations area**
- **Individual sample point assessment**

These soil horizons were selected based on the most likely depths that the identified ecological receptors might come into contact with. Specifically, the 0-5 foot range for terrestrial receptors covers the available soil data within the 0-6 foot range recommended by DTSC in the HERD Econote 1 (DTSC HERD 1998) for burrow dwelling animals. This range also approximates the anticipated root zone for grasses and shrubs on site based on the best professional judgment of biologists at the site and literature reports (e.g., http://www.fs.fed.us/database/feis/index.html). The 0-0.5 foot range identified for the wetland sediments was based on the best professional judgment of biologists as to the depth of sediment invertebrates at the site (Rincon Consultants 2003a), considering the ephemeral nature of many of the wetlands. The 0-10 foot range identified for the riparian zone was based on the best professional judgment regarding tree root depths at the site, depth to groundwater and literature reports (e.g., http://www.fs.fed.us/database/feis/index.html).

As discussed in Section 1.3, a number of areas of the site have been excluded from this risk evaluation. Specifically, data from Reservoirs 5 and 7 and all of the surface hydrocarbon expressions on-site (Figure 1-3) are not included in the data set used to estimate exposure. Risk to receptors in these areas is likely and as such these areas will be addressed separately by Unocal.

In addition to the exclusion of these areas, the former operations area of the site has been identified for likely commercial industrial reuse, and, therefore, the area would not provide viable ecological habitat in the future. For these reasons, the pERA includes two risk scenarios (Scenario 1 and Scenario 2) in the Tier 2 assessment. Scenario 1 includes data from the whole site in the development EPCs, and Scenario 2 includes all site data outside the former operations area. The following sections present the EPCs developed for Tier 1, Tier 2 – Scenario 1, and Tier 2 – Scenario 2.

4.1 Tier 1 Exposure Estimate

To ensure conservatism, the Tier 1 EPCs are based on the maximum detected concentration of each COPEC in each media, as defined above. To derive an exposure estimate for sum PAHs, the 16 individual priority pollutant PAHs were summed, using half the detection limit when a compound was not detected. The maximum detected concentrations and summary statistics for each COPEC in soil and sediment are presented in Tables 4-1 and 4-2. The maximum detected surface water concentration is presented in Table 6-4.

Food-chain exposures for the Tier 1 assessment were modeled using the maximum detected concentration in each media to estimate a daily dose to the identified receptors. The dose calculation model provides a conservative estimate of food-chain exposure using conservative parameters to estimate the uptake of contaminants via the ingestion of food items and the incidental ingestion of soil, sediment, or water.

4.1.1 Food-Chain Dose Model

The dose model follows the general equation:

$$\textbf{Dose} = \frac{SUF * IR_{food} \; [(C_{prey\,1} * Pd_{prey1}) + (C_{prey2} * Pd_{prey2}) + (C_{prey3} * Pd_{prey3}) + (Pd_{media} * C_{media})]}{BW} \qquad \textit{Equation 1}$$

where:

	Dose	= estimated daily dose of COPEC from ingestion ($mg/kg_{body\ weight}/day$)
	IR_{food}	= amount of food ingested per day (kg (dry weight) /day)
	BW	= body weight (kg)
	SUF	= site use factor (unitless)
	Pd_{prey}	= proportion of diet from prey[14] items (unitless)
	C_{prey}	= concentration of COPEC in prey items (mg/kg dry weight)
	Pd_{media}	= proportion of diet from soil, sediment, or water (unitless)
	C_{media}	= concentration of COPEC in media (i.e., EPC[15] in water [mg/L] or soil and sediment [mg/kg-dry weight])

[14] For the purposes of this example equation, prey is considered plant, invertebrate or vertebrate food items.
[15] EPC = exposure point concentration which is estimated as the 95% UCL on the arithmetic mean for a specified media.

All of these parameters except for C_{prey} and C_{media} for terrestrial and wetland wildlife receptors can be found in Tables 4-3 and 4-4 respectively. C_{media} can be found in Tables 4-1 and 4-2 (i.e., "Maximum detect" for Tier 1 EPCs and "EPC" for Tier 2 EPCs). C_{prey} is calculated by multiplying prey-, media- and COPEC-specific bioaccumulation factors by media EPCs (described above). For example:

$$C_{plant} = C_{soil} \times BAF_{soil\ to\ plant}$$ *Equation 2*

where: C_{plant} = modeled COPEC concentration in plant tissue

C_{soil} = COPEC EPC for site soil

$BAF_{soil\ to\ plant}$ = the bioaccumulation factor between soil and plants

Bioaccumulation factors for plants, invertebrates and vertebrates are presented in Table 4-5.

In general, exposure parameters for the selected receptors of concern (Section 3.4) were taken from the USEPA's *Wildlife Exposure Factors Handbook* (1993). Every effort was made to select ecologically relevant and conservative ingestion rates, body weights, and dietary compositions. To ensure conservatism, a site use factor (SUF) of 1 was assumed for each receptor. In other words, it was assumed that each receptor obtains 100% of its prey from the site. The selected exposure parameters for each receptor are summarized in Tables 4-3 and 4-4. The specific details of and rationale for the selected exposure parameters for each receptor are provided in Appendix F.

4.1.1.1 Bioaccumulation Factors

Site-specific prey (plant, terrestrial, and sediment invertebrates, or small mammal) tissue COPEC concentrations (C_{prey}) were not measured. Thus, it was necessary to model prey tissue concentrations using biota-soil and biota-sediment accumulation factors (BAFs). The most appropriate and conservative BAFs found in the available literature were selected for each prey item and are presented in Table 4-5. BAFs developed by Oakridge National Laboratory (ORNL) based on the 90th percentile of a large data set for terrestrial plants (Bechtel Jacobs, 1998a), terrestrial invertebrates (Sample et al., 1998a), and sediment invertebrates (Bechtel Jacobs, 1998b) were used preferentially over values from individual studies. Because BAFs can be highly variable, using a larger data set to more comprehensively capture this variability is appropriate for a screening-level assessment. ORNL small mammal BAFs were available for arsenic and lead (Sample et al., 1998b). The small mammal BAF for dioxin was used as a conservative surrogate for PAHs (Sample et al., 1998b). ORNL BAFs were available for plants and terrestrial and sediment invertebrates for arsenic and lead but were not available for PAHs. Because ORNL BAFs were not available for PAHs, specific BAFs were developed for plants, soil invertebrates and sediment invertebrates for this assessment as follows.

<u>Plants</u>

For PAHs in plants, the USEPA's K_{ow}-based model presented in the Ecological Soil Screening Level Guidance document (USEPA, 2003) was selected. The model takes the form:

$$BAF = 10^{(1.31 - 0.385 \times \log Kow)}$$ *Equation 3*

where: K_{ow} = compound-specific octonol-water partitioning coefficient;

F_{oc} = fraction organic carbon (assumed to be 1%)

The primary source of the K_{ow} values was the Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profile for polycyclic aromatic hydrocarbons (1995) (http://www.atsdr.cdc.gov/toxprofiles/tp69-c3.pdf). The K_{ow} values selected for each PAH are shown along with the modeled BAFs in Table 4-5.

Soil Invertebrates

For soil invertebrate PAH BAFs, available peer-reviewed literature was considered, and one study conducted by Van Brummelen et al. (1996) was selected as the basis for the soil invertebrate BAF. This study was specifically designed to evaluate the uptake of PAHs in soil invertebrates and was conducted using field soils with four different invertebrate species. The overall 90th percentile value for all species and PAHs of 0.16 was selected as the BAF for all PAHs for terrestrial invertebrates in the pERA. Details of the rationale for selection of this value and the underlying data from the Van Brummelen et al. (1996) study are presented in Appendix G.

Sediment Invertebrates

A PAH BAF for sediment invertebrates was also derived by reviewing the available literature. A value of 2.3 was selected based on two papers that provided current research conducted specifically to evaluate uptake (Ingersoll et al., 2003; Schuler et al., 2003). Ingersoll et al. (2003) evaluated individual PAHs and total PAH, and the resulting organic-carbon-adjusted BAFs for steady state for both low and high K_{ow} PAHs was 2.3. This value is also supported by data reported in Schuler et al. (2003). Schuler et al. (2003) presented BAFs for *Lumbriculus variegatus*, and additionally presented BAFs for *Hyalella azteca*, and *Chironomus tentans* for PAHs [i.e., benzo(a)pyrene]. BAFs ranged from 0.65 for *Hyalella azteca*, to 4.29 for *Lumbriculus variegatus*, with a middle value of 1.91 for *Chironomus tentans*. The average of these values (to represent a mixed diet of a potential wildlife receptor) is 2.28, which approximates the 2.3 steady state PAH BAF value presented by Ingersoll et al. (2003). Details of the rationale for selection of this value and the underlying data assessment are presented in Appendix G.

4.2 Tier 2 Exposure Assessment

For both Scenario 1 and Scenario 2, the Tier 2 exposure assessment is based on a more realistic but conservative exposure estimate for each media, the 95% upper confidence limit on the mean (95% UCL). The 95% UCL in each media is the EPC for the direct contact AEs (AEs T1, T2, W1, W3, and W4). The EPCs for the wildlife AEs (i.e., food-chain exposures for AEs T3-T8 and W5 – W8) are modeled daily doses as described in Section 4.1.1, but based on the 95% UCL media (C_{media}) concentrations.

In calculating the 95% UCL, sample locations with multiple depth measurements were treated as independent samples. In order for the exposure estimate to represent the integrated exposure potential at the site, it must capture the true variability of the data set. Because there was no clear pattern of higher or lower constituent concentrations at shallow or deeper depths within the soil horizon evaluated, the exclusion of samples at depth or combining multiple depth samples from a single location into one data value may misrepresent the variability of the data at the site.

To calculate the 95% UCL, contaminant distributions (normal, lognormal, neither) were determined based only on detected concentrations. Detection limits were excluded from the normality testing because the inclusion of censored data (i.e., detection limits) can cause skewed results (D'Agostina and Stephens in Marcel Dekker, 1986). To ensure that this was a conservative approach, distribution test were also conducted using all data, including the non-detects. Using this method, the distributions for all COPECs

were neither normal nor log normal. Calculating the 95% UCL for non-parametric data using the bootstrap method (as described below), resulted in lower UCLs than those used in the pERA in all cases. Thus, the exclusion of censored data in the distribution testing for the pERA was a conservative approach.

Once the distribution was identified, the following methods were used to calculate 95% UCL concentrations (with non-detects included at half the detection limit):

- normally distributed – Student's-t method
- lognormally distributed – Land's (H-statistic) method
- neither/distribution unknown – Bootstrap method via USEPA's ProUCL program (USEPA, 2002a).

The 95% UCLs can be found in Tables 4-1 and 4-2 for the terrestrial and wetland exposure areas respectively.

4.2.1 Scenario 1

The direct contact EPCs for Scenario 1 are the 95% UCLs for each COPEC for the whole site, as described above. Scenario 1 includes an evaluation of both terrestrial (soil) and wetland (sediment) exposures. The food-chain exposures for Tier 2 – Scenario 1 are modeled as described in Section 4.1.1, with the concentration in site soil and sediment (C_{media}) being estimated by the 95% UCL of the data set for the whole site. When any COPEC/receptor pair indicates Level 1 risk based on the 95% UCL (i.e., 95% UCL exceeds low benchmark), an individual point analysis is conducted.

4.2.2 Scenario 2

As shown on Figure 1-2, only those COPECs that show Level 1 risk in Scenario 1 are evaluated in Scenario 2. In addition, because the former operations area does not include wetland samples, Scenario 2 is conducted for the terrestrial exposures only. The soil EPC is the 95% UCL of the data set, as described above, but excluding all data from the former operations area. The food-chain exposure estimates for both Scenario 1 and for Scenario 2 are the same, with only the media-specific exposure concentrations (C_{soil}) being revised to exclude the operations area for Scenario 2.

The exposure concentrations used in Scenario 1, Scenario 2, and the individual point analysis are presented in the risk summary (Section 6, Tables 6-6 through 6-9 and 6-11 through 6-14).

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5. Effects Assessment

The effects assessment identifies toxicological effects data (e.g., sediment quality guidelines, water quality criteria, and TRVs) that are used as benchmarks to compare to site COPEC exposure concentrations. For this assessment, both low and high benchmarks were identified from the peer-reviewed literature. In general, benchmarks were selected to be conservative estimators of potential toxic effects. In other words, benchmarks were selected to minimize the possibility of reaching a finding of *de minimus* risk when risk actually exists. The low values represent a toxicological threshold below which there is high confidence in a finding of *de minimus* risk. This value is typically based on a no adverse effect level (NOAEL) or a 10th percentile of low effects data for non-lethal endpoints. Concentrations that fall between the low and high benchmarks represent a level above which there is a possibility of some level of risk. The high value represents a value above which risk may be probable or further evaluation is needed. This value is typically based on a lowest observed adverse effects level (LOAEL) or a specified percentile (e.g., 25th or 50th) of low effects data.

Key Elements

Toxicity Thresholds

- **Low Benchmarks based on:**
  - **NOAEL**
  - **10 th percentile of LOAEL data**
- **High Benchmarks based on:**
  - **LOAEL**
  - **25th or 50th percentile of LOAEL data**
- **Benchmarks developed for:**
  - **soil invertebrates**
  - **sediment invertebrates**
  - **plants**
  - **terrestrial birds and mammals**
  - **wetland birds and mammals**

In Tier 1, low benchmarks are used as an initial screen. For the Tier 2 assessment, both low and high benchmarks are used to help put any identified risk into context. This effects assessment identifies low and high benchmarks for plants (AE: T1 and W1), soil invertebrates (AE: T2), aquatic invertebrates and amphibians (AE: W2), sediment invertebrates (AEs: W3 and W4), birds (AEs: T3, T5, T7, W5, and W7), and mammals (AEs: T4, T6, T8, and W8). The development of each of these benchmarks is summarized below, and details of benchmark development are provided in Appendix G.

5.1 Terrestrial Plants (AE: T1)

Benchmarks were developed for arsenic, lead, PAHs, and TPH and are discussed below.

5.1.1 Arsenic and Lead

For arsenic and lead, values recommended by ORNL in the document entitled *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision* (Efroymson et al, 1997a) were utilized. Benchmarks recommended by ORNL were developed by rank-ordering lowest observed effect concentration (LOEC) values and choosing a number that approximated the 10th percentile. These recommended values were utilized as the low benchmarks. High benchmarks were developed by using the ORNL data set and choosing a number that approximated the 50th percentile, as the data allowed. This approach is consistent with the approach used by Long and Morgan

(1991) to develop the sediment benchmarks used by the National Oceanic & Atmospheric Administration (NOAA)[16]. Table 5-1 summarizes the benchmarks selected and their respective sources.

5.1.2 PAHs

For PAHs, plant benchmarks were available for benzo(a)pyrene and naphthalene based on the Canadian Council Ministries of the Environment (CCME) soil screening documents (CCME 1999 e and f). Because phytotoxicity benchmarks were available for only three of the individual PAHs[17], it was necessary to assign surrogate screening criteria to other detected PAHs. Surrogate benchmarks for specific PAHs were identified by dividing the PAHs into low and high molecular weight compounds. The low and high phytotoxicity screening values for naphthalene are used as a surrogate for all low molecular weight compounds (shown in italics in Table 5-1) because values for naphthalene were the more conservative of the available values. The low and high values for benzo(a)pyrene are used as surrogate values for high molecular weight compounds because this is the only high molecular weight compound for which screening values were available.

5.1.3 TPH

Readily available plant benchmarks were not available for TPH. To develop an appropriate TPH benchmark for the Unocal SLO Tank Farm site, a thorough literature review was conducted to locate toxicity studies with petroleum mixtures that may be representative of the mixture found at the site. This review included any studies conducted with fresh or weathered crude oil and terrestrial plants or invertebrates. Three primary studies evaluating the toxicity of hydrocarbon mixtures to soil invertebrates and plants have been identified as potentially useful in developing TPH benchmarks for the site. These studies are:

1) CCME: Study conducted by Canadian Council of Ministers of the Environment evaluating the toxicity of carbon fractions and whole federated crude oil to terrestrial plants and invertebrates (CCME, 2000).
2) Saterbak/Wong: Study that evaluated the toxicity of six different soils contaminated with different weathered crude oils (Saterbak et al., 1999) and (Wong et al., 1999).
3) Salanitro/Dorn: Study that evaluated the toxicity of two different soils contaminated with three different artificially weathered crude oils (Salanitro et al., 1997), and (Dorn and Salanitro, 2000).

Based on review of these studies, a low screening benchmark of 782 parts per million (ppm) for terrestrial plants was selected. This value is the 10th percentile of the observed 20% effect concentration (EC 20) values presented in the CCME document for plants. The high benchmark selected is 4,598 ppm. This value is the 10th percentile of the 50% effect concentration (EC 50) values presented in the CCME (2000) document. More detail of the data reviewed and the benchmark selection process is provided in Appendix G.

[16] The approach used herein is more conservative than that of Long and Morgan (1991) because only low effects data were considered in the data set whereas, Long and Morgan included all effects data, including lethal concentration (LC) data.

[17] Value is for plants only and the data set (Efroymson et al., 1997a) was not adequate to develop a high benchmark for acenaphthene using the 50th percentile approach. High benchmark selected is a surrogate.

5.2 Soil Invertebrates (AE: T2)

Benchmarks were developed for arsenic, lead, PAHs, and TPH and are discussed below.

5.2.1 Arsenic and Lead

For arsenic and lead, values recommended by the ORNL in the documents entitled *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision* (Efroymson et al., 1997b) were utilized. As with the plant values, benchmarks recommended by the ORNL were developed by rank-ordering LOEC values and choosing a number that approximated the 10th percentile. The recommended value was used as the low benchmark. The high benchmark was developed by using the ORNL data set and choosing a number that approximated the 50th percentile, as the data allowed. This approach is consistent with the approach used by Long and Morgan (1991) to develop the sediment benchmarks used by NOAA. Table 5-1 summarizes the benchmarks selected and their respective sources.

5.2.2 PAHs

Terrestrial invertebrate PAH benchmarks are based on studies conducted by Sverdrup et al. (2001 and 2002). It was not necessary to assign surrogate invertebrate benchmarks because screening criteria were available for most PAHs (Table 5-1).

5.2.3 TPH

Readily available soil invertebrate benchmarks were not available for TPH. See Section 5.1.3 regarding terrestrial plants for literature reviewed in the development of soil invertebrate TPH benchmarks. Based on review of these studies, a low screening benchmark of 842 ppm was selected. This value is the 10th percentile of the observed 20% effect concentration (EC 20) values presented in the CCME document for invertebrates. The selected high benchmark is 1,163. This value is the 10th percentile of the 50% effect concentration (EC 50) values presented in the CCME document. Selection of the 10th percentile of 20% and 50% effect concentrations is consistent with the approach used by Long and Morgan (1990) to develop sediment effect-range low and effect-range median values and by Efroymson et al 1997 to develop plant and invertebrate benchmarks for COPEC screening. Additional detail of the data reviewed and the benchmark selection process is provided in Appendix G.

5.3 Aquatic Invertebrates and Amphibians (AE: W2)

Low benchmarks for aquatic life are chronic freshwater federal AWQC (USEPA, 2002b), when available (arsenic, nickel and zinc). Secondary chronic values (SCVs) developed by Suter and Tsao (1996) were used as the low benchmark when AWQC were not available (barium, thallium, vanadium, and toluene). Based on recent surface water sampling data, only barium and thallium exceeded the low benchmark and required the development of a high benchmark. The Suter and Tsao (1996) secondary acute value (SAV) was used as the high benchmark. Table 5-2 summarizes the water screening criteria.

5.4 Sediment Invertebrates (AE: W3 and W4)

This section provides the rationale for selection of direct toxicity benchmarks for sediment invertebrates for arsenic, lead , PAHs, and TPH.

5.4.1 Arsenic and lead

For arsenic and lead sediment invertebrate benchmarks, Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) developed for freshwater sediments by MacDonald et al. (2000) were used for the low and high benchmark values, respectively. These values are based on a large data set, are widely used as preliminary screening values in freshwater sediments and are generally thought to provide an appropriately conservative screen.

5.4.2 PAHs

For most PAHs, Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) from MacDonald et al. (2000) for freshwater sediments were used for the low and high benchmark values, as discussed above. Other sources of the low and high benchmarks used in this assessment included values developed by ORNL for screening COPECs for effects on sediment-associated biota (Jones et al., 1997) and Upper Effect Threshold (UET) values provided in the NOAA screening quick reference tables (Buchman, 1999). Table 5-1 summarizes the benchmarks selected and their respective sources.

5.4.3 TPH

A sediment benchmark for TPH is not currently available. A search was conducted of scientific literature databases such as Toxline and Medline. In addition, a bibliography of petroleum-related literature citations from the U.S. Geological Service (USGS) was reviewed (Albers, 1998). Adequate data were not available to develop a TPH sediment benchmark for the site. The petroleum constituents at the site are addressed using the soil invertebrate screening values and by evaluating individual and total PAHs in sediment. Further discussion is included in Section 7, Uncertainty Analysis.

5.5 Wildlife TRVs for Birds and Mammals

A key component of a wildlife risk assessment is the identification of appropriate TRVs. A TRV is an exposure level for a receptor class that is not considered to pose unacceptable risk of deleterious effects. TRVs may be developed for different routes of exposure such as oral, inhalation, and dermal. They may be obtained from appropriate regulatory criteria or be developed using either exposure dose (expressed as milligrams per kilogram of body weight per day [mg/kg-BW/day] for oral intake), concentration in food, water, or air (expressed as mg/kg, mg/L, and milligram per cubic meter [mg/m^3], respectively), or body burden. This assessment focuses on food-chain exposure and incidental ingestion of soil, sediment, or water. Therefore, TRVs were selected from studies that were based on oral ingestion of COPECs.

TRVs developed by the USEPA's Region 9 Biological Technical Assistance Group (BTAG) (EFA West, 1998) were selected when available for the pERA. These values are based on a review and interpretation of the body of the available literature for each COPEC. Thus, values selected by the BTAG are

considered protective of a wide range of avian species. When BTAG TRVs were not available, NOAEL and LOAEL values were selected from the open literature, or an appropriate surrogate TRV was selected.

5.5.1 Metals

Low and high TRVs for both avian and mammalian receptors developed by the USEPA's BTAG were selected for use in the pERA. The BTAG values were developed by considering the available literature and selecting a value that is likely to be protective of a variety of avian and mammalian species.

5.5.2 PAHs

An avian TRV for naphthalene was identified based on a study conducted by Wildlife International Ltd. (1985). The TRVs for all other individual PAHs were selected from a study found in the open literature (Patton and Dieter, 1980). This study, entitled *Effects of Petroleum Hydrocarbons on Hepatic Function in the Duck,* evaluated the effect of PAH mixtures on hepatic function in mallard duck liver using Louisiana crude oil. No effects were observed for the 400-mg/kg treatment group. Therefore, 400 mg/kg (in feed) was the chronic NOAEL. This value was converted to a daily dose by multiplying by the mallard ingestion rate (in kg food per kg body weight per day), resulting in a NOAEL-based TRV of 32.5 mg/kg BW-day. Because this TRV is based on a non-specific hydrocarbon mixture as a surrogate for all individual PAHs, an uncertainty factor of 10 is applied to this value for screening threatened or endangered birds identified as AEs.

Mammalian TRVs were identified in the literature for several of the individual PAHs. The TRVs and their respective references are provided in Table 5-3. TRVs were not available for the majority of the high molecular weight PAHs. The TRV for benzo(a)pyrene is used as a surrogate for these compounds. The TRV identified for fluorene is used as a surrogate for phenanthrene.

5.5.3 TPH

Because of the variable composition of TPH, it is not possible to track this compound through the food chain. However, it is possible to evaluate the potential risk from incidental ingestion of TPH adhered to soil to the identified receptors.

The avian TPH TRV is based on the most appropriate study identified from the available literature. This study evaluated the effects of weathered EXXON Valdez crude oil on mallards (Stubblefield et al., 1995). A value of 218 mg/kg/day (2000 mg/kg in diet) was selected as the low avian TRV. This value is based on the NOAEL for endpoints including body weight, food consumption, egg production, eggs set, number of fertile eggs, number of viable eggs, hatch success, chick survival, egg shell thickness, organ weights, and blood chemistry. The high avian TRV of 2,180 mg/kg/day was selected based on the high dose from this study of 20,000 mg/kg in diet. At this dose, there were no effects on any of the reproductive parameters measured; however, shell thickness was slightly reduced, making this a LOAEL.

The low mammalian TPH TRV of 197 mg/kg/day was selected based on a study conducted by administering a dietary dose of weathered Prudhoe Bay crude oil to farm-raised mink over a period of 4 months (Beckett et al., 2002). The selected value is the NOAEL for body weight, organ weight, and

histopathology. While this is not a reproductive study, which is typically preferred in TRV development, the results of other studies conducted with mammalian species revealed that the selected NOAEL is one of the most conservative values. The high mammalian TPH TRV of 890 mg/kg/day was selected from a reproductive study conducted by Kahn et al. (1987) with rats and fresh Prudhoe Bay crude oil. This value represents an unbounded LOAEL, but, when considered in the context of the other LOAEL and NOAEL values found in the literature, it represents a reasonable estimate of a low effects level.

Specific details of the full literature review and the rationale for selection of the avian and mammalian TPH TRVs are provided in Appendix G.

6. Risk Characterization

The risk characterization integrates the results of the exposure and effects assessments to characterize risk to the receptors and the AEs identified in problem formulation. Specifically, information obtained during the exposure and effects assessment is combined to evaluate the relationship between environmental concentrations of chemical stressors and any observed or predicted adverse biological effects. The measurement endpoints used in this assessment to evaluate potential risk through direct exposure and food-chain exposure utilize an HQ approach. For direct exposure, the HQ represents the ratio of estimated exposure to a media-based toxicity benchmark. For food-chain assessment, the HQ represents the ratio of an estimated daily dose to a wildlife TRV.

Key Elements

Tier 1

- **HQs = site-wide maximum detected media COPEC concentrations/low toxicity benchmarks.**

Tier 2

- **Scenario 1 – HQs = site-wide 95% UCL media COPEC concentrations/low and high toxicity benchmarks.**
- **Scenario 2 – HQs = 95% UCL media COPEC concentrations for site excluding former operations area/low and high toxicity benchmarks.**
- **Spatial Evaluation of Risk – Individual sample point concentrations/low and high toxicity benchmarks.**

It should be noted that an HQ greater than 1 does not necessarily indicate risk. As described in the *Assessment and Remediation of Contaminated Sediments (ARCS) Program Risk Assessment and Modeling Overview*, "…hazard quotients must be interpreted relative to the assumptions on which the assessment is based, the AEs, and the degree of confidence in the relationship between the AEs and the measurement endpoint used in the hazard quotient" (Great Lakes National Program Office, 1993).

Proper interpretation of hazard quotients is critical to the risk assessment process, as well as to risk management decision making. Consistent with a screening level assessment, the pERA, HQs are interpreted as follows:

- When the HQ is less than 1 for the low benchmark comparison (i.e., NOAEL HQ <1), there is high confidence in a finding of *de minimus* risk.
- When the HQ is greater than 1 for the low benchmark comparison but less than 1 for the high benchmark comparison, risk is categorized as Level 1. Within this category the exact threshold of risk is unknown and to ensure conservatism, risk is considered possible.
- When the HQ is greater than 1 for the high benchmark comparison, risk is categorized as Level 2. Within this category, risks may be probable and/or further evaluation may be required.

In a screening-level assessment such as this pERA, the interpretation of results in the context of uncertainties and conservatism of the analysis (i.e., the exposure and effects assessment) is the final step. In this assessment, when the available exposure and effects information was uncertain, conservative assumptions were made to ensure that risks were not underestimated. Consideration of this conservatism is important in understanding risk findings as categorized above. For example, a Level 2 risk based on a benchmark that was selected in a highly conservative fashion to mitigate underlying uncertainties, may be interpreted as less critical than a Level 2 risk identified for a compound for which the benchmark is more certain. These factors should be considered along with the magnitude of the HQs, the spatial distribution of the exceedances, and the presence/absence of special-status species. Based on these results, risk

managers may decide that the pERA provides sufficient information for making risk management decisions or that further evaluation is warranted (e.g., a Validation Study).

This section includes risk characterization for Tier 1, Tier 2- Scenario 1, and Tier 2-Scenario 2 as described in Section 1.3.

6.1 Tier 1 Risk Characterization

The Tier 1 assessment was conducted specifically to determine whether COPECs are present in each media (i.e., soil, sediment, or surface water) at concentrations that could potentially pose risk to ecological receptors at the site. This assessment determined which COPECs in each medium require further evaluation in Tier 2 of the pERA. To conduct this analysis, COPECs were identified and conservative EPCs (e.g. maximum detected concentrations or modeled daily doses based on maximum detected concentrations) for each COPEC and AE were compared to highly conservative effect levels (i.e., NOAEL-based toxicity benchmarks) to calculate HQs. The Tier 1 analysis was designed to ensure that no COPECs that could potentially pose risk were eliminated at this stage. The following sections present the results of the Tier 1 assessment for terrestrial and wetland AEs, and the results are summarized in Tables 6-1 through 6-4. Table 6-5 summarizes each COPEC and receptor that is carried forward to Tier 2 of this assessment.

Tier 1 Results

Terrestrial

- **Arsenic and Lead**
  - **Potential risk to plants, invertebrates, and wildlife**
- **PAHs**
  - **Potential risk to plants**
  - ***De minimus* risk to invertebrates and wildlife**
- **TPH**
  - **Potential risk to plants, invertebrates, and wildlife**

Wetland

- ***De minimus* risk to aquatic invertebrates or amphibians and to riparian plants**
- **Arsenic and Lead**
  - **Potential risk to plants, sediment invertebrates, and wildlife**
- **PAHs**
  - **Potential risk to plants and sediment invertebrates**
  - ***De minimus* risk to wildlife**
- **TPH**
  - **Potential risk to plants, sediment invertebrates, and wildlife**

6.1.1 Tier 1 Terrestrial Risk Characterization

All eight of the identified terrestrial AEs were evaluated based on maximum detected COPEC concentrations in soil (0-5 feet). Arsenic and lead HQs are greater than 1 for plants (AE: T1), invertebrates (AE: T2), and terrestrial wildlife receptors (AEs T3 – T8) and were carried forward for further evaluation in Tier 2.

The PAH HQs for 10 of the 16 measured PAHs for terrestrial plants (AE: T1) are greater than 1, and were evaluated further in Tier 2 for potential plant toxicity. All PAH HQs for terrestrial invertebrates (AE: T2) and wildlife (AE: T3 – T8) are less than 1. In addition, an evaluation of cumulative risk from PAHs conducted by summing the individual PAH HQs for wildlife receptors indicated no risk. Thus, PAHs were not be evaluated further in Tier 2 for these receptors.

TPH HQs are greater than 1 for plants (AE: T1), invertebrates (AE: T2), and most of the terrestrial wildlife receptors (AEs: T3, T4, T5, T6 and T8). Thus, TPH was carried forward for further evaluation in Tier 2 for potential risk to these receptors.

6.1.2 Tier 1 Wetland Risk Characterization

Seven of the eight AEs identified for the wetland environment at the site were evaluated based on the maximum detected concentration of each COPEC in wetland sediments (0-0.5 feet). Plants (AE: W1) were also evaluated based on the maximum detected COPEC concentrations in sediment in the riparian areas of the site (0-10 feet). Survival and reproduction of aquatic invertebrate and amphibian populations (AE: W2), were evaluated based on maximum detected concentrations of each COPEC in site surface water. In addition, because fairy shrimp (AE: W3) have two distinct life stages, this species warrants protection based on both water column and sediment exposures. The following paragraphs present the results of the AEs based on the specified exposure media.

Wetland Sediment

Arsenic HQs are greater than 1 for plants (AE: W1), sediment invertebrates (AE: W3 and W4), and two wildlife receptors (western sandpiper [AE: W6] and raccoon [AE: W8]). Lead HQs are greater than 1 for plants (AE: W1), sediment invertebrates (AE: W3 and W4), and all wildlife receptors (AEs: W5 – W8). These metals were evaluated further for these receptors in Tier 2.

HQs for eight of 16 PAHs for plants (AE: W1) and HQs for 11 of the 16 PAHs for sediment invertebrates (AE: W3 and W4) are greater than 1. These PAHs were evaluated further in Tier 2 for potential risk to sediment invertebrates and wetland plants. As with the terrestrial evaluation, individual HQs for PAHs for wildlife (AEs: W5 – W8) did not exceed 1, nor did the sum of all individual PAH HQs. Thus, PAHs were not evaluated further for these receptors.

HQs for TPH for plants and sediment invertebrates are greater than 1, as is the HQ for one of the wildlife receptors (the western sandpiper [AE: W6]). TPH was evaluated in Tier 2 for potential risk to these receptors.

Riparian Sediment

HQs for all COPECs for plants in the riparian area are less than 1. Thus, riparian plants were not carried forward for further assessment in Tier 2 (Table 6-3).

Surface Water

As shown on Table 6-4, HQs for all metals except barium and thallium are less than 1 for aquatic invertebrates and amphibians (AE: W2). The barium HQ is greater than 1 in all 10 locations and the thallium HQ is slightly greater than 1 (1.08) in two locations. While both barium and thallium concentrations in surface water exceed benchmarks, because ambient concentrations of metals in surface waters at the SLO Tank Farm site are not characterized it is not clear whether the detected concentrations are representative of ambient conditions. As discussed with the ERWG, the likely mechanism for surface water contamination at the site is through leaching from contaminated surface soils. However, barium concentrations in site surface soils do not exceed background concentrations, and thallium was never detected in site soils. Therefore, it was agreed to by the ERWG that barium and thallium not be carried forward as a COPEC in Tier 2.

Toluene HQs are less than 1 for aquatic invertebrates and amphibians and were not carried forward for further evaluation. Additionally PAHs and TPH were not identified as surface water COPECs and were not evaluated in Tier 1 because the TPH detected in surface water does not appear to be related to known sources of petroleum at the site (Section 3.2.3).

In summary, the aquatic invertebrate and amphibian AE was not carried forward for Tier 2 evaluation. The uncertainties associated with eliminating barium, thallium, and TPH as risk drivers in surface water are discussed further in the uncertainty analysis (Section 7.5.1).

6.2 Tier 2 Risk Characterization

The Tier 2 risk characterization used a refined exposure estimate (i.e., the 95% UCL) and compared this value to both a low and a high toxicity benchmark for each receptor to calculate a HQ. As discussed in Section 1.3 and shown on Figure 1-2, the Tier 2 assessment included two scenarios. Scenario 1 evaluated both terrestrial and wetland AEs using data from the whole site. When Scenario 1 risks were categorized as Level 1 (HQ for whole site > low benchmark), a spatial evaluation (i.e., individual point analysis) was conducted for the COPEC/receptor pair[18].

The results of the terrestrial and wetland assessments for each AE for Tier 2, Scenario 1 and for the individual point analyses are summarized in Sections 6.2.1 and 6.2.2 respectively. The results of the Tier 2, Scenario 2 assessment for the terrestrial endpoints are discussed in Section 6.2.3.

6.2.1 Tier 2 Evaluation of Terrestrial Assessment Endpoints – Scenario 1

The results of the Scenario 1 risk evaluation for the eight AEs identified for the terrestrial environment at the site are summarized below and are presented in Table 6-6. Blank gray cells in the table indicate COPEC/receptor pairs that were not carried forward from Tier 1. Cells with no color or shading indicate Tier 2 HQs that are less than 1. Shaded cells indicate HQs are greater than 1. Only the COPEC/receptors with Tier 2 HQs greater than 1 (shaded cells) were evaluated spatially. The spatial evaluation for each AE is also discussed below, and the individual point analyses for each COPEC are presented by AE in Tables 6-7 (arsenic), 6-8 (lead), and 6-9 (TPH). These tables show blank gray cells for those receptors for which *de minimus* risk is indicated in Table 6-6 based on the low benchmark. Cells with no color or shading indicate HQs less than 1, and shaded cells indicate HQs greater than 1.

Figures 6-1 through 6-7b show the spatial evaluation for each AE. On these figures, each sample location is represented by a circle, and each quadrant represents a specific COPEC (i.e., upper right = lead, upper left = arsenic, lower right = PAHs, and lower left = TPH). The colors and shading in each of the four quadrants of the circle represent a particular result for a given COPEC as described in the figure legend. For the purposes of these figures, risk results were defined according to eight

Tier 2
Results of Terrestrial Assessment

AE: T1 (plants)
- ***De minimus* risk from PAHs**
- **Risk from arsenic and lead - Level 1**
- **Risk from TPH – Level 2**

AE: T2 (soil invertebrates)
- ***De minimus* risk from arsenic, lead, and PAHs**
- **Risk from TPH - Level 2**

AE: T3 (song sparrow) and T5 (Western meadowlark and loggerhead shrike)
- ***De minimus* risk from arsenic and PAHs**
- **Risk from TPH - Level 1 (western meadowlark and song sparrow only; *de minimus* for shrike)**
- **Risk from lead - Level 2**

AE: T4 (California vole) and T6 (ornate shrew)
- ***De minimus* risk from PAHs and TPH**
- **Risk from arsenic and lead – Level 1**

AE: T7 (American kestrel and northern harrier)
- ***De minimus* risk from arsenic, PAHs and TPH**
- **Risk from lead – Level 1**

AE: T8 (coyote)
- ***De minimus* risk from all COPECs**

[18]Only sample concentrations exceeding background inflection points were considered.

categories and a unique color or shading pattern was assigned to each category.

Using the example below (Sample T-2 on Figure 6-1 for AE: T1 [terrestrial plants]), the maps can be interpreted as follows:

For any COPEC for which the Tier 2 HQ for the site-wide 95% UCL exposure estimate for the low benchmark is less than 1 (i.e., *de minimus* risk for the site), the circle quadrant is gray as shown for PAHs in the lower right quadrant. If an asterisk (*) is located in a gray quadrant, this indicates that the individual point concentration exceeds the low benchmark even though the 95% UCL for the site does not. This information can be used to evaluate the potential for hot spots in those cases where the COPEC has been eliminated for further evaluation. A hatched quadrant (e.g., for TPH in the lower left quadrant) indicates that the site-wide 95% UCL exposure estimate exceeded the low benchmark but the individual point does not (i.e., *de minimus* risk for the individual point). When the quadrant is blue (e.g., the blue quadrant for arsenic), the sample concentration is less than identified background concentrations. A pink quadrant, as shown in the upper right quadrant for lead, indicates that the HQ for the high benchmark is greater than 1 (i.e., Level 2 risk)[19]. In addition to the four categories and colors shown in this example, quadrants can also reflect 4 additional categories and colors: no color, indicating that the COPEC was not analyzed at that station; green, indicating that the HQ based on the low benchmark is greater than one but the HQ for the high benchmark is less than 1; orange, indicating that the HQ based on the high benchmark is greater than 5 but less than 10; or red, indicating that the HQ for the high benchmark is greater than 10. This description of the risk categories is an example only and each map contains a complete key defining the categories represented by each color. These figures also show the state- and federally delineated wetlands and the identified surface hydrocarbon expressions at the site. Table 6-10 presents a summary of the site-wide and individual point results for each AE for Scenario 1 and Scenario 2. Results for each AE are summarized below.

AE: T1. Survival, growth, and reproduction of terrestrial plant populations

This AE includes assessment of both general terrestrial plant species and of the special-status San Luis Obispo morning glory. The evaluations are both based on the comparison to the identified phytotoxicity benchmarks.

As shown on Table 6-6, the site-wide arsenic and lead HQs are slightly greater than 1 (1.5 and 1.4 respectively) for the low benchmark, but less than 1 for the high benchmark. All PAH HQs are less than 1 for the low and high benchmarks, and the TPH HQs are greater than 1 for both the low and high benchmarks. Based on this evaluation, arsenic, lead, and TPH were evaluated on an individual sample point basis (Tables 6-7, 6-8, and 6-9 respectively). Figure 6-1 shows the HQ results for each sample point for each COPEC, as well as the distribution of the special-status plants on-site. While three species are shown, the San Luis Obispo morning glory is the only terrestrial species. As shown on Figure 6-1, the majority of the site areas where San Luis Obispo morning glory was observed have not been sampled for

[19] When either of the top quadrants (i.e., for arsenic and lead) are green, pink, orange, red or hatched, this also indicates that concentrations at that sample location were greater than background.

COPECs. Moreover, the observed distribution represents only one point in time, with no historical or reference data to provide context for interpretation. Thus, no determinations of potential impacts can be made from the observed distribution.

Arsenic

Ninety percent of the arsenic concentrations are below the identified background concentration and are shown in blue in the upper left quadrants of the sample circle on Figure 6-1. Of the 10% of samples greater than background, the majority (10 of 12 samples) are located within the former operations area. These samples have HQs greater than 1 based on the low benchmark and less than 1 for the high benchmark for all but one sample. While no specific source of arsenic within the former operations area has been identified, the higher concentrations in this area (10 of 42 samples greater than background) indicate that the arsenic may be a result of historical site activities.

Of the two locations outside the former operations area (B-36 and S-50), one (B-36) has samples at three depths (0.5, 2.5, and 5 feet). The middle sample (2.5 feet) has an HQ greater than 1, while the shallower and deeper samples are below background, demonstrating the variability of arsenic concentrations in this area. Data were collected for S-50 at only one depth (0.5 feet). These two sample locations are within areas identified as seasonal wetlands but are not in close proximity and seem to be unrelated. Based on this evaluation, risk from arsenic found in the former operations area is categorized as Level 1 for terrestrial plants. Arsenic concentrations outside the former operations area are generally below background.

Lead

The majority of lead concentrations are below the identified background concentration and are shown in blue in the upper right quadrant of the circles in Figure 6-1. Approximately 15% (21 of 136) of site samples contain lead concentrations greater than background: 12 inside the former operations area and nine outside. The HQs for the low terrestrial plant benchmark are greater than 1 for all but two samples, while only three samples (T-10, T-8, and T-2) have HQs greater than 1 (and less than 5) for the high benchmark (i.e., Level 2 risk). No pattern within the former operations area is evident, but, based on the observed spatial distribution, most of the elevated lead concentrations outside the former operations area appear to be associated with former tank bottoms within the northwest portion of the property. In each case, at least one additional sample that did not contain lead concentrations above background was collected within the tank bottom, indicating that lead concentrations within these tank bottoms are variable. Level 1 lead risk to plants at the site appears to be limited to the former operations area and localized areas within former tank bottoms in the northwest portion of the site. As the SLO morning glory is a terrestrial species and would not be expected in seasonal wetland areas, lead found in the tank bottoms is not likely to pose risk to this special-status species.

TPH

For TPH, 28% (66 of 237) of samples have low benchmark HQs greater than 1, and 14% (33 of 237) have high benchmark HQs greater than 1. These sample locations are distributed across the site, and most appear to be near or associated with surface hydrocarbon expressions at the site. Those samples with HQs greater than 1 that are not associated with surface hydrocarbon expressions appear to coincide with areas above the subsurface petroleum plume. For example, samples B-30, B-31, and B-32 in Reservoir 4 in the northeast corner of the site are situated on top of the northeast plume. Sample coverage in this area is limited such that the spatial (horizontal and vertical) extent of TPH exceedances cannot be determined.

Samples B-3, B-12, and B-21 were sampled at 5 feet bgs and are situated along the narrow portion of the subsurface northwest plume (Figure 2-1). The spatial area surrounding these samples is well characterized, and the TPH exceedances appear to be limited to the narrow strip on top of the identified plume. Figure 6-1 shows the TPH HQ exceedances (bottom left quadrant of sample circles) and also shows the surface hydrocarbon expressions.

One site sample (S-59), located in the seasonally-ponded wetland in the southwest corner of the site has TPH HQs for the low and high benchmarks greater than 1 for plants but is not associated with any known petroleum source. Two sample depths (0.5 and 2.5 feet) were evaluated at this location, with the deeper sample having higher TPH concentrations by an order of magnitude. The HQ for the shallow sample is slightly greater than 1 (1.7) for the low benchmark and less than 1 for the high benchmark. All other samples collected within this wetland show *de minimus* risk.

AE: T2. Survival, growth, and reproduction of terrestrial invertebrate populations

This assessment evaluates general terrestrial invertebrates, and the special-status Morro shoulderband snail.

The Morro shoulderband snail was found in a number of areas on-site during the 2003 wet season protocol survey (report in progress). The Morro shoulderband snail inhabits moist areas that provided cover. This AE is evaluated based on the potential exposure via contact with shallow soil. Because the assessment of the snail is identical to the assessment for generic terrestrial invertebrates, in terms of the exposure concentrations and effects criteria used, they are discussed together here.

As shown on Table 6-6, the site-wide arsenic and lead HQs are less than 1 for low and high benchmarks. PAHs were not carried forward from Tier 1 (i.e., site maximum less than low benchmark). TPH HQs are greater than 1 for both the low and high benchmarks. Based on this evaluation, TPH was evaluated on an individual sample point basis (Table 6-9). Figure 6-2 shows the HQ results for each sample point for each COPEC.

For TPH, 28% (66 of 237) of samples have low benchmark HQs greater than 1, and 26% (62 of 237) have high benchmark HQs greater than 1. These sample locations are distributed across the site, with 23 within the former operations area and 43 outside. As with plants, most of the locations with HQs greater than 1 for invertebrates outside the operations appear to be near or associated with surface hydrocarbon expressions or the subsurface petroleum plumes on-site (with the exception of S-59). The spatial distribution of these exceedances is identical to those for plants for the low benchmark, is similar for the high benchmark, and is discussed above under AE: T1. Figure 6-2 shows the TPH HQs for invertebrates (bottom left quadrant of sample circles) and also shows the surface hydrocarbon expressions. As with plants, a number of samples had TPH HQs greater than 1 for both low and high invertebrate benchmarks, and these risks are categorized as Level 2 for soil invertebrates.

AE: T3. Survival, growth, and reproduction of herbivorous bird populations

The song sparrow was selected as the representative receptor and no special-status species were identified for this AE.

As shown in Table 6-6, the site-wide arsenic HQs based on the 95% UCL are less than 1 for the low and high benchmarks, and the HQs for lead are greater than 1. PAHs were not carried forward from Tier 1 (i.e., site maximum was less than low benchmark). The TPH HQ is greater than 1 for the low benchmark,

and less than 1 for the high benchmark. Based on this evaluation, lead and TPH were evaluated on an individual sample point basis (Tables 6-8 and 6-9). Figure 6-3 shows the HQ results for each sample point for each COPEC.

Lead

The majority of lead concentrations are below the identified background concentration and are shown in blue in the upper right quadrant of the circles in Figure 6-3. Of the 21 samples where lead concentrations are greater than background, all are greater than 1 for the low benchmark, and 18 of the 21 are greater than 1 for the high benchmark. The avian HQs for lead based on the low benchmark are all high, ranging from 531 to 12,865, with the site-wide 95% UCL HQ of 754. The high benchmark HQs are much lower, ranging from 1.3 to 21, with the site-wide 95% UCL HQ of 1.2. To put these values into the context of the naturally occurring background concentrations of lead, HQs for background were calculated. The low benchmark HQ for background is 391, and the high benchmark HQ is 0.6. Thus, background concentrations account for approximately half of the estimated risk based on the 95% UCL.

In spite of the fact that exposure to background concentrations indicates some level of risk from lead, given the number of exceedances of both the low and the high benchmarks, risk to birds from lead cannot be ruled out. As discussed above for AE: T1, the spatial distribution of elevated lead indicates that, while some site samples indicate Level 1 or Level 2 risk from lead, these risks are localized to small areas within the former operations area and in several tank bottoms in the northwest portion of the site.

TPH

For TPH, 10% (24 of 237) of samples have low benchmark HQs greater than 1, and less than 1% (2 of 237) high benchmark HQs greater than 1. These exceedances are predominantly outside the former operations area (23 of the 24). As discussed previously for AE: T1, the identified exceedances outside the operations appear to be near or associated with the plastic or pliable surface hydrocarbon expressions at the site or with subsurface plumes on-site. Samples in Trench 3 and S-43 are the two highest detected concentrations of TPH on-site and, thus, have the highest corresponding HQs (33 and 11, respectively, for the low benchmark). Trench 3 is located within an identified surface hydrocarbon expression near the western side of Reservoir 4. S-43 is located near the north end of the northwest marsh near an identified surface hydrocarbon expression. If it is assumed that these two sample locations will be considered along with the surface tar evaluation to be conducted separately from the pERA by UNOCAL, the remaining samples all have low benchmark HQs of less than 5 and high benchmark HQs of less than 1. Based the low frequency and magnitude of benchmark exceedances (i.e., HQs >1), TPH is not likely to pose significant risk to herbivorous bird populations.

AE: T4. Survival, growth, and reproduction of herbivorous mammal populations

The California vole was selected as the representative receptor, and no special-status species were identified for this AE.

As shown in Table 6-6, the site-wide arsenic and lead HQs are greater than 1 for the low benchmark and less than 1 for the high benchmark. PAHs were not carried forward from Tier 1 (i.e., site maximum was less than low benchmark). TPH HQs are less than 1 for the low and high benchmarks. Based on this evaluation, lead and arsenic were evaluated on an individual sample point basis (Tables 6-7 and 6-8). Figure 6-4 shows the HQ results for each sample point for each COPEC.

Arsenic

As discussed for AE: T1, the majority of the arsenic concentrations are below the identified background concentration and are shown in blue in the upper left quadrants of the sample circle on Figure 6-4. Of the 12 samples (10 within the former operations area) with arsenic concentrations above background, all have HQs greater than 1 for the low benchmark and greater than 1 for six of the 12 samples for the high benchmark. While no specific source of arsenic within the former operations area has been identified, the higher concentrations in this area indicate that the arsenic may be a result of historical site activities and may pose risk to herbivorous mammals within the former operations area.

Based on this evaluation, overall risks associated with arsenic concentrations within the former operations area are characterized as Level 1 for herbivorous mammals. However, as discussed previously, the majority of the samples collected within the former operations area indicate *de minimus* risk from arsenic (32 of 42 samples). Arsenic concentrations outside the former operations area are generally below background and indicate *de minimus* risk.

Lead

The majority of lead concentrations are below the identified background concentration and are shown in blue in the upper right quadrant of the circles in Figure 6-4. As discussed previously for AE: T1, there are 21 samples on-site where lead concentrations are greater than background: 12 inside the former operations area and nine outside. The HQs for theses 21 samples are all greater than 1 for the low benchmark (3.5 to 84), with the highest HQs being from samples within former tank bottoms. The high benchmark HQs were all less than 1. The spatial distribution of elevated lead is discussed above under AE: T1 and indicates that, while risk associated with some site samples may be categorized as Level 1 for lead, these risks are localized to small areas within the former operations area and in several tank bottoms in the northwest portion of the site.

AE: T5. Survival, growth, and reproduction of insectivorous bird populations

The western meadowlark was selected as the representative receptor for this AE. The loggerhead shrike was identified as a special-status species observed on-site and is also evaluated for this AE.

As shown in Table 6-6, the site-wide arsenic HQs are less than 1, and the HQs for lead are greater than 1 for both receptors. PAHs were not carried forward from Tier 1 (i.e., site maximum was less than low benchmark). TPH HQs are greater than 1 for the low benchmark and less than 1 for the high benchmark for the western meadowlark. Because the TPH food-chain evaluation is based on incidental soil ingestion only, and the loggerhead shrike does not have an incidental soil ingestion component to its diet, no risk was estimated to this receptor from TPH. Based on this evaluation, lead and TPH were evaluated on an individual sample point basis (Tables 6-8 and 6-9) for the western meadowlark, and lead was evaluated for the loggerhead shrike. Figure 6-5a and 6-5b show the HQ results for these two receptors, respectively.

Lead

As discussed for AE: T1, the majority of lead concentrations are below the identified background concentration and are shown in blue in the upper right quadrant of the circles in Figures 6-5a and 6-5b. HQs for the 21 samples that are greater than background are all greater than 1 for the low benchmark, and 20 of 21 are greater than 1 for the high benchmark for the western meadowlark. The HQs for the loggerhead shrike were greater than 1 for both the low and high benchmarks for all samples. As

discussed for AE: T3, background concentrations represent approximately half of the risk estimated for these receptors based on the site-wide 95% UCL exposure estimate. Individual point HQs based on the low benchmark range from 627 to 13,203, and HQs based on the high benchmark range from 1.6 to 21.

The spatial distribution of elevated lead is discussed above under AE: T1 and indicates that, while risk associated with some site samples is categorized as Level 1 from lead, these risks are localized to small areas within the former operations area and in several tank bottoms in the northwest portion of the site.

TPH

For TPH, 7% (16 of 237) of samples have low benchmark HQs greater than 1, and less than 1% (1of 237) have high benchmark HQs greater than 1 (Trench 3) for the western meadowlark. These exceedances are all outside the former operations area. Figure 6-5a shows the TPH HQs (bottom left quadrant of sample circles) for the western meadowlark and also shows the surface hydrocarbon expressions. The identified exceedances outside the operations appear to be near or associated with the plastic or pliable surface hydrocarbon expressions at the site or subsurface plumes on-site. As discussed for AE: T3, if it were assumed that the two highest detected TPH concentrations (Trench 3 and S-43) would be addressed separately with the other surface hydrocarbon expressions, the remaining HQs based on the low benchmark are all less than five and are less than 1 for the high benchmark. Based the low frequency and magnitude of benchmark exceedances (i.e., HQs >1), TPH is not likely to pose significant risk to insectivorous bird populations. Risk from TPH to the loggerhead shrike, the special-status species identified for this AE, is considered *de minimus.*

AE: T6. Survival, growth, and reproduction of insectivorous mammal populations

The ornate shrew was selected as the representative receptor, and no special-status species were identified for this AE.

As shown in Table 6-6, the site-wide arsenic and lead HQs are greater than 1 for the low benchmark and less than 1 for the high benchmark. PAHs were not carried forward from Tier 1 (i.e., site maximum was less than low benchmark). TPH HQs are less than 1 for the low and high benchmarks. Based on this evaluation, lead and arsenic were evaluated on an individual sample point basis (Tables 6-7 and 6-8). Figure 6-6 shows the HQ results for each sample point for each COPEC.

Arsenic

The majority of the arsenic concentrations are below the identified background concentration and are shown in blue in the upper left quadrants of the sample circle on Figure 6-6. Of the 12 samples with arsenic concentrations above background, all have HQs greater than 1 for the low benchmark, and four of the 12 samples have HQs greater than 1 for the high benchmark. While no specific source of arsenic within the former operations area has been identified, the higher concentrations in this area indicate that the arsenic may be a result of historical site activities. As discussed above under AE: T1, the two locations outside the operations area (B-36 and S-50) have low benchmark HQs greater than 1 and high benchmark HQs less than 1. These samples are within areas identified as seasonal wetlands but are not in close proximity to each other and seem to be unrelated. Based on this evaluation, arsenic found in the former operations area indicates Level 1 or Level 2 risk for insectivorous mammals, and arsenic outside the former operations area is generally within background.

Lead

The majority of lead concentrations are below the identified background concentration and are shown in blue in the upper right quadrant of the circles in Figure 6-6. As discussed previously for AE: T1, there are 21 samples on-site where lead concentrations are greater than background: 12 inside the former operations area and nine outside. The HQs for theses 21 samples are all greater than 1 for the low benchmark (15 to 364), with the highest HQs being from samples within former tank bottoms. The high benchmark HQs were greater than 1 for three of 21 locations, all within the former tank bottoms in the northwest portion of the site (T-2, T-8 and T-10). While risks associated with some site samples is categorized as Level 1 for lead, these risks are localized to small areas within the former operations area and in several tank bottoms in the northwest portion of the site.

AE: T7. Survival, growth, and reproduction of carnivorous bird populations

The American kestrel was selected as the representative receptor for this AE. The northern harrier was identified as a special-status species observed on-site and is also evaluated for this AE.

As shown in Table 6-6, the site-wide arsenic HQs are less than 1 for the American kestrel, and arsenic was not carried forward to Tier 2 for the northern harrier. Lead HQs are greater than 1 for the low benchmark and less than 1 for the high benchmark for both receptors. PAHs and TPH were not carried forward from Tier 1 (i.e., site maximum was less than low benchmark). Based on this evaluation, lead was evaluated on an individual sample point basis (Table 6-8). Figures 6-7a and 6-7b show the HQ results for each receptor.

Lead

As discussed previously, the majority of lead concentrations are below the identified background concentration and are shown in blue in the upper right quadrant of the circles in Figure 6-7a and 6-7b. Of the 21 samples with lead concentrations greater than background, all have HQs greater than 1 for the low benchmark for both receptors. The HQs for the high benchmarks are greater than 1 for 16 of 21 samples for the kestrel and for 4 of 21 for the harrier. As with the other avian receptors evaluated, the HQs based on the low benchmark are high and range from 114 to 8,634. The HQs based on the high benchmark range from 1.2 to 12. In spite of the uncertainties associated with the assessment (Section 7), given the number of exceedances of both the low and the high benchmarks, risk to birds from lead cannot be ruled out, although this analysis indicates that risk to carnivorous birds is lower than that for herbivorous or insectivorous species. This is a function of the differences in potential site-related exposure between the species.

The spatial distribution of elevated lead is discussed above under AE: T1 and indicates that, while risks associated with some site samples is categorized as Level 1 for lead, these risks are localized to small areas within the former operations area and in several tank bottoms in the northwest portion of the site.

AE: T8. Survival, growth, and reproduction of carnivorous mammal populations

The coyote was selected as the representative receptor, and no special-status species were identified for this AE.

As shown in Table 6-6, the site-wide HQs for arsenic, lead, and TPH are all less than 1 for the coyote. PAHs were not carried forward from Tier 1 (i.e., site maximum was less than low benchmark). Based on

this evaluation, no individual point analysis was conducted for the coyote, and risk for carnivorous mammals is considered *de minimus* risk.

6.2.2 Tier 2 Evaluation of Wetland Assessment Endpoints

AE: W2, protection of aquatic invertebrates and amphibians, was not carried forward to Tier 2, as all detected COPECs in site surface water were below the identified low benchmarks or were found to be associated with background soil concentrations. The results of the risk evaluation for the remaining seven AEs identified for the wetland environment at the site are summarized below. As with the terrestrial assessment, each AE was evaluated first using a site-wide EPC (95% UCL) compared to low and high benchmarks (Table 6-11). This EPC is based on all soil or sediment samples from 0 to 0.5 feet within the state- or federally delineated wetlands. Because arsenic was generally not detected above background within the wetland areas at the site, further risk evaluation was not warranted. Thus, the following discussion focuses on lead, PAHs, and TPH. When the site-wide EPC exceeded the low benchmark (i.e., Level 1 risk), an individual point analysis was conducted. Tables 6-12, 6-13, and 6-14 present the individual point analyses for lead, PAHs, and TPH respectively. Table 6-15 presents a summary of the site-wide and individual point results for each AE.

Tier 2
Results of Wetland Assessment

AE: W1 (plants)
- ***De minimus* risk from arsenic**
- **Risk from lead – Level 1**
- **Risk from PAHs and TPH – Level 2**

AE: W3 (sediment invertebrates) and W4 (fairy shrimp)
- ***De minimus* risk from arsenic**
- **Risk from lead, PAHs and TPH - Level 2**

AE: W5 (mallard), W7 (great blue heron), and W8 (raccoon)
- ***De minimus* risk from arsenic, PAHs and TPH**
- **Risk from lead – Level 1**

AE: W6 (western sandpiper)
- ***De minimus* risk from arsenic and PAHs**
- **Risk from lead and TPH – Level 2**

AE: W1. Survival and reproduction of wetland plant populations

This AE includes assessment of both general wetland plant species and of the special-status Congdon's tar plant. The evaluations are both based on comparison of site media concentrations to identified phytotoxicity benchmarks.

As shown in Table 6-11, the site-wide lead HQs are slightly greater than 1 for the low benchmark, but less than 1 for the high benchmark. Five individual PAH site-wide HQs are greater than 1 for the low benchmark, and two are greater than 1 for the high benchmark. TPH HQs are greater than 1 for both the low and high benchmarks. Based on this evaluation, lead, PAHs, and TPH were evaluated on an individual sample point basis (Tables 6-12, 6-13, and 6-14 respectively). Figure 6-8 shows the HQ results for each sample point for each COPEC, as well as the distribution of the special-status plants. Of the three species shown on the figure, the Congdon's tar plant and the Hoover's button celery are the wetland species that are considered for this AE. As shown on Figure 6-8, many of the sample locations with HQs greater than 1 occur near or within the distribution of the special-status Congdon's tar plant. While this suggests that COPEC concentrations are not adversely affecting survival of the tar plant community, impacts on other more subtle endpoints, such as growth, cannot be evaluated. The observed distribution represents only one point in time with no historical or reference data to provide context for interpretation. Thus, no conclusive determinations of potential impacts (or lack of impacts) can be made from the observed distribution.

Lead

The majority of lead concentrations are below the identified background concentration and are shown in blue in the upper right quadrant of the circles in Figure 6-8. There are five samples within the wetlands where lead concentrations are greater than background. All HQs for theses five samples are greater than 1 for the low benchmark and greater than 1 for two of five samples for the high benchmark. Risk associated with these two samples (T-10 and T-2) is categorized as Level 2 for terrestrial plants (AE: T1). While these HQs indicate Level 1 or Level 2 risk to plants from lead, the spatial area is limited to several small areas within the tank bottoms in the northwest portion of the site. While this limited area is not likely to affect plants on a population level, because this AE includes special status species, consideration of smaller spatial areas may be warranted. On this level, these areas of elevated lead may pose risk to special-status plants within the identified tank bottoms.

PAHs

The point-by-point analysis for PAHs demonstrated that, for all five PAHs with site-wide 95% UCL HQs greater than 1, only one sample (S-63) has an individual point HQ greater than 1 for any PAH. This sample is situated in an identified surface hydrocarbon expression. Because of the limited spatial extent of the PAH exceedance, PAHs are not likely to pose risk to the plants on a population or community level within the wetland areas of the site.

TPH

For TPH, 24% (7of 29) of samples have low benchmark HQs greater than 1, and 10% (3 of 29) have high benchmark HQs greater than 1 (S-63, B-23 and S-41). Sample S-63 contains the highest concentration of TPH within the site wetlands and is located within an identified surface hydrocarbon expression. B-23 and S-41 are located within the northwest marsh near identified surface hydrocarbon expressions, but their exact proximity to these expressions is not known. The HQs based on the low benchmark for the other four samples are low in magnitude (i.e., < 6) and are located on or near surface hydrocarbon expressions or are associated with the identified subsurface plumes. Sample S-59 is an exception and is discussed in detail under AE: T1. Based on the frequency and magnitude of the HQs greater than 1, risk to plant populations is unlikely, but possible risk to special-status plants from TPH in the wetland areas cannot be ruled out.

AE: W2. Survival, growth, and reproduction of aquatic invertebrate and amphibian populations

This AE was not carried forward to Tier 2.

AE: W3. Survival, growth, and reproduction of individual special-status fairy shrimp and
AE: W4. Survival, growth, and reproduction of sediment invertebrate populations

Fairy shrimp *(Branchinecta lynchi)* cysts were found in a number of areas on-site during the 2003 dry season protocol survey (Rincon, 2003b) (Figure 2-3). Fairy shrimp have two distinct life stages (adult within the water column and cyst/larvae within the sediment), and therefore warrant protection based on both water column and sediment exposures. However, as discussed in Section 6.1.2 above for AE: W2, COPEC concentrations in surface water are not carried forward for evaluation in Tier 2. Thus, this AE is evaluated based on the potential exposure of these cysts/shrimp via contact with sediment. Because this sediment assessment of AE: W3 is identical to the sediment assessment for AE: W4 in terms of the exposure concentrations and effects criteria used, they are discussed together here.

Site-wide lead HQs are greater than 1 for both the low and high benchmarks. HQs for PAHs carried forward from Tier 1 are greater than 1 based on the low benchmark and less than 1 for the high benchmark, with the exception that fluoranthene HQs are less than 1 for both low and high benchmarks, and benzo(a)pyrene, pyrene and sum PAH HQs are greater than 1 for both low and high benchmarks. TPH HQs are greater than 1 for both the low and the high benchmarks. Based on this evaluation, lead, PAHs, and TPH were evaluated on an individual point basis (Figure 6-9).

Lead

The same five sample locations that were identified as potentially posing risk to wetland plants (AE: W1) also indicate Level 1 or Level 2 risk to sediment invertebrates (i.e., HQs >1). See previous discussion for details of the spatial distribution of these HQs. In addition, cysts of the special status fairy shrimp were observed in each of these locations (Figure 6-9). While this limited area is not likely to affect sediment invertebrates on a population level, because this AE includes a special-status species, consideration of smaller spatial areas may be warranted. On this level, the potential for elevated lead to pose risk to fairy shrimp in these areas cannot be ruled out.

PAHs

Three sample locations (S-63, S-53, and S-41) have HQs greater than one for the PAHs carried forward from Tier 1 based on the low benchmarks. HQs for the low benchmark for S-53 and S-41 are low in magnitude (i.e., $\leq$ 2.5) and are less than 1 for the high benchmark. S-63 is the only sample location with HQs greater than 1 for the high benchmark. Figure 6-9 presents these exceedances using benzo(a)pyrene as a surrogate for PAHs because it is the most representative PAH (with the exception of the two compounds discussed below).

Benzo(b)fluoranthene and benzo(k)fluoranthene HQs for 10 and 9 sample locations, respectively, were greater than 1 for the low benchmark and all were less than 1 for the high benchmark. These exceedances appear to be an artifact of a benchmark that is an order of magnitude lower than any other PAH sediment benchmarks. These exceedances may not represent realistic estimates of risk and will be discussed further in the uncertainty analysis.

Based on the limited frequency and magnitude of PAH HQs greater than 1, PAHs would not likely pose risk to sediment invertebrate populations. However, risks to individual special-status fairy shrimp cannot be ruled out.

TPH

As with the wetland plant assessment, 24% (7 of 29) of samples have low benchmark HQs for TPH greater than 1 and 21% (6 of 29) have high benchmark HQs greater than 1. Figure 6-9 shows the TPH HQ exceedances (bottom left quadrant of sample circles) and also shows the surface hydrocarbon expressions. B-23 and S-41, located in the northwest marsh, appear to be near identified surface hydrocarbon expressions and show Level 2 risk (high benchmark HQ > 5) for TPH. Two other samples within the northwest marsh show *de minimus* risk (low benchmark HQ < 1), indicating the variability in TPH distribution even within proximal areas of the site. S-63 (Level 2 risk) and S-62 (Level 1 risk) are in the wetlands between Reservoirs 5 and 6 and are also on or near surface hydrocarbon expressions. S-53 (Level 1 risk) is in Tank 3 and is near identified surface hydrocarbon expressions. S-59 and S-58 (Level 1 risk) are in the southwest corner of the site and do not appear to be associated with any identified

petroleum source. Based on the benchmark exceedances, risk from TPH to sediment invertebrates and, in particular, to the special-status fairy shrimp, in these areas cannot be ruled out.

AE: W5. Survival, growth, and reproduction of herbivorous bird populations and
AE: W7. Survival, growth and reproduction of carnivorous bird populations

The mallard was selected as the representative receptor for herbivorous birds, and the great blue heron was selected as the representative receptor for carnivorous birds. No special-status species were identified for these AEs. These endpoints are presented together because the results for each were nearly identical.

As shown in Table 6-11, the site-wide lead HQs are greater than 1 for the low benchmark but less than 1 for the high benchmark. PAHs and TPH were not carried forward from Tier 1. Lead was evaluated on an individual sample point basis (Tables 6-12). Figure 6-10 shows the HQ results for each sample point and COPEC for the mallard and heron.

Lead

The majority of lead concentrations are below the identified background concentration and are shown in blue in the upper right quadrant of the circles in Figure 6-10. For the five samples within the wetlands where lead concentrations are greater than background, all HQs for the low benchmark are greater than 1 and, for the high benchmark, three of five sample HQs are greater than one. As discussed above for AE: W2, the Level 1 or Level 2 risk associated with these HQs is localized within several tank bottoms in the northwest portion of the site.

The avian HQs for lead based on the low benchmark are all high, ranging from 147 to 2,617, with the wetland 95% UCL HQ of 497. The high benchmark HQs are much lower, ranging from 0.24 to 4.2, with the wetland 95% UCL HQ of 0.79. To put these values into the context of the naturally occurring background concentrations of lead, HQs for background were calculated. The low benchmark HQ for background is 91, and the high benchmark HQ is 0.15. Thus, background concentrations account for approximately 20% of the estimated risk based on the 95% UCL. In spite of the fact that the background concentration indicates some level of risk from lead, given the number of exceedances of both the low and the high benchmarks, risk to birds from lead cannot be ruled out. As discussed above for AE: W1, the spatial distribution of elevated lead indicates that any potential risks are localized to small areas within several tank bottoms in the northwest portion of the site.

AE: W6. Survival, growth, and reproduction of insectivorous birds populations

The western sandpiper was selected as the representative receptor, and no special-status species were identified for this AE.

Site-wide lead HQs are greater than 1 for both the low and high benchmarks. PAHs were not carried forward from Tier 1. TPH HQs are greater than 1 for both the low and the high benchmarks. Based on this evaluation, lead and TPH were evaluated on an individual point basis.

Lead

The majority of lead concentrations are below the identified background concentration and are shown in blue in the upper right quadrant of the circles in Figure 6-11. The five samples within the wetlands where

lead concentrations are greater than background all had HQs greater than 1 for both the low and high benchmarks. As discussed above for AE: W3, any potential risk associated with these five samples is localized within several tank bottoms in the northwest portion of the site and should be interpreted in the context of the conservatism of the exposure estimates (i.e., site use assumptions). As with AE: W3, risk to insectivorous populations is not likely based on the limited spatial area of elevated lead concentrations, but these risks cannot be ruled out.

TPH

For TPH, 10% (3 of 29) of the samples have low benchmark HQs greater than 1, and 3% (1 of 29) has a high benchmark HQ greater than 1. Figure 6-11 shows the TPH HQ exceedances (bottom left quadrant of sample circles) and also shows the surface hydrocarbon expressions. Locations B-23 and S-41 exceed only the low benchmark. These two samples are located in the northwest marsh and appear to be near identified surface hydrocarbon expressions. Location S-63 exceeds both low and high benchmarks and is in the wetland between Reservoirs 5 and 6 and is on or near a surface hydrocarbon expression. Based on the low frequency and magnitude of TPH benchmark exceedances (i.e., HQs > 1), TPH is not likely to pose significant risk to insectivorous bird populations that may forage in site wetlands.

AE: W8. Survival, growth, and reproduction of omnivorous mammal populations

The raccoon was selected as the representative receptor, and no special-status species were identified for this AE.

As shown in Table 6-11, the site-wide lead HQ is greater than 1 for the low benchmark, but less than 1 for the high benchmark. PAHs and TPH were not carried forward from Tier 1. Thus, lead was evaluated on an individual sample point basis (Tables 6-12). Figure 6-12 shows the HQ results for each sample point and COPEC.

Lead

Of the five samples within the wetlands where lead concentrations are greater than background, four have HQs greater than 1 for the low benchmark, and all are less than 1 for the high benchmark. As discussed previously, these risks associated with these samples is categorized as Level 1 or Level 2 in a localized area within tank bottoms in the northwest portion of the site and are not likely to indicate population level risk to omnivorous mammals.

Tables 6-10 and 6-15 summarize the results of the terrestrial and wetland Scenario 1 analyses respectively.

6.2.3 Scenario 2 Risk Characterization

As discussed in Section 3.2, arsenic was not carried forward as a COPEC for Scenario 2 because concentrations outside the former operations area are generally within background. In addition, as discussed previously, only those compounds for which the Scenario 1 assessment indicated Level 1 risk were evaluated in Scenario 2 (Figure 1-2). Thus, PAHs were not included in the Scenario 2 assessment. The Scenario 2 results for lead and TPH are discussed below. Table 6-6 includes the evaluation of Scenario 2 based on the 95% UCL EPC. Table 6-10 summarizes the results of the Scenario 2 evaluations for each AE.

Lead

For Scenario 2, HQs are categorized as Level 2 for the song sparrow (AE: T3), the western meadowlark (AE: T5), and the loggerhead shrike (AE: T5). Risk to terrestrial plants (AE: T1), the California vole (AE: T4), ornate shrew (AE: T6), American kestrel, and northern harrier (AE: T7) are categorized as Level 1. Risk to soil invertebrates and the coyote from lead is *de minimus.* The results of the Scenario 2 analysis for lead indicate that excluding the former operations area did not result in significantly different lead EPCs (e.g., the 95% UCL is 71 mg/kg for Scenario 1 and is 69 mg/kg for Scenario 2). Thus, it follows that risk findings were not significantly different. As discussed above for AEs: T1 – T7, when the spatial distribution of elevated lead concentrations was evaluated, the elevated concentrations outside the former operations area that are the focus of this Scenario 2 evaluation were found to be localized in several tank bottoms within the northwest portion of the site. In addition, within the tanks with elevated lead concentrations, at least one sample with concentrations below background or toxicity benchmarks was found. This indicates that lead concentrations within the tank bottoms are variable and that the areas of elevated lead concentrations that may pose risk are smaller than the entirety of the tank bottoms.

TPH

For Scenario 2, risk for all wildlife receptors (AEs: T3 – T8) from TPH is *de minimus*, and risk to plants (AE: T1) and soil invertebrates (AE: T2) is categorized as Level 2. The evaluation of Scenario 2 revealed that, while the highest TPH concentrations on-site fall outside the former operations area, the frequency of elevated concentrations is lower. Thus, the EPC for Scenario 2 is approximately half the EPC for the entire site. The overall risk analysis for the two scenarios is similar with the song sparrow (AE: T3) and the western meadowlark (AE: T5), differing slightly (i.e., *de minimus* risk was indicated under Scenario 2, while risk for both receptors was categorized as Level 1 under Scenario 1). The areas of Level 1 or Level 2 risk identified in Scenario 2 are generally associated with surface hydrocarbon expressions or subsurface plumes identified on-site. The exception of S-59 is discussed under AE: T1 above.

6.2.4 Conclusion

This risk characterization presented the results of the risk analysis and included a spatial evaluation of the data. However, it is important to consider the uncertainties associated with the screening-level assessment so that the results can be interpreted in this context. Section 7 discusses the primary uncertainties associated with this assessment, and Section 8 presents final risk conclusions for the pERA.

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7. Uncertainty Analysis

The understanding of the underlying uncertainties inherent in the data and models used in the risk assessment is a critical aspect of a risk-based decision-making process. Identifying the sources and potential magnitude of the major uncertainties is crucial to the appropriate interpretation of risk assessment results. The objective of this section is to discuss the major sources of uncertainty associated with the SLO Tank Farm pERA.

The nature of the pERA as a screening-level assessment mandates that the uncertainties are largely mitigated by making conservative assumptions to ensure that no risk is overlooked or under estimated. Thus, a significant portion of the uncertainty discussed in this section relates to conservative assumptions used in the screening-level pERA. These conservative assumptions, when taken together, result in predicted risk levels that are likely higher than those actually present at the site. Wherever possible, factors that may have resulted in underestimation of risk were identified and discussed in detail.

Several major sources of uncertainty are associated with each step in the risk assessment process. These uncertainties may affect the interpretation of the risk assessment for the site by over or underestimating risks. These uncertainties are discussed in the following sections.

7.1 Data Quality

The primary uncertainties of the data quality in this assessment are associated with the spatial data coverage and the detection limits. These issues are discussed below in the context of how they affect the results of the pERA below.

7.1.1 Spatial Data Coverage

While the spatial and temporal data coverage has been deemed adequate for the purposes of this screening-level risk assessment (Appendix A), there are a number of uncertainties associated with the spatial data coverage that impact the pERA. These types of data uncertainties (i.e., data gaps) are inherent in a screening level risk assessment and are discussed here only to reiterate that the estimated risks identified in this assessment are conservative by design. There are three types of uncertainties associated with spatial data coverage: (1) media-specific (versus biological-specific data); (2) COPEC-specific (PAH data); and (3) area-specific (i.e., unbounded exceedances) coverage. Each of these uncertainties are discussed below.

<u>Media-Specific Versus Biological-Specific Data Coverage</u>

Data for the site include only primary site media (surface water, soil and sediment) measurements. Site-specific tissue data for prey items for the food web models (i.e., plant, invertebrate or small mammal) are not available, nor are site-specific measures of aquatic or terrestrial toxicity (i.e., bioassays). The lack of site-specific biological data to verify the theoretical risks identified in this assessment (based on models and generic toxicity benchmarks) makes the risk conclusions uncertain. The models and benchmarks selected for this assessment are selected such that any predicted risk would over- rather than under

estimate risk. The specific uncertainties and conservatism associated with the media exposure estimates, food chain models and benchmarks are discussed below in Section 7.3 and 7.4.

COPEC-Specific Data Coverage

PAHs are often considered indicator compounds of potential petroleum toxicity to ecological receptors. These compounds are a part of the larger petroleum mixture that has been observed and measured (TPH) at the site. While TPH measurements have been taken extensively at the site, PAH measures are less frequent (68 PAH of 237 TPH samples considered for the terrestrial evaluation and 13 PAH samples of 29 TPH samples considered for the wetland evaluation). In general the TPH evaluation is more conservative than the PAH assessment. Using the wetland assessment as an example (because sediment invertebrate PAH benchmarks are the most conservative), Tables 6-13 and 6-14 demonstrate that the frequency and magnitude of benchmark exceedances based on TPH are greater than those for PAHs.

Because of the uncertainties associated with developing benchmarks for petroleum mixtures such as TPH, a great deal of conservatism was used in developing the TPH benchmarks for this assessment (Section 7.4). For this reason, the PAH assessment based on individual constituents of petroleum may be less uncertain than that for TPH. Thus, when both TPH and PAH data are available for a single sample location, these two lines of evidence are considered together to evaluate possible petroleum risks. However, in many cases as described above, PAH coverage was limited. To address this, a regression analysis was conducted by AGS (Appendix H) to determine if PAH concentrations could be predicted from TPH concentrations for samples in which PAHs were not analyzed. Co-located TPH and PAH data were evaluated and a statistically significant relationship between TPH and most PAHs was found. However, this analysis indicated that the modeled PAH data could over- or under estimate the PAH concentrations by as much as 80%.

For example, TPH and PAHs were measure for sample location S-63. Using the regression equation, the estimated PAH concentration under estimates the concentration by approximately 55% (Table 7.1). Likewise, TPH and PAHs were measured for sample S-57. In this example, however, the modeled PAH concentration over estimates the measured concentration by over 80%. Because of this uncertainty, estimating PAH concentrations would not add clarity to the overall pERA and has therefore not been included. Thus, the TPH evaluation remains the primary estimation of petroleum risk at locations lacking PAH data. Because the TPH assessment is more conservative than the PAH assessment, petroleum constituents are adequately addressed across the site regardless of whether co-located PAH data are available for a specific sample.

Area-Specific Data Coverage

In addition to the lack of biological data, when risks were identified, in many cases, the risk was for a single sample location without surrounding data to bound the spatial extent. For example, Sample S-59 is located in the southwest portion of the site just below tank 6 and risk associated with TPH for this sample is categorized as Level 2 for plants and invertebrates and Level 1 for birds. No other samples were collected within this area and there are no clear petroleum sources to this area. Thus, the horizontal extent of any petroleum risk in this area is unknown. Likewise, risk from TPH for three samples (B-30, B-31 and B-32) collected at 5 feet bgs in the area of Reservoir 4 is categorized as Level 2 for plants and invertebrates and Level 1 for birds. No surrounding samples are available to confirm whether elevated TPH exists at shallower depths (only one sample has multiple depth intervals). Because information about the horizontal and vertical extent of elevated TPH concentrations in some areas of the site is lacking, uncertainty regarding risk in the areas surrounding these samples remains.

7.1.2 Detection Limits

The other primary data uncertainty is associated with the detection limits of the analytes measured in site soils/sediments. Detection limits for selenium and thallium were above available ecological screening criteria. No background population could be identified for selenium or thallium because these compounds were never or rarely (selenium) detected on or in the vicinity of the site. While this is an indication that these compounds are not likely present at elevated concentrations and are not present as a result of site-related activities, the detection limits reported for these two compounds are above the lowest available ecological toxicity benchmarks. It was decided based on professional judgment that these compounds did not require further evaluation in the pERA, but there is uncertainty associated with whether these compounds could be present at concentrations above ecological benchmarks. Thus, the exclusion of these compounds from the assessment may under estimate risk.

No pesticides were detected on site and most detection limits were adequate. However, all detection limits for chlordane and toxaphene were above available screening criteria (Table 3-1). Thus, it is unclear if these compounds are present on site at concentrations that may pose risk to ecological receptors. While uncertainty remains about these detection limits, there is no evidence of these compounds being used on site and because no other pesticides were detected, there is no reason to expect that these compounds would be present at concentrations that would indicate ecological risk.

Herbicides were also not detected on site. While no screening criteria were available for specific assessment of detection limits, these compounds were excluded from the pERA because available historical site information does not suggest that they are site-related constituents. This uncertainty could under estimate risk.

7.2 Problem Formulation

A number of uncertainties are associated with the specific components of the problem formulation. These include COPEC selection, CSM development and receptor selection.

7.2.1 COPEC Selection

A COPEC screen was conducted for site soil, sediment and surface water. The primary uncertainties are associated with the individual steps in the COPEC screening process including detection limits, background determination, frequency of detection, and professional judgment. Detection limits are discussed above in Section 7.1.2 and the uncertainties associated with the remaining steps are discussed below by media.

<u>Soil/Sediment</u>

Uncertainties associated with the use of the background concentrations as a screen in the COPEC screening process are associated with those inorganic constituents that were detected on-site in a few locations that exceed the identified inflection point (Table 3-4). These include arsenic, barium, cadmium, cobalt, lead, mercury, molybdenum, vanadium and zinc. While these limited exceedances are not thought to indicate an anomalous population on site, the exclusion of these constituents as COPECs could result in the underestimation of risk.

The uncertainties of the frequency of detection step in the COPEC screening process are associated with those compounds that were detected at slightly greater than 5% and not carried forward in the pERA. Three VOCs were detected in greater than 5% of samples, including, isopropylbenzene (6 of 55), n-propylbenzene (6 of 55), and sec-butylbenzene (5 of 55). All detects were within a limited spatial area of the operations area (Figure 3-2) at a depth of 2.5 feet and were two orders of magnitude lower than the lowest available terrestrial screening criteria for VOCs (5 mg/kg for xylenes). In addition to these VOCs, Aroclor 1254 was detected in greater than 5% of samples (6 of 55). The highest detection of Aroclor 1254 (0.1126 mg/kg) is lower than the lowest available benchmark for plants or invertebrates of (0.81). While PCBs can bioaccumulate, the limited spatial area of the detections would indicate that this compound would not pose food chain risks. Moreover, a food chain estimate based on the most sensitive receptor evaluated (the song sparrow) indicated that the low benchmark HQ for PCBs would be less than 1. Because the number, magnitude and spatial area of detections was generally minimal, and the range of detections was below available screening values, and no food chain risk would be expected, these compounds are not carried forward as COPECs. This exclusion of these COPECs could potentially under estimate risk in this limited area of the site.

Surface Water

Background was not determined for surface water. However, background concentrations of inorganic constituents in soil are used to interpret surface water concentration as discussed in Section 7.5.1. TPH was the only constituent detected in surface water at greater than 5% that was eliminated as a COPEC. TPH (C10-C40) was detected in surface water in eight of the ten locations sampled on the site during March 2003, with detected concentrations ranging from 0.13 to 1.9 mg/L. Concentrations exceeding 1 mg/L were observed only in water collected from SW-4 and SW-1; all remaining detections were below 0.4 mg/L. As reported in the AGS technical memorandum (Appendix E) these detections of TPH do not appear to be related to known petroleum sources at the site. Moreover, silica gel cleanup, which removes polar compounds, resulted in the removal of detectable TPH from all the samples. If the detected TPH has, in fact, resulted from polar compounds, potential sources of polar material could include biological derivation from plant materials, biological degradation of petroleum compounds, or polar compounds derived directly from petroleum in the soils, although the last source is unlikely given the long time that the petroleum contaminated soils have been exposed to the environment. Mass spectral analyses were conducted on the three surface water samples with the highest TPH concentrations (SW-4, SW-1, and SW-2), to identify compounds comprising the TPH detected in these samples (Appendix E). Overall, AGS concluded that, taken together, the lack of detectable aliphatic/aromatic material or PAHs in surface water, the removal of detectable TPH by silica gel, the particular compounds identified in the mass spectral analysis, and field observations of vegetation and water color and clarity, suggest that petroleum is unlikely to be a major source of the organic material found in the surface water from the site. However, conclusive determinations regarding the source of the TPH at SW1 and SW2 could not be made. Thus, the exclusion of TPH as a surface water COPEC may under estimate potential risk, because the source of surface water TPH at the site has not been definitively resolved.

7.2.2 Conceptual Site Model

The CSM for the site considered all possible receptors and exposure pathways. The primary uncertainties associated with the CSM are for those pathways that cannot be assessed quantitatively because toxicity data are lacking. These include dermal contact between wildlife receptors (i.e., birds and mammals) and soil, sediment or surface water. While this is not likely to be a significant exposure pathway relative to ingestion, this exclusion of this pathway may under estimate exposure.

7.2.3 Identification of Potential Receptors

Receptors of concern identified to represent each assessment endpoint were selected so that they maximize exposure, thus producing conservative estimates of risk. This likely over estimates exposure to many receptors on site. For example, the ornate shrew was selected as the representative receptor for insectivorous mammals (AE: T5). While this species was not observed on site it was selected because: a) the only insectivorous mammal actually observed on site was the bat, which would not likely have significant site-related exposure based on its feeding strategy; b) habitat for the shrew is present and it is likely to occur; and c) exposure parameters for the shrew would predict high site-related exposure. The conservatism of the exposure parameters selected for each receptor are discussed below in Section 7.3.

7.3 Exposure estimates

All of the exposure estimates used in this pERA were selected to be highly conservative estimators of potential exposure. Exposure to plants and invertebrates is based on direct exposure to site media. For these EPCs the Tier 2 exposure estimate is the 95% UCL. In addition each assessment endpoint was assessed on an individual point basis. For the upper trophic level wildlife receptors (i.e., birds and mammals), there are two components to the exposure estimates used in this pERA. The first component is the EPC for each site media as described above. The second component of the exposure estimate is the model used to estimate a daily dose to the receptor based on the media EPCs. The conservatism and uncertainties associated with each of these elements is discussed below.

7.3.1 Media EPCs

The use of the 95% UCL to estimate exposure may be an over estimate in some cases. This value defines the upper range of the interval in which the mean may occur (with 95% degree of confidence) and as such is a conservative assessment of the EPC. As shown in Tables 4-1 and 4-2, the 95% UCL can be dramatically higher than the mean and in some cases higher than the maximum if the variability within the dataset is high (e.g., for TPH). When the 95% UCL exceeds the maximum, the EPC defaults to the maximum detected concentration. For example, the Tier 2 EPC for several PAHs and for TPH in the wetland assessment (Table 4-2) is the maximum detected concentration. This likely over estimates exposure to these COPECs.

7.3.2 Estimates of Food Chain Exposure

The estimates of food chain exposure used in this pERA are based on a modeled daily dose to each receptor. This model includes receptor-specific exposure parameters that were selected from the available literature. Because the parameters used to estimate exposure through the food chain have not been empirically measured, conservative assumptions were made which could result in an over estimate of exposure and risks. The dose calculations model wildlife exposure through diet to site-related COPECs. The model uses the media EPCs discussed above along with a literature-derived bioaccumulation factor to determine COPEC concentrations in the prey items of each receptor. In addition the model includes specific biological parameters for the receptor (body weight, daily ingestion rate, and dietary composition), and the exposure frequency (SUF). Each of these inputs has varying degrees of uncertainty which are discussed in the following sections.

7.3.2.1 Concentrations in Prey

Because this is a screening level assessment, site-specific tissue data for prey items were not collected. Consequently, COPEC concentrations in vegetation, invertebrate, and vertebrate prey items were modeled using literature-derived bioaccumulation factors (BAFs). The use of BAFs in general, introduces uncertainty into the dose estimation, as these values may or may not accurately represent site-specific concentrations in these media. Site specific parameters such as soil organic carbon, pH, grain size and temperature can all affect uptake. Thus, deriving a BAF that is applicable to the site based on non-site specific studies adds uncertainty to the evaluation. In general, literature derived BAFs that are based on upper percentiles of a large dataset, such as the ORNL values described below, are conservative and often over estimate food item concentrations of chemicals resulting in an over estimate of exposure. However, BAFs developed based on single studies or limited data may over- or under estimate exposure.

Bioaccumulation factors developed by ORNL (Bechtel Jacobs, 1998a and b; Sample et al., 1998a and b) were available for plant, soil and sediment invertebrates and prey for arsenic and lead. The uncertainties associated with these BAFs are predicated principally on differences between the conditions used to support the published value and those actually present at the site (e.g., soil type, chemical properties, plant/animal type). The uncertainties associated with the BAFs were mitigated by selecting the 90th percentile values, defined by ORNL as the "conservative estimators". As demonstrated in the ORNL documents, these values over estimate uptake by as much as 100% when compared to the actual measured data (e.g., Table 5 in Bechtel Jacobs 1998a). The use of such a conservative estimate ensures that uptake is not under estimated.

PAH BAFs were not available from ORNL for plants, soil invertebrates and sediment invertebrates, thus literature was reviewed for development these BAFs. The plant BAF was developed using the model proposed in the EcoSSL document (EPA 2000b). The model selected is based on the K_{ow} of the individual PAHs. Log K_{ow} values can vary up to an order of magnitude, depending on the measurement method (Mackay et al, 1992). While every effort was made to make a conservative estimate, there is some degree of uncertainty. Because a low K_{ow} is conservative (i.e., would predict higher uptake) the lower value was selected when multiple values were available. While this model is expected to be a conservative estimator of uptake, no quantitative data are available to support this assertion and it is unknown whether the model might over- or under estimate uptake and therefore exposure.

The BAF values selected from the literature for PAHs in soil invertebrates are based on the 90_{th} percentile of data from 4 different species and 8 different PAHs. While this dataset is likely to capture much of the variability in estimating uptake, these BAFs are not organic carbon normalized and the uptake of organic constituents can be heavily influenced by the amount of organic carbon in the soil. The effect this may have on the estimated BAFs is unknown. The sediment invertebrate PAH BAFs are based on a review of a number of different studies in the literature that all support BAFs within the range of the selected value. The selected BAF value is normalized to organic carbon, however no measured organic carbon data for the site is available. Thus, the value is based on an assumption of 1% organic carbon in the soil. While this is a common assumption in the absence of site-specific data, the potential over or under estimation of uptake from this assumption is unknown. More detail on the development of BAFs for the site can be found in Appendix G.

7.3.2.2 Biological Parameters

The biological parameters included in the dose model for the food chain include receptor ingestion rate, body weight, and dietary composition. These parameters were selected for each receptor from the available literature. Individuals within a population vary in several life history and behavioral traits. This variation can impact the output of the dose models. Body weights vary widely, and lower body weights are generally associated with higher calculated doses. However, the ingestion rate that corresponds with a high body weight will usually be higher as well, making this assumption false in some cases. Body weights and ingestion rates were chosen based on an ecologically relevant combination that would yield a conservative (highest) dose. Thus, these assumptions may over estimate exposure for some individuals in the population.

Uncertainties associated with the assumptions made about the percent diet composition and foraging behavior of the receptors were taken from published literature when available. The dietary composition, however, will vary depending on season and availability of preferred food sources. For most receptors assumptions regarding dietary composition were made to maximize potential exposure for the feeding guild/trophic group the receptor represents. For example, the percent vegetation in the mallard diet was assumed to be the highest proportion reported (92%) because the mallard represents herbivorous feeding guild for birds. These assumptions may over- or under- estimate exposure due to differences in actual feeding behaviors throughout the year and differences in uptake for various prey items and COPECs. However, as all trophic groups and feeding guilds were evaluated using the same assumption, the worst case exposure scenario is captured in the assessment.

7.3.2.3 Exposure Frequency

Exposure frequency is defined by the site use factor (SUF) used in the dose equation. Site use factors are affected by the size of the site, the home or foraging range of the receptor, the appropriateness and quality of habitat at the site, and the availability and quality of food items at the site. A SUF for a receptor is based on the relative size of the home range of the receptor to the size of the site. Thus, it is an estimate of the amount of time the species might use the site. For this screening-level assessment, it was assumed that receptors would be year-round residents and have ranges such that they forage and live within the site 100% of the time (i.e., a SUF of 1). The uncertainties associated with this assumption affect two different aspects of the assessment. First, the site-wide 95% UCL evaluation is affected for a number of the receptors (e.g., the mallard and northern harrier), because the home or foraging range of the receptor is much larger than the site and or the receptor is migratory and spends a portion of the year in other breeding or wintering grounds. In these cases, the assumption of a SUF of 1 over estimates exposure.

The second aspect of the evaluation affected by the SUF is the individual point analysis. In this analysis, HQs were calculated for each individual sample location using a SUF of 1. This is a dramatic overestimation of exposure as it assumes that the receptor is foraging in the area of one sample location 100% of the time. Thus, the individual HQs should not be interpreted as a single risk estimate but rather should be used collectively to identify the spatial extent of potential risk.

7.4 Effects Assessment

The effects assessment includes uncertainties associated with the toxicity benchmarks selected for the pERA. The over or underestimation of risk in the assessment is directly related to the conservatism and uncertainty of the benchmarks. The benchmarks used for this risk assessment are not site-specific, and therefore represent sources of uncertainty for the overall risk assessment. However, they have been developed using conservative approaches to mitigate uncertainty, and are considered to be protective (i.e., the possibility of reaching a finding of no risk when risk actually exists at the site has been minimized).

Wildlife and direct toxicity benchmarks for this assessment were selected from a number of primary sources. Uncertainty arises in part from the fact that the underlying toxicity studies can vary in quality, study design, and relevance to species at a site. Uncertainties associated with specific benchmarks used in this assessment are discussed below.

7.4.1 Terrestrial Plant Benchmarks

The uncertainties associated with the plant benchmarks for specific COPECs are discussed below.

Arsenic and lead

The plant benchmarks selected for arsenic and lead are based on Efroymson et al, (1997a) and benchmarks are based on data provided by toxicity studies in the field or, more commonly, in laboratory settings. Many of these soil toxicity tests are conducted with soluble metal salts which are likely to be more bioavailable than mixtures of forms found in the field at contaminated sites such as SLO Tank Farm. Thus, these benchmarks would likely over- rather than under estimate potential toxicity.

PAHs

For PAHs, the low and high benchmarks were based on the Canadian Council Ministries of the Environment (CCME) soil screening documents (CCME 1999 e and f). This document was designed to provide generic conservative screening values for contaminant screening. As such, these values are expected to over- rather than under estimate potential toxicity. Because phytotoxicity benchmarks in the CCME documents were available for only three of the individual PAHs, it was necessary to assign surrogate screening criteria to other detected PAHs. The use of surrogate benchmarks for specific PAHs may over- or under estimate potential toxicity.

TPH

There are a number of uncertainties associated with the development of the TPH contact-toxicity benchmarks for terrestrial plants. The primary uncertainty is the paucity of available data in the literature to address the potential toxicity of weathered crude in soil similar to that of SLO Tank Farm. The largest uncertainty associated specifically with the benchmark is the fact that it is based on fresh crude rather than weathered crude. The toxicity of TPH, and in particular of weathered TPH, is highly variable and depends largely on the specific composition of the TPH mixture. Because weathered products typically contain a higher percentage of the larger less bioavailable carbon compounds, it follows that the associated toxicity would be less than that of a fresher crude or a mixture containing more of the lighter carbon compounds (i.e., diesel).

Preliminary studies conducted on behalf of CCME with weathered crude support this assertion and indicate that weathered crude in concentrations of up to 29,603 mg/kg in soil did not adversely affect plant germination or root elongation. However, this study is based on acute exposures only (Visser et al., cited in CCME 2000) and studies with chronic exposures are not complete at this time. In addition, Appendix G of the CCME document provides a compilation of available plant toxicity data comparing weathered and fresh products. The evaluation of this larger data set indicates that the toxic responses are variable and that the general assertion that weathered crude is less toxic (chronically) than fresh crude is not always accurate, particularly for sensitive species.

Two other studies identified in the literature were found to be applicable to the SLO Tank Farm site. These studies were conducted with crude oils in various soil types and evaluated chronic exposures. These studies and the resulting benchmark development are discussed in detail in Appendix G. These studies generally indicate that concentrations ranging from 2,000 to 7,453 mg/kg do not adversely affect plant germination and growth. While these studies were not used in the selection of the benchmark, they do provide an indication of the conservatism of the selected values (Table 5-1). Based on all of the available data reviewed, the selected TPH benchmarks likely over estimate plant toxicity.

7.4.2 Soil Invertebrate Benchmarks

Arsenic and lead

The soil invertebrate benchmarks selected for arsenic and lead are based the ORNL document described above (Efroymson et al, 1997b). The uncertainties associated with this approach are discussed above and these benchmarks would likely over- rather than under estimate potential toxicity.

TPH

There are a number of uncertainties associated with the development of the TPH contact-toxicity benchmarks for soil invertebrates. Because the literature sources considered are the same as those considered for plants, many of the uncertainties are the same. The primary uncertainties associated with the paucity of available data in the literature and the use of fresh rather than weathered crude studies are discussed above for plants. The CCME study provides less data for terrestrial invertebrates and therefore, the selected benchmark values may be less robust than the plant values.

As with plants, other studies conducted with crude oils were reviewed for benchmark development and are discussed in detail in Appendix G. These studies generally indicated concentrations ranging from 1,008 to 7,453 mg/kg as no or low effect levels. However, these studies were more acute in nature (14 day survival and avoidance tests). Thus, the TPH benchmarks for soil invertebrates may over estimate toxicity but data are lacking to verify the toxicity of weathered crude for chronic exposures.

7.4.3 Sediment Invertebrate Benchmarks

The empirically-based TECs and PECs (MacDonald et al., 2000) were used as sediment benchmarks for arsenic, lead and most PAHs. Other PAHs and TPH were addressed separately.

Arsenic, Lead and PAHs

These "consensus-based" TECs and PECs were developed to provide a unifying synthesis of existing sediment guidelines and to account for chemical mixtures (MacDonald et al, 2000). The TEC is defined as the concentration below which adverse effects are not expected to occur and the PEC is the concentration above which adverse effects are expected to occur. These levels were derived using an averaging approach based on similar thresholds from the following published sources:

- Effects-Level SQGs (TELs and PELs; Smith et al., 1996);
- *Hyalella azteca* Effects-Level SQGs (TEL-HA28 and PEL-HA28; Ingersoll et al., 1996 and USEPA, 1996);
- Effects-Range SQGs (ER-Ls and ER-Ms; Long and Morgan, 1991);
- Screening-Level Concentration SQGs (LELs and SELs; Persaud et al., 1993); and
- Sediment Quality Advisory Level SQGs (METs and TETs, EC and MENVIQ, 1992).

There is significant uncertainty inherent in all of the approaches developed based on empirical data relationships, and consequently compound specific values can vary by several orders of magnitude depending on the intent of their use and the derivation procedure (MacDonald et al., 2000; Smith et al., 1996). Empirical approaches may not reflect contaminant specific response thresholds (due to un-addressed co-contaminant and chemical mixture issues), and they don't incorporate site-specific factors that influence bio-availability (MacDonald et al., 2000; DiToro et al., 1991).

TECs and PECs are based on associations observed between measures of adverse biological effects and the concentrations of potential chemicals of concern in sediments (MacDonald et al., 2000). The consensus-based sediment guidelines were evaluated by MacDonald (MacDonald et al. 2000) to determine if they would be effective tools for predicting sediment quality in freshwater ecosystems. Based on the evaluation criteria, TECs and PECs for most of the individual chemicals and mixtures were considered reliable as predictive tools (i.e. predictive ability was greater than 75 percent). This reliability was associated with the narrative intent of TECs and PECs (i.e., sediment samples were predicted not to be toxic if the measured concentration of a chemical was less than its corresponding TEC and similarly, sediment samples were predicted to be toxic if the measured concentration of a chemical was greater than its corresponding PEC). However, MacDonald et al., (2000) have acknowledged that sediment samples with concentrations of chemicals that lie between its corresponding TEC and PEC could not be predicted as being not toxic or toxic. Thus, the true toxicity threshold (i.e., NOEC) theoretically lies between the TEC and PEC. For these reasons, these screening values are likely to over estimate toxicity.

PAHs

For sum PAH, TECs and PECs are based on the sum of only 13 of the individual PAHs while the sum PAH value used in this pERA is based on the sum of 16 individual PAHs. Thus, the sum PAH benchmark for sediment invertebrates could over estimate toxicity.

For 5 PAHs, TECs and PECs were not available, so various values available in the NOAA SQirRT tables were used. Benchmarks for acenaphthene and acenaphthylene are upper effects thresholds (UETs). These values are the concentration above which effects are expected and may under estimate toxicity. However, the endpoint tested in both cases is a microtox assay which is often more a biomarker of exposure rather than an indication of toxicity. Thus, the effect observed may not be associated with biological effects on the organism. These benchmarks are uncertain and may over- or under estimate toxicity. The benchmark for benzo(b)fluoranthene and benzo(k)fluoranthene was taken from the Great

Lakes ARCs Threshold Effect Levels (TELs) and is the lowest TELs for the amphipod *Hyalella azteca* for both isomers. This value was found to correctly predict toxicity only 53% of the time and indicated false positives 30% of the time. As such this value is highly uncertain and is likely to over estimate toxicity.

TPH

As discussed in Section 5.4.3, data were not available to develop a TPH benchmark for sediment invertebrates. As such, the terrestrial values were used to assess the wetland areas. Because aquatic and terrestrial species may have variable sensitivity to petroleum, the use of this value as a surrogate is uncertain and may over- or under estimate toxicity.

7.4.4 Wildlife TRVs

The uncertainties associated with wildlife TRVs are generally associated with inter-species extrapolations, the chemical form used in dosing, NOAEL to LOAEL conversions and use of surrogate COPEC values.

Wildlife TRVs are often based upon studies found in the literature that may not be specific to the species being evaluated in risk assessments, making it necessary to extrapolate results from the test species (as a surrogate) directly to the species of interest at a site (for example using data from a domestic chicken to represent the western meadowlark). Toxicity thresholds estimated from data on laboratory animals, which in many cases are selected due to their high relative sensitivity to contaminants, must be evaluated carefully and the possible limitations of the data must be considered. Variations in physiological or biochemical factors may exist among species (e.g., uptake, metabolism, and disposition), which can alter the potential toxicity of a contaminant to a particular species. Furthermore, inbred laboratory strains may have an unusual sensitivity or resistance to the tested compound. Behavioral and ecological parameters (e.g., stress factors such as competition, seasonal changes in temperature or food availability, diseased states, or exposure to other contaminants) may also make a wildlife species' sensitivity to an environmental contaminant different from that of a laboratory or domestic species.

An additional source of uncertainty associated with TRV derivation is the dosing method and the form of the chemical being administered. For example, the avian TRV for lead is based on a daily dose of lead acetate in feed. This form of lead is likely to be significantly more bioavailable, and therefore more toxic, than other lead complexes typically found in soils or sediments. As such, it is likely that this TRV over estimates potential risk to site receptors.

In reviewing the literature, a NOAEL is not always reported. In these situations, the LOAEL is converted to an NOAEL by dividing by a factor of 10. While this is standard practice, the factor of 10 is not based on toxicological information and is somewhat arbitrary. While it is likely to be conservative, it is not necessarily accurate and is therefore a potential source of uncertainty which over estimates potential toxicity.

7.4.4.1 Lead TRV

The primary uncertainty associated with the use of the BTAG avian and mammalian lead TRVs is associated with lead bioavailability. First, to have an adequate evaluation of exposure, the potential

bioavailability of lead in site-specific soils and its comparability to the lead compound used in laboratory toxicity studies must be understood (HERD ERA Note 4, DTSC 2000). This is due to the fact that the studies on which the lead TRVs are based used lead acetate, a form of lead not commonly found in nature. Lead acetate is highly soluble and more bioavailable than inorganic lead or other lead salts, making it more toxic than other forms of lead that are commonly found in the environment. To address this problem, DTSC has recommended that exposure assessments for lead be refined so that site-specific lead bioavailability is estimated or directly measured. However, as discussed with the SERRT, this approach provides only a partial solution, since it can only address bioavailability of lead in soil and not the uptake and transfer of lead through the food chain, which is generally the more significant exposure route. For the pERA at SLO Tank Farm, the SERRT decided not to conduct site-specific lead bioavailability assays. Therefore the screening-level risk assessment food chain models assume 100% bioavailability and transfer of lead in soil/sediment and the food chain and likely over estimate the actual exposure of avian and mammalian receptors to lead.

Additionally, for the avian lead TRV specifically, a NOAEL was not identified in the selected study and therefore, an effect level was converted to a NOAEL by dividing by an uncertainty factor (UF) of 10. Using this UF assumes that the NOAEL is an order of magnitude lower than the observed effect level. However, the actual dose-response relationship is not known. For example, in another study (Edens and Garlich 1983), a NOAEL for the same endpoint in the same species was observed that was only slightly lower than the effect level used for TRV development. In summary, due to these uncertainties, the avian and mammalian lead TRVs may lead to an overestimation of toxicity.

Additionally, there have been numerous interpretations of the avian lead toxicity dataset that has resulted in different recommendations for a no effect TRV (see Table 2 in HERD ERA Note 4), with the BTAG low TRV being the lowest proposed value. The challenge of using the BTAG lead TRV values for risk-based decision making has been recognized by many in the regulatory community. This has resulted in a recent revision of the Region 9 BTAG mammalian lead TRV (HERD ERA Note 5, DTSC 2002) and current discussions regarding the need to reevaluate the avian TRV for lead.

7.4.5 PAH TRVs

For a number of the individual PAHs assessed in this pERA, no studies were available for TRV development. The avian PAH TRVs are based on a 7 month study conducted with mallards and Louisiana crude oil (Patton and Dieter, 1980). While not a reproductive study as would be preferred in TRV development, the endpoint measured was a sensitive endpoint (increase in liver weight). However, this endpoint may or may not be associated with impairment in the organism. While the evaluation of a mixture is appropriate since PAHs most often occur in mixtures, there is no way to discern exactly how much of the observed toxicity is caused by each constituent. Because of the lack of cause and effect data for specific compounds, the selected values are in essence surrogate values and therefore may over- or under estimate toxicity. Because of the uncertainty associated with this benchmark, it was agreed that an uncertainty factor of 10 would be applied to this value for special status species. The use of this uncertainty factor may over estimate toxicity to these species.

The mammalian PAH TRVs use available toxicity values for benzo(a)pyrene as a surrogate for all high molecular weight compounds and for naphthalene as a surrogate for all low molecular weight compounds. While the TRVs for naphthalene and benzo(a)pyrene are considered appropriately conservative, their application to other PAHs is unknown and thus, this approach may over- or under estimate toxicity.

7.4.6 TPH TRVs

The avian TPH TRV is based on a study that evaluated the effects of weathered EXXON Valdez crude oil on mallards (Stubblefield et al, 1995). A value of 218 mg/kg/day (2000 mg/kg in diet) was selected as the low avian TRV. This value is based on the NOAEL for endpoints including body weight, food consumption, egg production, eggs set, number of fertile eggs, number of viable eggs, hatch success, chick survival, egg shell thickness, organ weights, and blood chemistry. A higher dose of 2180 mg/kg/day was a reproductive NOAEL but because shell thickness was slightly reduced at this dose, it was conservatively considered the LOAEL (or high TRV). Thus, the low TRV used in this assessment likely over estimates toxicity.

The mammalian TPH low TRV (197 mg/kg/day) is based on a study conducted with weathered Prudhoe Bay crude oil and farm raised mink over a period of 4 months (Beckett et al, 2002). The selected value is the NOAEL for body weight, organ weight and histopathology. Because this is not a reproductive study, which is typically preferred in TRV development, other studies conducted with mammalian species and crude oils were reviewed to evaluate potential reproductive effects. No reproductive studies were identified that presented NOAELs but other observed non-reproductive NOAELs ranged from 1780 to >5000 mg/kg/day. These studies were for acute durations (i.e., 5 days) and cannot be compared directly to the selected value. Thus, the selected value may over- or under estimate potential toxicity. However, the mink is known to be a highly sensitive test species and its use as a representative species for mammals at the SLO Tank Farm can be considered conservative.

7.4.7 Biological Surveys

Biological surveys were conducted at the site for the purposes of identifying the presence or absence of special status species. Because protocol level surveys (survey methodology developed by USFWS specifically to identify special status species) were conducted, there is high confidence that if a species was not found on Site, it is not there. These surveys were not designed to identify specific locations at the site where these species can be found, or to evaluate cause and effect relationships between occurrence of a species and contaminants. Therefore, while the results of these surveys were used to identify assessment endpoints and receptors of concern for evaluation in the pERA, they were not used to evaluate the potential for risk.

7.5 Risk Characterization

While not a technical uncertainty, it is important to recall as final risk conclusions are drawn, that the results of this pERA are predicated on the assumption that UNOCAL will be addressing the surface hydrocarbon expressions at the site separately from the risk assessment process. The potential risks to ecological receptors that may be associated with these areas have not been evaluated in this pERA. The uncertainties associated with the technical aspects of the Risk Characterization can be divided into three general categories: 1) extrapolation from individual to population level impacts; 2) Tier 1 evaluation; and Tier 2 evaluation.

7.5.1 Extrapolation from individual to population-level effects

For the assessment endpoints that represent non-special status species, the pERA risk evaluation is focused on evaluating potential risks to the representative receptor at the population level. However, the metrics used at this screening-level step generally evaluate individual-level impacts. Thus the evaluation

of population-level risk in the pERA is largely influenced by how a population is defined. For the purposes of the pERA, receptor populations were generally considered to be the group of individuals that might reside or forage at the SLO Tank Farm and general vicinity. For most birds and mammals this is a conservative assumption recognizing that these receptors have foraging and breeding territories that are larger than the site and that the number of these receptors using the site would not actually represent a true population. However, for the more immobile species such as plants and invertebrates, this assumption may be a more accurate representation. Based on this assumption, potential risks (i.e., HQs greater than 1) were interpreted spatially relative to the site as a whole.

A second factor used in the pERA to consider potential population-level impacts is the toxicity benchmarks used. These benchmarks are often based no effect and low effect levels for non-lethal endpoints in sensitive test species and are typically highly conservative (See Sections 7..4.1 – 7.4.6). To use these studies to evaluate population-level effects, the conservatism of the benchmark should be considered along with the endpoints measured and the magnitude of any exceedances. In this pERA, the magnitude of the low and high benchmark exceedances was considered in the context of the uncertainty of specific benchmarks to evaluate potential risk. Thus, while there is uncertainty because population metrics have not been quantitatively measured for the pERA, these uncertainties are likely to result in an over-estimate of potential population-level impacts because of the conservative assumptions used in the spatial evaluation and benchmark selection.

7.5.2 Tier 1

As discussed in the previous sections, the conservative assumptions made in Tier 1 of this pERA are designed to minimize the possibility of a COPEC being eliminated in this Tier when risk actually exists. Thus, the primary uncertainty with the Tier 1 risk characterization is associated with the two surface water COPECs (barium and thallium) that were not carried forward to Tier 2 but exceeded their respective low benchmarks. Thallium was detected in surface water in two locations at a concentration slightly above the low benchmark (HQ = 1.1). Thus the exclusion of thallium in Tier 1 could under estimate risk. However, these concentrations are well below the high screening value. Moreover, thallium was never detected in site soil (i.e., the only potential site-related source of thallium to surface water). Because thallium only slightly exceeded the low benchmark and because it was never detected on site, it was decided that these two detections did not warrant further evaluation. This could under estimate potential risk.

Barium was detected in surface water at all locations at concentrations exceeding the low benchmark and at three locations exceeding the high benchmark (SCVs and ACVs respectively). Thus the elimination of barium in Tier 1 could under estimate risk. However, background concentrations of barium in site soils ranged up to 313 mg/kg. Based on this background concentration, it was decided that any barium in surface water is most likely associated with background concentrations in site soil and further evaluation was not warranted.

7.5.3 Tier 2

The uncertainties of the Tier 2 risk characterization are associated with the interpretation of the hazard quotients. The HQs must be considered in the context of the underlying uncertainties that affect each component of the risk assessment. When uncertainties are consistently mitigated with conservative assumptions, these components have an additive effect and can make the final risk conclusions overly conservative.

In this assessment categories of risk have been defined as *de minimus* (low benchmark HQs < 1), Level 1 (low benchmark HQ > 1 > high benchmark HQ) and Level 2 (high benchmark HQ >1). While these designations are appropriate for the purposes of this screening-level pERA, the results should not be considered definitive conclusions of Level 1 or Level 2 risk. The use of NOAEL-based (i.e., low) benchmarks to evaluate risks is appropriate to determine if the potential for risk exists, but is not appropriate to quantify or characterize risk. Thus, the Level 1 risk category should not be interpreted as a finding of actual risk. A NOAEL-based benchmark represents a level of exposure below which no adverse effects are expected (i.e., there is no potential for risk), while a LOAEL represents a level of exposure above which adverse effects are expected (i.e., there is a significant potential for risk). There is a great deal of uncertainty associated with characterizing risk in the range of exposures bounded by the NOAEL and LOAEL.

The uncertainties and conservatism of both the exposure and effect assessments should be considered in interpreting the frequency and magnitude of the HQs (Sections 7.3 and 7.4 above). In addition, for inorganic COPECs with background concentrations that indicate risk such as lead, an exceedance of the low TRV, in and of itself, is not adequate for making decisions. As discussed in Section 6.2, background accounts for approximately half of the exposure in the risk analysis. This determination of the site-related contribution to risk is important to the decision-making process.

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8. Conclusions

In the preceding sections of this document, a characterization of potential ecological risk was developed. The objective of this section is to integrate the uncertainties described in Section 7 so that the results of the pERA can be interpreted within the context of this screening-level pERA.

A Tier 1 assessment was conducted using the most conservative exposure and effects assumptions to evaluate each AE. AEs and COPECs for which risk was categorized as Level 1 were carried forward for further analysis in the Tier 2 assessment. The Tier 2 terrestrial assessment included evaluation of: lead and arsenic for all terrestrial AEs; 10 of the PAHs for terrestrial plants; and TPH for plants, invertebrates, and most of the terrestrial wildlife receptors (excluding the loggerhead shrike, American kestrel, and northern harrier).

The Tier 2 wetland assessment included evaluation of: arsenic for plants, sediment invertebrates, and two wildlife receptors (western sandpiper and raccoon); lead for plants, sediment invertebrates, and all wildlife receptors; 8 PAHs for plants and 11 PAHs for sediment invertebrates; TPH for plants and sediment invertebrates and one of the wildlife receptors (the western sandpiper). No COPECs in surface water were identified as requiring further evaluation in Tier 2. Additionally, there was no indication of potential risk to riparian plants. Thus, potential risk to AE: W2 (aquatic invertebrates and amphibians) and AE: W1-ME3 (riparian plants) is considered *de minimus*.

Tables 8-1 and 8-2 summarize the results of the Tier 2 assessment for the terrestrial and wetland AEs respectively. Based on the benchmarks used in the pERA, the terrestrial AEs, plants are the most sensitive receptors to the COPECs detected at the site (Table 8-1). Among terrestrial wildlife receptors, herbivorous and insectivorous birds (AE: T3 and AE: T5) are the most sensitive receptors, with carnivorous mammals represented by the coyote (AE: T8) being the least sensitive. In general, exposure to inorganic COPECs resulted in more terrestrial wildlife receptors demonstrating potential risk than exposure to organic COPECs. Conversely, plants and terrestrial invertebrates are more sensitive to exposure to TPH than wildlife receptors.

Conclusions

- ***De minimus* risk to aquatic invertebrates and amphibians and riparian plants for all COPECs based on site-wide exposure**
- **Arsenic**
  - ***De minimus* risk to soil and sediment invertebrates and birds**
  - **Risk to plants and mammals - Level 1 *limited to former operations area where ecological habitat is low quality**
- **Lead**
  - ***De minimus* risk to soil invertebrates**
  - **Risk to plants and mammals - Level 1 * low in magnitude and spatial extent**
  - **Risk to sediment invertebrates and birds - Level 2**
  - **Risks limited to tank bottom in northwest portion of the site and the former operations area**
- **PAHs**
  - ***De minimus* risk to terrestrial receptors and to wetland birds and mammals**
  - **Risk (low magnitude) to wetland plants and sediment invertebrates - Level 2 * one location only**
  - **Risk to sediment invertebrates - Level 1 * two locations only**
- **TPH**
  - ***De minimus* risk to most wildlife (Level 1 for song sparrow and meadowlark and Level 2 for the western sandpiper)**
  - **Risk to soil or sediment invertebrates and plants - Level 2 *largely associated with surface hydrocarbon expressions**

For the wetland AEs evaluated in Tier 2 (Table 8-2), and based on the benchmarks used in the pERA, sediment invertebrates (AE: W3, W4) are the most sensitive receptors followed by wetland plants and

wildlife receptors. This difference between the apparent sensitivity of plants versus invertebrates in the terrestrial versus the wetland assessment results from a greater availability of sediment invertebrate benchmarks and lower values for these benchmarks. In contrast to the terrestrial assessment, arsenic poses *de minimus* risk to all wetland AEs. However, as in the terrestrial assessment, exposure to inorganic COPECs resulted in more wetland wildlife receptors demonstrating potential risk than exposure to organic COPECs. Additionally, wetland plants and sediment invertebrates appear to be more sensitive to TPH than wildlife receptors.

As discussed above and previously in Section 6.2, the sensitivity of the assessment endpoints varies, but the identified areas of risk for each COPEC are generally consistent. To understand the risks identified in this pERA in the context of the spatial distribution of each COPEC, the risk results for each AE/receptor are discussed below by COPEC for each Scenario.

8.1 Scenario 1

Scenario 1 includes the entire site for both terrestrial and wetland receptors.

Arsenic

Figure 8-1 summarizes the risks for each terrestrial AE from arsenic. The former operations area of the site is the primary location of background exceedances of arsenic. This area contains 10 sample locations showing some level of risk to terrestrial plants and mammals and *de minimus* risk to soil invertebrates and birds. With the exception of location S-8, HQs for terrestrial plants are greater than 1 for the low benchmark, but less than 1 based on the high benchmark, thus risk can be categorized as Level 1 for plants. Arsenic risks are also categorized as Level 1 at six locations and Level 2 at six locations to two of the eight terrestrial wildlife receptors: the California vole (six locations) and the ornate shrew (four locations).

While risk within the former operations area cannot be ruled out, the likelihood that the spatial extent and magnitude of the elevated concentrations would adversely affect plant or mammal populations is unlikely for the following reasons. First, the vast majority of elevated arsenic concentrations are located within the operations area which currently represents low quality habitat since the majority of the area contains parking lots and buildings. Second, higher quality habitat represented by the rest of the site (excluding the operations area) is within background for arsenic. Third, for these AEs, protection is at the level of the population; thus, given the small area of elevated arsenic concentrations, arsenic is not likely to pose significant risk to the populations of these species at the SLO Tank Farm site. However, based on the uncertainties associated with the risk estimates in the pERA, hot spot analysis may be necessary, especially if future reuse might result in habitat restoration.

Lead

The majority of lead concentrations on site are within the identified background population. For those samples that exceed background, the Tier 2 assessment indicated that lead poses *de minimus* risk to soil invertebrates. Risk to terrestrial and wetland plants is categorized as Level 1 and as Level 2 for sediment invertebrates in a few wetland locations. Due to the limited extent of the lead exceedances and the low magnitude of the HQs, it is unlikely that lead would adversely affect terrestrial/wetland plant or sediment invertebrate populations. However, for those AEs that include special-status species that need to be protected at the level of the individual, the potential for risk may need to be evaluated further. For

example, the only observed special-status terrestrial plant (SLO morning glory) does not occur in the former operations area or in seasonal wetlands where all of the elevated lead is found; thus, risk this receptor is expected to be *de minimus*. However, because the special-status Congdon's tar plant and the cysts of the special-status fairy shrimp have been observed in the wetland areas where elevated lead concentrations occur, risks to these species may require further evaluation.

The Tier 2 assessment also indicates that lead risk to birds can be categorized as Level 2 and as Level 1 for mammals. As discussed previously, 100% site use was assumed in each wildlife exposure estimate. For special-status species such as the loggerhead shrike and northern harrier that require a higher level of protection, this assumption may be appropriately conservative. However, given the conservatism of the lead food-chain model, where it is assumed that there is 100% bioavailability and assimilation efficiency, and the small area of elevated lead concentrations in relation to the home ranges of the identified receptors, lead is not likely to pose risk to wildlife populations in general. However, since uncertainty remains regarding the potential bioavailability of lead at the Site, additional hot spot assessment may be necessary to refine estimates of potential impacts to birds. Figures 8-2 and 8-3 summarize risk to terrestrial and wetland receptors respectively.

PAHs

Risk from PAHs is *de minimus* for terrestrial plants, invertebrates and wildlife receptors. Risk from PAHS at one sample location within the wetlands is categorized as Level 2 for wetland plants and sediment invertebrates, and as Level 1 at two locations for sediment invertebrates. Each of these locations is on or near a surface hydrocarbon expression. Figure 8-4 summarizes the risk to wetland receptors from PAHs. These limited exceedances are not expected to adversely affect wetland plant or invertebrate populations.

TPH

For TPH, Tier 2 risk is categorized as Level 2 for terrestrial and wetland plants and invertebrates. Wildlife receptors were assessed for exposure to TPH based on incidental soil ingestion. Of the eight terrestrial wildlife receptors, risk from TPH is categorized as Level 1 for the song sparrow and western meadowlark, but HQs are only slightly greater than 1 (2.0 and 1.5, respectively for the low benchmarks). For the wetland wildlife receptors, TPH risks are characterized as Level 2 for the western sandpiper (low benchmark HQ of 11 and high benchmark HQ of 1.1). As discussed above, when the conservatism of the site use factor (i.e., site use = 100%) is considered, this small magnitude of estimated risk is not likely to adversely impact avian populations. TPH risk to the remaining terrestrial and wetland wildlife receptors via incidental ingestion of soil is *de minimus*. Therefore, any future evaluation of TPH should focus on potential exposure to terrestrial and wetland plants and invertebrates as they are the most sensitive receptors evaluated.

While terrestrial and wetland plants and invertebrates are the most sensitive AEs evaluated at SLO Tank Farm for exposure to TPH, the spatial extent and magnitude of these exceedances should be considered. While risk is categorized as Level 2 for these AEs from exposure to TPH, only between 10% and 26% of the sample locations have HQs greater than the high benchmark depending on the AE (Tables 8-1 and 8-2). Additionally, Figures 8-5 and 8-6 show that the majority of TPH exceedances are on or near identified surface hydrocarbon expressions. A few notable exceptions include several samples within reservoir 4 (i.e., northeast corner of the site, Figure 8-5). Two samples in the wetland areas in the southwest corner of the site (B-52 in reservoir 6 and S-59, Figure 8-6) are also categorized as Level 2 and are not associated with known surface hydrocarbon expressions. Therefore, while TPH is the main risk driver

identified at the SLO Tank Farm, areas of potential risk are limited and the majority of the site presents either *de minimus* or Level 1 risks to plants and invertebrates.

8.2 Scenario 2

Scenario 2 evaluated the site excluding the former operations area. As discussed previously, this area has been identified as a potential area of commercial industrial use in the future. Under this scenario, ecological habitat within the former operations area would be negligible; thus, exposure pathways to ecological receptors would be incomplete.

Arsenic

As discussed previously, arsenic was not evaluated in Scenario 2 because concentrations outside the former operations area are generally within the range of background concentrations. Therefore, exposure to arsenic does not pose a threat to ecological receptors in Scenario 2.

Lead

Scenario 2 risks to herbivorous and insectivorous birds area categorized as Level 2; as Level 1 for terrestrial plants, herbivorous and insectivorous mammals and carnivorous birds; and as *de minimus* for soil invertebrates and carnivorous mammals. The results of Scenario 2 are not significantly different from the findings of Scenario 1. As previously discussed, the spatial distribution of elevated lead concentrations outside the former operations area are localized in several tank bottoms within the northwest portion of the site.

PAHs

PAHs were not evaluated for Scenario 2 because the 95% UCL is less than benchmarks. Therefore, in Scenario 2, PAH risks to all assessment endpoints are considered *de minimus*.

TPH

For Scenario 2, risk is categorized as *de minimus* for birds and mammals from TPH, and as Level 2 for terrestrial and wetland plants and terrestrial invertebrates. Risk to wetland sediment invertebrates is categorized as Level 1. The overall risk analysis for Scenario 2 is similar to Scenario 1, with only the song sparrow and the western meadowlark showing Level 1 risk to Scenario 1 and *de minimus* risk in Scenario 2. The areas of Level 1 or Level 2 risk identified in Scenario 2 are generally associated with surface hydrocarbon expressions or subsurface plumes identified on-site.

8.3 Conclusions

In general terms, terrestrial/wetland plants and terrestrial/sediment invertebrates are the most sensitive receptors evaluated in the pERA, especially in terms of risk due to exposure to petroleum. Potential risk to wildlife through exposure to petroleum (either as TPH or PAHs) is generally *de minimus*. Spatially, the majority of TPH exceedances are on or near identified surface hydrocarbon expressions. A few notable exceptions include several samples within reservoir 4 and 2 samples in the wetland areas in the southwest corner of the site (B-52 in Tank 6 and S-59). The main risks to wildlife are through exposure to lead and to a lesser extent arsenic. Elevated concentrations of both compounds are localized and limited to the operations area (arsenic) and to tank bottoms in the northeastern portion of the site (lead).

While the pERA has identified the potential for risk, as described above, the screening-level framework resulted in conservative estimates of risk. A validation study focused on the most significant sources of uncertainty would further refine the evaluation and could corroborate these initial findings or result in a finding of *de minimus* risk. Risk managers will need to evaluate the findings presented herein and decide whether sufficient information exists to manage identified risks at the site, or whether a focused validation study is needed to help reduce uncertainty and to refine the estimate of potential risk.

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Table 3-1. Soil and Sediment COPEC Screen Summary
San Luis Obispo Tank Farm

Constituent	COPEC?	Frequency Detects / Total	Percent Detects	Range of SQLs Min – Max	Range of Detects Min – Max	Background Inflection Point	Lowest Screening Value	Benchmark Source	Decision Rationale/Professional Judgment
Metals (mg/kg - dry weight)									
Antimony	No	0 / 119	0 %	6.3 - 6.3	-	ND	5.0	Efroymson et al., 1997a.	Background not developed; never detected, 1/2 detection limit below low benchmark
Arsenic	Yes/No	98 / 120	82 %	1.3 - 13	1.4 - 388	8.6	9.79	MacDonald, et al., 2000.	Frequently detected; samples within operations area exceed background (Scenario 1); samples outside operations area are within the background population (Scenario 2).
Barium	No	119 / 119	100 %	-	29 - 4380	313	50	Phillips, et al., 2001.	Low frequency of background exceedance (3 out of 213 samples) - data generally within background population.
Beryllium	No	26 / 119	22 %	0.13 - 0.63	0.63 - 0.88	0.89	10	Efroymson et al., 1997a.	All on-site data within background population.
Cadmium	No	20 / 119	17 %	0.63 - 1.3	1.3 - 5.4	2.4	0.99	MacDonald, et al., 2000.	Low frequency of background exceedance (4 out of 213 samples) - data generally within background population.
Chromium	No	123 / 123	100 %	-	6.8 - 651	911	0.40	Efroymson et al., 1997b.	All on-site data within background population.
Cobalt	No	119 / 119	100 %	-	6.0 - 138	55	20	Efroymson et al., 1997a	Low frequency of background exceedance (8 out of 209 samples)- data generally within background population.
Copper	No	119 / 119	100 %	-	8.1 - 115	116	31.6	MacDonald, et al., 2000.	All on-site data within background population.
Lead	Yes	127 / 136	93 %	1.3 - 13	2.4 - 1151	35	35.8	MacDonald, et al., 2000.	Exceeds background for Scenarios 1 and 2; frequently detected; exceeds low benchmark
Mercury	No	32 / 120	27 %	0.13 - 0.13	0.13 - 0.63	0.38	0.10	Efroymson et al., 1997b.	Low frequency of background exceedance (2 out of 235 samples) - data generally within background population.
Molybdenum	No	14 / 119	12 %	1.3 - 6.3	1.3 - 663	2	2.0	Efroymson et al., 1997a.	Low frequency of background exceedance (5 out of 213 samples)- data generally within background population.
Nickel	No	122 / 123	99 %	1.3 - 1.3	14 - 926	1392	22.7	MacDonald, et al., 2000.	All on-site data within background population.
Selenium	No	2 / 123	2 %	0.63 - 13	1.9 - 2.1	ND	1.0	Efroymson et al., 1997a.	Background not developed; detected less than 5%; 11% of detection limits exceed low benchmark. COPEC discussed in uncertainty analysis.
Silver	No	0 / 119	0 %	1.3 - 1.3	-	ND	2.0	Efroymson et al., 1997a.	Background not developed; never detected, detection limit is below low benchmark
Thallium	No	0 / 119	0 %	6.3 - 19	-	ND	1.0	Efroymson et al., 1997a.	Background not developed; never detected; all detection limits exceed low benchmark. COPEC discussed in uncertainty analysis.
Vanadium	No	123 / 123	100 %	-	20 - 188	105	2.0	Efroymson et al., 1997a.	Low frequency of background exceedance (4 out of 240 samples)- data generally within background population.
Zinc	No	119 / 119	100 %	-	16 - 313	163	50	Efroymson et al., 1997a.	Low frequency of background exceedance (6 out of 213 samples) - data generally within background population.
Petroleum Hydrocarbons (mg/kg - dry weight)									
Sum TPH (C10-C40)	Yes	141 / 237	59 %	6.3 - 13	19 - 337922	NA	782	see BBL Benchmark and BAF Memo, Appendix F.	Frequently detected; known site-related compound based on historical site activity
Acenaphthene	Yes	11 / 68	16 %	0.0063 - 6.3	0.016 - 0.88	NA	0.29	Buchman, 1999.	Frequently detected; known site-related compound based on historical site activity
Acenaphthylene	Yes	8 / 68	12 %	0.0063 - 6.3	0.051 - 0.50	NA	0.16	Buchman, 1999.	Frequently detected; known site-related compound based on historical site activity
Anthracene	Yes	7 / 68	10 %	0.0063 - 6.3	0.010 - 0.38	NA	0.0572	MacDonald, et al., 2000.	Frequently detected; known site-related compound based on historical site activity
Benzo(a)anthracene	Yes	10 / 68	15 %	0.0063 - 6.3	0.019 - 2.3	NA	0.108	MacDonald, et al., 2000.	Frequently detected; known site-related compound based on historical site activity
Benzo(a)pyrene	Yes	16 / 68	24 %	0.0063 - 6.3	0.0088 - 4.5	NA	0.15	MacDonald, et al., 2000.	Frequently detected; known site-related compound based on historical site activity
Benzo(b)fluoranthene	Yes	21 / 68	31 %	0.0063 - 6.3	0.0075 - 3.6	NA	0.0272	Jones et al., 1997.	Frequently detected; known site-related compound based on historical site activity
Benzo(k)fluoranthene	Yes	7 / 68	10 %	0.0063 - 6.3	0.0088 - 0.75	NA	0.0272	Buchman, 1999.	Frequently detected; known site-related compound based on historical site activity

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Constituent	COPEC?	Frequency Detects / Total	Percent Detects	Range of SQLs Min – Max	Range of Detects Min – Max	Background Inflection Point	Lowest Screening Value	Benchmark Source	Decision Rationale/Professional Judgment
Benzo(g,h,i)perylene	Yes	16 / 68	24 %	0.0063 - 6.3	0.0063 - 2.4	NA	0.17	Jones et al., 1997.	Frequently detected; known site-related compound based on historical site activity
Chrysene	Yes	19 / 68	28 %	0.0063 - 6.3	0.011 - 3.9	NA	0.166	MacDonald, et al., 2000.	Frequently detected; known site-related compound based on historical site activity
Dibenzo(a,h)anthracene	Yes	4 / 68	6 %	0.0063 - 6.3	0.014 - 0.25	NA	0.033	MacDonald, et al., 2000.	Frequently detected; known site-related compound based on historical site activity
Fluoranthene	Yes	13 / 68	19 %	0.0063 - 6.3	0.0075 - 1.4	NA	0.423	MacDonald, et al., 2000.	Frequently detected; known site-related compound based on historical site activity
Fluorene	Yes	12 / 68	18 %	0.0063 - 6.3	0.023 - 2.8	NA	0.077	MacDonald, et al., 2000.	Frequently detected; known site-related compound based on historical site activity
Indeno(1,2,3-cd)pyrene	Yes	12 / 68	18 %	0.0063 - 6.3	0.0063 - 2.1	NA	1.2	CCME, 1999f (BaP vlaue used as surrogate)	Frequently detected; known site-related compound based on historical site activity
Naphthalene	Yes	11 / 111	10 %	0.0063 - 6.3	0.0088 - 11	NA	0.176	MacDonald, et al., 2000.	Frequently detected; known site-related compound based on historical site activity
Phenanthrene	Yes	20 / 68	29 %	0.0063 - 2.5	0.041 - 6.4	NA	0.204	MacDonald, et al., 2000.	Frequently detected; known site-related compound based on historical site activity
Pyrene	Yes	25 / 68	37 %	0.0063 - 6.3	0.0088 - 5.3	NA	0.195	MacDonald, et al., 2000.	Frequently detected; known site-related compound based on historical site activity
Sum PAH	Yes	38 / 68	56 %	0.050 - 20	0.054 - 53	NA	1.61	MacDonald, et al., 2000.	Frequently detected; known site-related compound based on historical site activity
PCBs (mg/kg - dry weight)									
Aroclor 1016	No	0 / 55	0 %	0.038 - 0.038	-	NA	40 a	Efroymson et al., 1997a.	Never detected; detection limits adequate
Aroclor 1221	No	0 / 55	0 %	0.038 - 0.038	-	NA	40 a	Efroymson et al., 1997a.	Never detected; detection limits adequate
Aroclor 1232	No	0 / 55	0 %	0.038 - 0.038	-	NA	40 a	Efroymson et al., 1997a.	Never detected; detection limits adequate
Aroclor 1242	No	0 / 55	0 %	0.038 - 0.038	-	NA	40 a	Efroymson et al., 1997a.	Never detected; detection limits adequate
Aroclor 1248	No	0 / 55	0 %	0.038 - 0.038	-	NA	40 a	Efroymson et al., 1997a.	Never detected; detection limits adequate
Aroclor 1254	No	6 / 55	11 %	0.038 - 0.038	0.04 - 0.11	NA	40 a	Efroymson et al., 1997a.	Maximum detected value below benchmark; bioaccumulation risk not relevant based on limited spatial area of detected concentrations
Aroclor 1260	No	0 / 55	0 %	0.038 - 0.038	-	NA	40 a	Efroymson et al., 1997a.	Never detected; detection limits adequate
Herbicdes (mg/kg - dry weight)									
2,4,5-T	No	0 / 23	0 %	0.025 - 0.025	-	NA	NC*		
2,4-D	No	0 / 23	0 %	0.25 - 0.25	-	NA	NC*		
2,4-DB	No	0 / 23	0 %	0.25 - 0.25	-	NA	NC*		
Dalapon	No	0 / 23	0 %	0.63 - 0.63	-	NA	NC*		
Dicamba	No	0 / 23	0 %	0.03 - 0.03	-	NA	NC*		
Dichloroprop	No	0 / 23	0 %	0.25 - 0.25	-	NA	NC*		
Dinoseb	No	0 / 23	0 %	0.050 - 0.050	-	NA	NC*		
MCPA	No	0 / 23	0 %	25 - 25	-	NA	NC*		
MCPP	No	0 / 23	0 %	25 - 25	-	NA	NC*		
Silvex	No	0 / 23	0 %	0.025 - 0.025	-	NA	NC*		
Pesticides (mg/kg - dry weight)									
4,4'-DDD	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.00488	MacDonald, et al., 2000.	Never detected; 20% of detection limits elevated, 80% adequate
4,4'-DDE	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.00316	MacDonald, et al., 2000.	Never detected; 30% of detection limits elevated, 70% adequate
4,4'-DDT	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.00416	MacDonald, et al., 2000.	Never detected; 20% of detection limits elevated, 80% adequate
Aldrin	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.002	Jones et al., 1997.	Never detected, 32% of detection limits elevated, 68% adequate
alpha-BHC	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.120	Jones et al., 1997.	Never detected: detection limits adequate
beta-BHC	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.120	Jones et al., 1997.	Never detected: detection limits adequate
Chlordane	No	0 / 40	0 %	0.13 - 1.9	-	NA	0.00324	MacDonald, et al., 2000.	Never detected: all detection limits elevated
delta-BHC	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.120	Jones et al., 1997.	Never detected: detection limits adequate
Dieldrin	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.00190	MacDonald, et al., 2000.	Never detected, 32% of detection limits elevated, 68% adequate
Endosulfan I	No	0 / 23	0 %	0.0025 - 0.038	-	NA	0.0055	Jones et al., 1997.	Never detected; 35% of detection limits elevated, 65% adequate

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Endosulfan II	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.0055	Jones et al., 1997.	Never detected; 20% of detection limits elevated, 80% adequate
Endosulfan sulfate	No	0 / 57	0 %	0.0025 - 0.038	-	NA	0.0055	Jones et al., 1997.	Never detected; 14% of detection limits elevated, 86% adequate
Endrin	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.00222	MacDonald, et al., 2000.	Never detected, 32% of detection limits elevated, 68% adequate
Endrin aldehyde	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.0019 b		Never detected; 32% of detection limits elevated, 78% adequate
Endrin ketone	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.0019 b		Never detected; 32% of detection limits elevated, 78% adequate
gamma-BHC (Lindane)	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.00237	MacDonald, et al., 2000.	Never detected, 32% of detection limits elevated, 68% adequate
Heptachlor	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.068	Jones et al., 1997.	Never detected; detection limits adequate
Heptachlor epoxide	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.00247	MacDonald, et al., 2000.	Never detected, 32% of detection limits elevated, 68% adequate
Methoxychlor	No	0 / 40	0 %	0.0025 - 0.038	-	NA	0.019	Jones et al., 1997.	Never detected; detection limits adequate
Toxaphene	No	0 / 40	0 %	0.13 - 1.9	-	NA	0.0019 b		Never detected; all detection limits elevated
Semi-volatile Organic Compounds (SVOCs) (mg/kg - dry weight)									
2,4,5-Trichlorophenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	4	Efroymson et al., 1997a.	Never detected; detection limits adequate
2,4,6-Trichlorophenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	10	Efroymson et al., 1997b.	Never detected; detection limits adequate
2,4-Dichlorophenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
2,4-Dimethylphenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
2,4-Dinitrophenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	20	Efroymson et al., 1997a.	Never detected; detection limits adequate
2,4-Dinitrotoluene	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
2,6-Dinitrotoluene	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
2-Chloronaphthalene	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
2-Chlorophenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
2-Methylnaphthalene	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
2-Methylphenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
2-Nitroaniline	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
2-Nitrophenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
3,3'-Dichlorobenzidine	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
3-Nitroaniline	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
4,6-Dinitro-2-methylphenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
4-Bromophenyl phenyl ether	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
4-Chloro-3-methylphenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
4-Chloroaniline	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
4-Chlorophenyl phenyl ether	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
4-Methylphenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
4-Nitroaniline	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
4-Nitrophenol	No	0 / 5	0 %	0.63 - 0.63	-	NA	7	Efroymson et al., 1997b.	Never detected; detection limits adequate
Aniline	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
Azobenzene	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
Benzoic acid	No	0 / 5	0 %	0.63 - 0.63	-	NA	3 c		Never detected; detection limits adequate
Benzyl alcohol	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
bis(2-chloroethoxy) methane	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
bis(2-Chloroethyl) ether	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
bis(2-Chloroisopropyl) ether	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
bis(2-Ethylhexyl) phthalate	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
Butyl benzyl phthalate	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
Dibenzofuran	No	0 / 5	0 %	0.13 - 0.13	-	NA	14	Sverdrup et al., 2001.	Never detected; detection limits adequate
Diethyl phthalate	No	0 / 5	0 %	0.13 - 0.13	-	NA	100	Efroymson et al., 1997a.	Never detected; detection limits adequate
Dimethyl phthalate	No	0 / 5	0 %	0.13 - 0.13	-	NA	200	Efroymson et al., 1997b.	Never detected; detection limits adequate
Di-n-butyl phthalate	No	0 / 5	0 %	0.13 - 0.13	-	NA	200	Efroymson et al., 1997a.	Never detected; detection limits adequate
Di-n-octyl phthalate	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
Hexachlorobenzene	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
Hexachlorocyclopentadiene	No	0 / 5	0 %	0.13 - 0.13	-	NA	10	Efroymson et al., 1997a.	Never detected; detection limits adequate
Hexachloroethane	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
Isophorone	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate

Table 3-1. Soil and Sediment COPEC Screen Summary
San Luis Obispo Tank Farm

Constituent	COPEC?	Frequency Detects / Total	Percent Detects	Range of SQLs Min – Max	Range of Detects Min – Max	Background Inflection Point	Lowest Screening Value	Benchmark Source	Decision Rationale/Professional Judgment
Nitrobenzene	No	0 / 5	0 %	0.13 - 0.13	-	NA	40	Efroymson et al., 1997b.	Never detected; detection limits adequate
n-Nitrosodimethylamine	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
N-Nitrosodi-n-propylamine	No	0 / 5	0 %	0.13 - 0.13	-	NA	3 c		Never detected; detection limits adequate
n-Nitrosodiphenylamine	No	0 / 5	0 %	0.13 - 0.13	-	NA	20	Efroymson et al., 1997b.	Never detected; detection limits adequate
Pentachlorophenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	3	Efroymson et al., 1997a.	Never detected; detection limits adequate
Phenol	No	0 / 5	0 %	0.13 - 0.13	-	NA	30	Efroymson et al., 1997b.	Never detected; detection limits adequate
Volatile Organic Compounds (VOCs) (mg/kg - dry weight)									
1,1,1,2-Tetrachloroethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
1,1,1-Trichloroethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.03	Jones, et al., 1997.	Never detected; detection limits adequate
1,1,2,2-Tetrachloroethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	1.4	Jones, et al., 1997.	Never detected; detection limits adequate
1,1,2-Trichloroethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	1.2	Jones, et al., 1997.	Never detected; detection limits adequate
1,1-Dichloroethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.027	Jones, et al., 1997.	Never detected; detection limits adequate
1,1-Dichloroethene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.031	Jones, et al., 1997.	Never detected; detection limits adequate
1,1-Dichloropropene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
1,2,3-Trichlorobenzene	No	0 / 55	0 %	0.013 - 0.013	-	NA	20	Efroymson et al., 1997b.	Never detected; detection limits adequate
1,2,3-Trichloropropane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
1,2,4-Trichlorobenzene	No	0 / 60	0 %	0.013 - 0.13	-	NA	9.6	Jones, et al., 1997.	Never detected; detection limits adequate
1,2,4-Trimethylbenzene	No	3 / 55	5 %	0.0063 - 0.0063	0.02 - 0.12	NA	0.022 b		Low frequency of detection; detection limits adequate
1,2-Dibromo-3-chloropropane	No	0 / 55	0 %	0.013 - 0.013	-	NA	0.022 b		Never detected; detection limits adequate
1,2-Dibromoethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
1,2-Dichlorobenzene	No	0 / 60	0 %	0.0063 - 0.13	-	NA	0.33	Jones, et al., 1997.	Never detected; detection limits adequate
1,2-Dichloroethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.25	Jones, et al., 1997.	Never detected; detection limits adequate
1,2-Dichloropropane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	700	Efroymson et al., 1997b.	Never detected; detection limits adequate
1,3,5-Trimethylbenzene	No	3 / 55	5 %	0.0063 - 0.0063	0.01 - 0.04	NA	0.022 b		Low frequency of detection; detection limits adequate
1,3-Dichlorobenzene	No	0 / 60	0 %	0.0063 - 0.13	-	NA	1.7	Jones, et al., 1997.	Never detected; detection limits adequate
1,3-Dichloropropane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
1,4-Dichlorobenzene	No	0 / 60	0 %	0.0063 - 0.13	-	NA	0.34	Jones, et al., 1997.	Never detected; detection limits adequate
2,2-Dichloropropane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
2-Chloroethyl vinyl ether	No	0 / 55	0 %	0.013 - 0.013	-	NA	0.022 b		Never detected; detection limits adequate
2-Chlorotoluene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
4-Chlorotoluene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Benzene	No	4 / 219	2 %	0.0063 - 0.13	0.06 - 3.13	NA	0.16/24	Jones et al., 1997/CCME, 1999a.	All samples within wetland have adequate detection limits. All terrestrial samples have adequate detection limits.
Bromobenzene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Bromochloromethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Bromodichloromethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Bromoform	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Bromomethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Carbon tetrachloride	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.047	Jones, et al., 1997.	Never detected; detection limits adequate
Chlorobenzene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.41	Jones, et al., 1997.	Never detected; detection limits adequate
Chloroethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Chloroform	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022	Jones, et al., 1997.	Never detected; detection limits adequate
Chloromethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
cis-1,2-Dichloroethene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
cis-1,3-Dichloropropene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Dibromochloromethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Dibromomethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Dichlorodifluoromethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Dichlorotrifluoroethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Ethylbenzene	No	4 / 219	2 %	0.0063 - 0.13	0.01 - 18.77	NA	0.089/6	Jones et al., 1997/CCME, 1999b.	All samples within wetland have adequate detection limits. All terrestrial samples have adequate detection limits.
Hexachlorobutadiene	No	0 / 60	0 %	0.0063 - 0.13	-	NA	0.022 b		Never detected; 8% of detection limits elevated, 92% adequate
Isopropylbenzene	No	6 / 55	11 %	0.0063 - 0.0063	0.02 - 0.05	NA	0.022 b		Low frequency of detection; detection limits adequate
Methylene chloride	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.37	Jones, et al., 1997.	Never detected; detection limits adequate
n-Butylbenzene	No	1 / 55	2 %	0.0063 - 0.0063	0.01 - 0.01	NA	0.022 b		Low frequency of detection; detection limits adequate
n-Propylbenzene	No	6 / 55	11 %	0.0063 - 0.0063	0.01 - 0.05	NA	0.022 b		Low frequency of detection; detection limits adequate

Table 3-1. Soil and Sediment COPEC Screen Summary
San Luis Obispo Tank Farm

Constituent	COPEC?	Frequency Detects / Total	Percent Detects	Range of SQLs Min – Max	Range of Detects Min – Max	Background Inflection Point	Lowest Screening Value	Benchmark Source	Decision Rationale/Professional Judgment
p-Isopropyltoluene	No	1 / 55	2 %	0.0063 - 0.0063	0.01 - 0.01	NA	0.022 b		Low frequency of detection; detection limits adequate
sec-Butylbenzene	No	5 / 55	9 %	0.0063 - 0.0063	0.01 - 0.02	NA	0.022 b		Low frequency of detection; detection limits adequate
Styrene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	300	Efroymson et al., 1997a.	Never detected; detection limits sufficient
tert-Butylbenzene	No	1 / 55	2 %	0.0063 - 0.0063	0.01 - 0.01	NA	0.022 b		Low frequency of detection; detection limits adequate
Tetrachloroethene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.41	Jones, et al., 1997.	Never detected; detection limits adequate
Toluene	No	4 / 219	2 %	0.0063 - 0.13	0.03 - 4.51	NA	0.05/7	Jones et al., 1997/CCME, 1999c.	All samples within wetland have adequate detection limits. All terrestrial samples have adequate detection limits.
trans-1,2-Dichloroethene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
trans-1,3-Dichloropropene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Trichloroethene	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.22	Jones, et al., 1997.	Never detected; detection limits adequate
Trichlorofluoromethane	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Vinyl chloride	No	0 / 55	0 %	0.0063 - 0.0063	-	NA	0.022 b		Never detected; detection limits adequate
Xylenes (total)	No	5 / 219	2 %	0.0063 - 0.13	0.02 - 46.31	NA	0.16/5	Jones et al., 1997/CCME, 1999d.	All samples within wetland have adequate detection limits. All terrestrial samples have adequate detection limits.

Notes:
Concentrations are mg/kg dry weight.
ND = Background concentration could not be developed due to infrequent detection.
NA = No background analysis conducted.
NC = No crtiteria.
SQL = Sample quantitation limit.
Statistics are for all onsite soil and sediment samples from depths less than or equal to 5 feet bgs.
* Detection limits were adequate for most pesticides and herbicides. As no compounds in this class were detected and historical site information would not indicate these compounds as Site-related constituents, these compounds are excluded as COPECs based on professional judgment.
a = Total PCB benchmark for terrestrial plants used as surrogate for Aroclors; all samples collected from terrestrial habitat.
b = Surrogate value is minimum benchmark for compound class.
c = Surrogate value is minimum soil benchmark for compound class; all samples collected from terrestrial habitat.

Table 3-2. Surface Water COPEC Screen Summary
San Luis Obispo Tank Farm

Constituent	COPEC?	Frequency Detects / Total	Percent Detects	Range of SQLs Min – Max	Range of Detects Min – Max	Decision Rationale/Professional Judgment
Metals (mg/L)						
Antimony	No	0 / 10	0 %	0.010 - 0.010	-	Not detected. Detection limits adequate.
Arsenic	Yes	7 / 10	70 %	0.001 - 0.001	0.002 - 0.01	Detected in greater than 5% of samples.
Barium	Yes	10 / 10	100 %	-	0.055 - 0.26	Detected in greater than 5% of samples.
Beryllium	No	0 / 10	0 %	0.00066 - 0.00066	-	Not detected. Detection limits adequate.
Cadmium	No	0 / 10	0 %	0.00025 - 0.00025	-	Not detected. Detection limits adequate.
Chromium	No	0 / 10	0 %	0.010 - 0.010	-	Not detected. Detection limits adequate.
Cobalt	No	0 / 10	0 %	0.010 - 0.010	-	Not detected. Detection limits adequate.
Copper	No	0 / 10	0 %	0.009 - 0.009	-	Not detected. Detection limits adequate.
Lead	No	0 / 10	0 %	0.0025 - 0.0025	-	Not detected. Detection limits adequate.
Mercury	No	0 / 10	0 %	0.0002 - 0.0002	-	Not detected. Detection limits adequate.
Molybdenum	No	0 / 10	0 %	0.010 - 0.010	-	Not detected. Detection limits adequate.
Nickel	Yes	9 / 10	90 %	0.010 - 0.010	0.01 - 0.03	Detected in greater than 5% of samples.
Selenium	No	0 / 10	0 %	0.005 - 0.005	-	Not detected. Detection limits adequate.
Silver	No	0 / 10	0 %	0.0032 - 0.0032	-	Not detected. Detection limits adequate.
Thallium	Yes	2 / 10	20 %	0.012 - 0.012	0.013 - 0.013	Detected in greater than 5% of samples.
Vanadium	Yes	1 / 10	10 %	0.010 - 0.010	0.01 - 0.01	Detected in greater than 5% of samples.
Zinc	Yes	8 / 10	80 %	0.010 - 0.010	0.01 - 0.02	Detected in greater than 5% of samples.
Petroleum Hydrocarbons (ug/L)						
Sum TPH (C10-C40)	No	8 / 10	80 %	100 - 100	130 - 1900	Geochemical analysis found likely biogenic source of detected TPH (polar fraction)
Sum TPH (C10-C40) - with silica gel clean up	No	0 / 10	0 %	100 - 100		Not detected. Detection limits adequate.
Acenaphthene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Acenaphthylene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Anthracene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Benzo(a)anthracene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Benzo(a)pyrene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Benzo(b)fluoranthene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Benzo(k)fluoranthene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Benzo(g,h,i)perylene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Chrysene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Dibenzo(a,h)anthracene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Fluoranthene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.

Table 3-2. Surface Water COPEC Screen Summary
San Luis Obispo Tank Farm

Constituent	COPEC?	Frequency Detects / Total	Percent Detects	Range of SQLs Min – Max	Range of Detects Min – Max	Decision Rationale/Professional Judgment
Fluorene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Indeno(1,2,3-cd)pyrene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Naphthalene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Phenanthrene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Pyrene	No	0 / 10	0 %	0.01 - 0.01	-	Not detected. Detection limits adequate.
Volatile Organic Compounds (VOCs) (ug/L)						
Benzene	No	0 / 10	0 %	0.50 - 0.50	-	Not detected. Detection limits adequate.
Ethylbenzene	No	0 / 10	0 %	0.50 - 0.50	-	Not detected. Detection limits adequate.
Toluene	Yes	3 / 10	30 %	0.50 - 0.50	0.70 - 7.10	Detected in greater than 5% of samples.
Xylenes	No	0 / 10	0 %	0.50 - 0.50	-	Not detected. Detection limits adequate.

Notes:
Concentrations are mg/l.
Statistics are for all onsite surface water from all depths.

Table 3-3. Riparian Soil COPEC Screen Summary

San Luis Obispo Tank Farm

Constituent	COPEC?	Frequency* Detects / Total	Percent Detects	Range of SQLs Min – Max	Range of Detects Min – Max	Decision Rationale/Professional Judgment
Metals (mg/kg - dry weight)						
Antimony	No	0 / 4	0 %	6.26 - 6.26	-	Not retained based on site-wide soil COPEC screen
Arsenic	Yes	3 / 4	75 %	12.51 - 12.51	1.88 - 3.75	Retained based on site-wide soil COPEC screen
Barium	No	4 / 4	100 %	-	187.73 - 250.31	Not retained based on site-wide soil COPEC screen
Beryllium	No	1 / 4	25 %	0.125 - 0.626	0.876 - 0.876	Not retained based on site-wide soil COPEC screen
Cadmium	No	0 / 4	0 %	0.626 - 1.25	-	Not retained based on site-wide soil COPEC screen
Chromium	No	4 / 4	100 %	-	125.2 - 325	Not retained based on site-wide soil COPEC screen
Cobalt	No	4 / 4	100 %	-	16.3 - 41	Not retained based on site-wide soil COPEC screen
Copper	No	4 / 4	100 %	-	18.8 - 31	Not retained based on site-wide soil COPEC screen
Lead	Yes	3 / 4	75 %	12.51 - 12.51	13.8 - 15	Retained based on site-wide soil COPEC screen
Mercury	No	2 / 4	50 %	0.125 - 0.125	0.25 - 0.25	Not retained based on site-wide soil COPEC screen
Molybdenum	No	0 / 4	0 %	1.25 - 6.26	-	Not retained based on site-wide soil COPEC screen
Nickel	No	4 / 4	100 %	-	125.16 - 550.69	Not retained based on site-wide soil COPEC screen
Selenium	No	0 / 4	0 %	1.25 - 1.25	-	Not retained based on site-wide soil COPEC screen
Silver	No	0 / 4	0 %	1.25 - 1.25	-	Not retained based on site-wide soil COPEC screen
Thallium	No	0 / 4	0 %	6.26 - 18.77	-	Not retained based on site-wide soil COPEC screen
Vanadium	No	4 / 4	100 %	-	40.05 - 50.06	Not retained based on site-wide soil COPEC screen
Zinc	No	4 / 4	100 %	-	30.04 - 62.59	Not retained based on site-wide soil COPEC screen
Petroleum Hydrocarbons (mg/kg - dry weight)						
Sum TPH (C10-C40)	Yes	6 / 8	75 %	13 - 13	19 - 148	Retained based on site-wide soil COPEC screen
Acenaphthene	Yes	0 / 2	0 %	0.0063 - 0.0063	-	Retained based on site-wide soil COPEC screen
Acenaphthylene	Yes	0 / 2	0 %	0.0063 - 0.0063	-	Retained based on site-wide soil COPEC screen
Anthracene	Yes	1 / 2	50 %	0.0063 - 0.0063	0.01 - 0.01	Retained based on site-wide soil COPEC screen
Benzo(a)anthracene	Yes	1 / 2	50 %	0.0063 - 0.0063	0.053 - 0.053	Retained based on site-wide soil COPEC screen
Benzo(a)pyrene	Yes	1 / 2	50 %	0.0063 - 0.0063	0.076 - 0.076	Retained based on site-wide soil COPEC screen
Benzo(b)fluoranthene	Yes	2 / 2	100 %	-	0.0075 - 0.163	Retained based on site-wide soil COPEC screen
Benzo(k)fluoranthene	Yes	1 / 2	50 %	0.0063 - 0.0063	0.043 - 0.043	Retained based on site-wide soil COPEC screen
Benzo(g,h,i)perylene	Yes	1 / 2	50 %	0.0063 - 0.0063	0.043 - 0.043	Retained based on site-wide soil COPEC screen
Chrysene	Yes	1 / 2	50 %	0.0063 - 0.0063	0.075 - 0.075	Retained based on site-wide soil COPEC screen
Dibenzo(a,h)anthracene	Yes	1 / 2	50 %	0.0063 - 0.0063	0.014 - 0.014	Retained based on site-wide soil COPEC screen
Fluoranthene	Yes	1 / 2	50 %	0.0063 - 0.0063	0.109 - 0.109	Retained based on site-wide soil COPEC screen
Fluorene	Yes	0 / 2	0 %	0.0063 - 0.0063	-	Retained based on site-wide soil COPEC screen
Indeno(1,2,3-cd)pyrene	Yes	1 / 2	50 %	0.0063 - 0.0063	0.061 - 0.061	Retained based on site-wide soil COPEC screen
Naphthalene	Yes	0 / 2	0 %	0.0063 - 0.0063	-	Retained based on site-wide soil COPEC screen
Phenanthrene	Yes	1 / 2	50 %	0.0063 - 0.0063	0.041 - 0.041	Retained based on site-wide soil COPEC screen
Pyrene	Yes	1 / 2	50 %	0.0063 - 0.0063	0.113 - 0.113	Retained based on site-wide soil COPEC screen

Table 3-3. Riparian Soil COPEC Screen Summary
San Luis Obispo Tank Farm

Constituent	COPEC?	Frequency* Detects / Total	Percent Detects	Range of SQLs Min – Max	Range of Detects Min – Max	Decision Rationale/Professional Judgment
Volatile Organic Compounds (VOCs) (mg/kg - dry weight)						
Benzene	No	0 / 8	0 %	0.0063 - 0.0063	-	Not retained based on site-wide soil COPEC screen
Ethylbenzene	No	0 / 8	0 %	0.0063 - 0.0063	-	Not retained based on site-wide soil COPEC screen
Toluene	No	0 / 8	0 %	0.0063 - 0.0063	-	Not retained based on site-wide soil COPEC screen
Xylenes	No	0 / 8	0 %	0.0063 - 0.0063	-	Not retained based on site-wide soil COPEC screen

Notes:
Concentrations are mg/kg dry weight
* Frequency of detection was not used as a COPEC screening criteria due to small sample sizes.
Statistics are for all onsite soil and sediment identified within the riparian corridor from depths less than or equal to 10 feet bgs.
COPEC selection based on site-wide soil and sediment screen (Table 3-1)

Table 3-4. Inorganic Background Inflection Points
San Luis Obispo Tank Farm

Metal	Inflection Point (mg/kg WW)	Inflection Point (mg/kg DW)
Antimony	N/A	N/A
Arsenic	6.9	8.6
Barium	250	313
Beryllium	0.7	0.89
Cadmium	1.9	2.4
Chromium	720	911
Cobalt	44	55
Copper	92	116
Lead	28	35
Mercury	0.3	0.38
Molybdenum[2]	1.6	2.0
Nickel	1100	1392
Selenium	N/A	N/A
Silver	N/A	N/A
Thallium	N/A	N/A
Vanadium	89	105
Zinc	130	163

N/A = not available, background not determined due to low number of detects.

[1]Non-detected concentrations evaluated at half detection limit.

[2]Of the 8 samples that exceed the inflection point, 6 are non-detects at 6.26 mg/kg.

WW = wet weight DW = dry weight

Wet weight concentrations converted to dry weight assuming 21% moisture in soil.

Source: England Geosystem, 2003b.

Table 3-5. Terrestrial Problem Formulation Summary
San Luis Obispo Tank Farm

	Risk Question	Assessment Endpoint (AE)	Measurement Endpoint (ME)
Primary Producers	Are chemical constituents in the terrestrial environment adversely affecting terrestrial plant species?	AE-T1: Survival and reproduction of terrestrial plant populations conducive to maintenance of the terrestrial plant community and maintenance of the SLO morning glory population	1) Compare soil concentrations to phytotoxicity benchmarks • Compare against low and high benchmarks 2) Overlay SLO morning glory population map to evaluate risk to this species of special concern
Primary Consumers	Are chemical constituents in the terrestrial environment adversely affecting terrestrial invertebrate communities?	AE-T2: Survival and reproduction of terrestrial invertebrate populations conducive to the maintenance of the terrestrial invertebrate community	1) Comparison of soil concentrations to terrestrial soil invertebrate toxicity benchmarks • Compare against low and high benchmarks
	Are chemical constituents in terrestrial environment adversely affecting herbivorous birds populations?	AE-T3: Survival, growth and reproduction of herbivorous bird populations*	1) Estimate average daily dose by modeling COPEC concentrations in plant tissue and soil from SLO TF and compare the modeled dose to avian TRVs. • Compare to low and high TRVs
	Are chemical constituents in terrestrial environment adversely affecting herbivorous mammal populations?	AE-T4: Survival, growth and reproduction of herbivorous mammal populations	1) Estimate average daily dose by modeling COPEC concentrations in plant tissue and soil from SLO TF and compare the modeled dose to mammalian TRVs. • Compare to low and high TRVs

Table 3-5. Terrestrial Problem Formulation Summary
San Luis Obispo Tank Farm

	Risk Question	Assessment Endpoint (AE)	Measurement Endpoint (ME)
Secondary Consumers	Are chemical constituents in terrestrial environment adversely affecting insectivorous bird populations?	AE-T5: Survival, growth and reproduction of insectivorous bird species*	1) Estimate average daily dose by modeling COPEC body burdens in invertebrate tissue and soil from SLO TF and compare the modeled dose to avian TRVs. • Compare to low and high TRVs
	Are chemical constituents in terrestrial soils affecting insectivorous mammal populations?	AE-T6: Survival, growth and reproduction of insectivorous mammal species	1) Estimate average daily dose by modeling COPEC body burdens in invertebrate tissue and soil from SLO TF and compare the modeled dose to mammalian TRVs. • Compare to low and high TRVs
Tertiary Consumers	Are chemical constituents in terrestrial environment adversely affecting carnivorous bird populations?	AE-T7: Survival, growth and reproduction of carnivorous bird species*	1) Estimate average daily dose by modeling COPEC body burdens in vertebrate tissue from SLO TF soils and compare the modeled dose to avian TRVs. • Compare to low and high TRVs
	Are chemical constituents in terrestrial environment adversely affecting carnivorous mammal populations?	AE-T8: Survival, growth and reproduction of omnivorous mammal species	1) Estimate average daily dose by modeling COPEC body burdens in vertebrate tissue and soil from SLO TF and compare the modeled dose to mammalian TRVs. • Compare to low and high TRVs

* Assessment endpoint may include protection of individual threatened, endangered or special status species as appropriate.

Table 3-6. Wetland Problem Formulation Summary
San Luis Obispo Tank Farm

	Risk Question	Assessment Endpoint (AE)	Measurement Endpoint (ME)
Primary Producers	Are chemical constituents in the wetland environment adversely affecting aquatic/wetland plant species?	AE-W1: Survival and reproduction of wetland plant populations conducive to maintenance of the wetland plant community and maintenance of the Congdon's tarplant population.	1) Compare wetland sediment concentrations ** to phytotoxicity benchmarks • Compare to low and high benchmarks 2) Overlay Cogdon's tarplant map to evaluate risk to this species of special concern 3) Compare riparian sediment concentrations*** to phytotoxicity benchmarks • Compare to low and high benchmarks
Primary Consumers	Are chemical constituents in water adversely affecting the aquatic community?	AE-W2: Survival and reproduction of aquatic invertebrate and vertebrate populations conducive to maintenance of the aquatic community	1) Compare water concentrations to aquatic toxicity benchmarks (e.g., AWQC)
	Are chemical constituents in water and sediment adversely affecting individual threatened or endangered aquatic invertebrates?	AE-W3: Survival, growth and reproduction of individual special-status fairy shrimp	1) Compare water concentrations to aquatic toxicity benchmarks (AWQC). 2) Compare sediment concentrations to sediment benchmarks • Compare to low and high benchmarks 3) Overlay map of suitable habitat for the fairy shrimp to evaluate risk to the fairy shrimp.
	Are chemical constituents in wetland sediments adversely affecting benthic invertebrate communities?	AE-W4: Survival and reproduction of sediment invertebrate populations conducive to_maintenance of the sediment invertebrate community	1) Compare wetland sediment concentrations to benthic invertebrate toxicity benchmarks • Compare to low and high benchmarks
	Are chemical constituents in wetlands adversely affecting herbivorous birds populations?	AE-W5: Survival, growth and reproduction of herbivorous bird populations.	1) Estimate average daily dose by modeling COPEC concentrations in plant tissue from wetland sediment concentrations** and compare the modeled dose to avian TRVs. • Compare to low and high TRVs

Table 3-6. Wetland Problem Formulation Summary
San Luis Obispo Tank Farm

	Risk Question	Assessment Endpoint (AE)	Measurement Endpoint (ME)
Secondary Consumers	Are chemical constituents in wetlands adversely affecting insectivorous bird populations?	AE-W6: Survival, growth and reproduction of insectivorous bird species*	1) Estimate average daily dose by modeling COPEC body burdens in invertebrate tissue from wetland sediment concentrations** and compare the modeled dose to avian TRVs. • Compare to low and high TRVs
Tertiary Consumers	Are chemical constituents in wetlands adversely affecting carnivorous bird populations?	AE-W7: Survival, growth and reproduction of carnivorous bird species*	1) Estimate average daily dose by modeling COPEC body burdens in vertebrate tissue from wetland sediment concentrations** and compare the modeled dose to avian TRVs. • Compare to low and high TRVs
	Are chemical constituents in wetlands affecting omnivorous mammal populations?	AE-W8: Survival, growth and reproduction of omnivorous mammal species	1) Estimate average daily dose by modeling COPEC body burdens in prey tissues from wetland sediment concentrations** and compare the modeled dose to mammalian TRVs. • Compare to low and high TRVs

* Assessment endpoint may include protection of individual threatened, endangered or special status species as appropriate.
** All wetland sediment concentrations are based on soil or sediment concentrations within the footprint of the federal or state delineated wetlands from 0 – 0.5 feet below ground surface (bgs).
*** Riparian sediment concentrations are based on soil or sediment concentrations within the riparian footprint from 0-10 feet bgs.

Table 4-1. Terrestrial Soil COPEC Summary Statistics
San Luis Obispo Tank Farm

Analyte	Detects	Total Counted	Percent	Minimum Detection Limit	Maximum Detection Limit	Minimum Detect	Maximum Detect	Arithmentic Mean	Standard Deviation	Distribution	UCL Calculation Method	95% UCL	EPC
Scenario 1													
Arsenic	98	120	82%	1.3	13	1.4	388	9.5	37	Neither	Standard Bootstrap	15	15
Lead	127	136	93%	1.3	13	2.4	1151	49	153	Neither	Standard Bootstrap	71	71
Acenaphthene	11	68	16%	0.0063	6.3	0.016	0.88	0.23	0.48	Normal	Student's-t	0.33	0.33
Acenaphthylene	8	68	12%	0.0063	6.3	0.051	0.50	0.20	0.46	Normal	Student's-t	0.30	0.30
Anthracene	7	68	10%	0.0063	6.3	0.010	0.38	0.19	0.46	Normal	Student's-t	0.29	0.29
Benzo(a)anthracene	10	68	15%	0.0063	6.3	0.019	2.3	0.26	0.55	LogNormal	95% H-UCL	0.50	0.50
Benzo(a)pyrene	16	68	24%	0.0063	6.3	0.0088	4.5	0.31	0.76	LogNormal	95% H-UCL	0.49	0.49
Benzo(b)fluoranthene	21	68	31%	0.0063	6.3	0.0075	3.6	0.31	0.69	Neither	Standard Bootstrap	0.45	0.45
Benzo(g,h,i)perylene	16	68	24%	0.0063	6.3	0.0063	2.4	0.24	0.54	LogNormal	95% H-UCL	0.38	0.38
Benzo(k)fluoranthene	7	68	10%	0.0063	6.3	0.0088	0.75	0.20	0.47	LogNormal	95% H-UCL	0.34	0.34
Chrysene	19	68	28%	0.0063	6.3	0.011	3.9	0.30	0.65	LogNormal	95% H-UCL	0.58	0.58
Dibenzo(a,h)anthracene	4	68	6%	0.0063	6.3	0.014	0.25	0.19	0.46	Neither	Standard Bootstrap	0.28	0.25
Fluoranthene	13	68	19%	0.0063	6.3	0.0075	1.4	0.26	0.52	LogNormal	95% H-UCL	0.52	0.52
Fluorene	12	68	18%	0.0063	6.3	0.023	2.8	0.33	0.69	LogNormal	95% H-UCL	0.77	0.77
Indeno(1,2,3-cd)pyrene	12	68	18%	0.0063	6.3	0.0063	2.1	0.23	0.52	LogNormal	95% H-UCL	0.38	0.38
Naphthalene	11	111	10%	0.0063	6.3	0.0088	11	0.30	1.3	LogNormal	95% H-UCL	0.35	0.35
Phenanthrene	20	68	29%	0.0063	2.5	0.041	6.4	0.69	1.4	LogNormal	95% H-UCL	2.4	2.4
Pyrene	25	68	37%	0.0063	6.3	0.0088	5.3	0.39	0.84	LogNormal	95% H-UCL	0.91	0.91
Sum PAH	38	68	56%	0.050	20	0.054	53	4.5	9.1	Neither	Standard Bootstrap	6.3	6.3
TPH (C10-C40)	141	237	61%	6.3	13	19	337922	4690	24300	LogNormal	95% H-UCL	20300	20300
Scenario 2													
Lead	84	91	92%	1.3	13	2.8	1151	42	154	Neither	Standard Bootstrap	69	69
TPH (C10-C40)	83	151	57%	6.3	13	19	337922	6770	30400	Neither	Standard Bootstrap	10500	10500

Notes:
All concentrations are mg/kg dry weight.
Statistics are for all onsite soil and sediment samples from depths less than or equal to 5 feet bgs.
All caclulations used 1/2 detectiopn limit for non-detected data.
Distributions determined using ProUCL, based on detected concentrations.

Table 4-2. Wetland COPEC Summary Statistics
San Luis Obispo Tank Farm

Analyte	Detects	Total Counted	Percent	Minimum Detection Limit	Maximum Detection Limit	Minimum Detect	Maximum Detect	Arithmentic Mean	Standard Deviation	Distribution	UCL Calculation Method	95% UCL	EPC
Arsenic	17	19	89%	1.3	1.3	1.8	28	4.2	5.9	Neither	Standard Bootstrap	6.4	6.4
Lead	25	25	100%	--	--	4.3	1001	108	260	Neither	Standard Bootstrap	190	190
Acenaphthene	0	13	0%	0.0063	0.63	--	--	--	--	--	--	--	**0.31**
Acenaphthylene	0	13	0%	0.0063	0.63	--	--	--	--	--	--	--	**0.31**
Anthracene	2	13	15%	0.0063	0.63	0.01	0.025	0.067	0.11	Neither	Standard Bootstrap	0.12	0.025
Benzo(a)anthracene	3	13	23%	0.0063	0.63	0.053	2.3	0.22	0.62	Neither	Standard Bootstrap	0.49	0.49
Benzo(a)pyrene	7	13	54%	0.0063	0.63	0.0088	4.5	0.43	1.2	Lognormal	95% H-UCL	6.7	4.5
Benzo(b)fluoranthene	8	13	62%	0.0063	0.63	0.0075	3.6	0.38	0.98	Lognormal	95% H-UCL	4.5	3.6
Benzo(g,h,i)perylene	6	13	46%	0.0063	0.63	0.0063	2.4	0.25	0.65	Lognormal	95% H-UCL	2.9	2.4
Benzo(k)fluoranthene	3	13	23%	0.0063	0.63	0.043	0.75	0.11	0.21	Neither	Standard Bootstrap	0.20	0.20
Chrysene	4	13	31%	0.0063	0.63	0.063	3.9	0.35	1.1	Neither	Standard Bootstrap	0.82	0.82
Dibenzo(a,h)anthracene	2	13	15%	0.0063	0.63	0.014	0.025	0.067	0.11	Neither	Standard Bootstrap	0.12	0.025
Fluoranthene	5	13	38%	0.0063	0.63	0.0075	1.1	0.15	0.31	Neither	Standard Bootstrap	0.28	0.28
Fluorene	1	13	8%	0.0063	0.63	1.8	1.8	0.18	0.48	Neither	Standard Bootstrap	0.39	0.39
Indeno(1,2,3-cd)pyrene	6	13	46%	0.0063	0.63	0.0063	2.1	0.23	0.58	Lognormal	95% H-UCL	2.7	2.1
Naphthalene	0	13	0%	0.0063	0.63	--	--	0.065	0.11	--	--	--	**0.31**
Phenanthrene	4	13	31%	0.0063	0.13	0.041	4.3	0.43	1.2	Neither	Standard Bootstrap	0.93	0.93
Pyrene	7	13	54%	0.0063	0.063	0.0088	2.4	0.30	0.67	Lognormal	95% H-UCL	5.4	2.4
Sum PAH	9	13	69%	0.050	0.50	0.054	31	3.3	8.4	Lognormal	95% H-UCL	47	31
TPH (C10-C40)	23	29	79%	13	13	19	51314	4310	12200	Lognormal	95% H-UCL	66100	51314

Notes:
All concentrations are mg/kg dry weight.
Statistics are for all onsite soil and sediment samples within designated wetlands from depths less than or equal to 0.5 feet bgs.
All caclulations used 1/2 detectiopn limit for non-detected data.
Bold text indicates all non-detects. Value is one-half maximum detection limit.
Distributions determined using ProUCL, based on detected concentrations.

Table 4-3. Terrestrial Receptor Exposure Parameters
San Luis Obispo Tank Farm

Parameter	Parameter	(units)	Song Sparrow	California Vole	Western Meadowlark	Loggerhead Shrike	Ornate Shrew	American Kestrel	Northern Harrier	Coyote
Diet										
Proportion of Diet - Invertebrates	Pinv	unitless	0.11 [a]	0	0.63 [h]	0.88 [j]	1 [l]	0.26 [o]	0	0.1 [t]
Proportion of Diet - Plants	Pveg	unitless	0.89 [a]	1 [f]	0.37 [h]		0		0	0.034 [t]
Proportion of Diet - Vertebrates	Pvert	unitless	0	0		0.12 [j]	0	0.74 [o]	1 [r]	0.87 [t]
Ingestion Rate of Food	IR	(kg/day DW)	0.0054 [b]	0.0053 [b]	0.014 [b]	0.0088 [b]	0.0010 [b]	0.0193 [b]	0.043 [b]	0.33 [b]
Body Weight	bw	(kg)	0.023 [a]	0.036 [f]	0.091 [h]	0.048 [j]	0.00478 [m]	0.111 [p]	0.37 [r]	10.0 [t]
Media Uptake										
Fraction of Soil Ingested	sfr	% diet	9.3 [c]	2.4 [g]	10 [i]	0 [k]	3.0 [n]	0 [q]	0 [s]	2.8 [u]
Incidental Soil Ingestion Rate	IRs	(kg/day)	0.00050 [d]	0.00013 [d]	0.0014 [d]	0 [d]	0.00003 [d]	0 [d]	0 [d]	0.0093 [d]
Site Usage										
Home Range	hr	(ha)		0.010 [f]					260 [r]	1570 [t]
Site Use Factor	SUF	(unitless)	1 [e]	1 [e]	1 [e]	1 [e]	1 [e]	1 [e]	1 [e]	1 [e]

Notes: kg/day = kilograms per day. kg = kilograms. ha = hectares.

[a] Arcese et al., 2002. Highest estimated seasonal vegetation ingestion rate based on intake in non-breeding season (average of Fall and Winter) from study by Martin et al., 1951. Body weight is for female control group in Mandarte Island study (Arcese, 1989).
[b] Nagy, 2001.
[c] Beyer et. al., 1994. Wild turkey percentage soil in diet used as a surrogate.
[d] Calculated by multiplying the fraction of soil ingested by the ingestion rate of food.
[e] Conservatively assumed to equal 1.
[f] Cal Ecotox, 2003. Dietary composition entirely plants in both studies listed. Body weight is mid-point of range for non-breeding females in Contra Costa, CA. Home range is midpoint of range for adult female.
[g] Beyer et. al., 1994.
[h] Lanyon, W.E., 1994. Dietary composition is annual diet of adults (Bryant, 1914 as cited in Lanyon, 1994). Body weight is average of female means.
[i] Beyer et. al., 1994. American woodcock percentage soil in diet used as a surrogate.
[j] Yosef, 1996. Dietary composition from study of birds in western US (Beal & McAtee, 1912 in Yosef, 1996), with highest estimated insect uptake (total only 97%; allocated remaining 3% proportionally). Body weight is mean of 2 studies reported.
[k] No soil ingestion rate available. Assumed to be zero based on prey type and feeding strategy.
[l] Zeiner et al., 1990.
[m] Cal Ecotox, 2003. Body weight is mid-point of range reported for adult females in CA study.
[n] US EPA, 2000b. 90th percentile value for short-tailed shrew used as a surrogate.
[o] US EPA, 1993. Dietary composition from study of California pasture (Callopy & Koplin, 1983), highest vertebrate ingestion (total 96.3%; allocated 3.7% proportionally).
[p] Smallwood and Bird, 2002. Body weight is average of males (less than female).
[q] No soil ingestion information found. Assumed to be zero based on feeding strategy.
[r] MacWhitter and Bildstein, 1996. Diet comprised of mammals, birds, reptiles and frogs. Body weight is average for male reported from Bildstein, 1988. Home range is median of 8 studies.
[s] No soil ingestion information found. Assumed to be zero based on feeding strategy.
[t] Cal Ecotox, 2003. Dietary composition from Coastal CA study - based on % volume of stomach contents (Ferrel et al., 1953). Miscellaneous category assumed to be invertebrates. Body weight is average of three mean values reported for California adult females.
[u] Beyer et. al., 1994. Red fox percentage soil in diet used as a surrogate. Used byCH2M Hill, 2003.

Table 4-4. Wetland Receptor Exposure Parameters

San Luis Obispo Tank Farm

Parameter	Parameter	(units)	Mallard		Western Sandpiper		Great Blue Heron		Raccoon	
Diet										
Proportion of Diet - Invertebrates	Pinv	unitless	0.078	[a]	1	[f]	0		0.172	[k]
Proportion of Diet - Plants	Pveg	unitless	0.922	[a]	0		0		0.583	[k]
Proportion of Diet - Vertebrates	Pvert	unitless	0		0		1	[h]	0.245	[k]
Ingestion Rate of Food	IR	(kg/day DW)	0.075	[b]	0.006	[b]	0.140	[b]	0.147	[b]
Body Weight	bw	(kg)	1.043	[a]	0.024	[f]	2.204	[i]	5.45	[k]
Media Uptake										
Fraction of Soil Ingested	sfr	%	3.3	[c]	18	[g]	2.7	[j]	9.4	[g]
Incidental Soil Ingestion Rate	IRs	(kg/day)	0.0025	[d]	0.001	[d]	0.004	[d]	0.014	[d]
Site Usage										
Home Range	hr	(ha)	468	[a]					39	[k]
Site Use Factor	SUF	(unitless)	1	[e]	1	[e]	1	[e]	1	[e]

Notes: kg/day = kilograms per day. kg = kilograms. DW = dry weight ha = hectares.

[a] US EPA, 1993. Dietary composition from study of non-breeding adults which provides the highest estimated seasonal vegetation ingestion rate (Dillon, 1959). "Other" category assumed to be invertebrates.
Body weight is avg female (Nelson & Martin, 1953). Home range is for non-egg laying female (from Dwyer et al., 1979).
[b] Nagy, 2001.
[c] Beyer et. al., 1994.
[d] Calculated by multiplying the fraction of sediment ingested by the ingestion rate of food.
[e] Conservatively assumed to equal 1.
[f] Wilson, W.H., 1994. Dietary composition identified as invertebrates in all studies reported.
Body weight is average of California birds from March to mid-April.
[g] Beyer et. al., 1994.
[h] Dietary composition is assumed to be amphibians, given the paucity of fish at the Site.
[i] US EPA, 1993. Body weight is average female body weight (less than male; from Hartman, 1961).
[j] Beyer, et al., 1994. No heron sediment ingestion available. Used mid-point of range (<2.0 to 3.3) of non-probing aquatic birds (ducks).
[k] US EPA, 1993. Dietary composition is summer diet from New York study (Hamilton, 1951). Total of 1.007 normalized to 1.0.
Body weight is mean of adult female body weights. Mean home range of adult female in Georgia coastal study from US EPA, 1993.

Table 4-5. Biota-Soil/Sediment Accumulation Factor Summary
San Luis Obispo Tank Farm

	Soil Invertebrates		Sediment Invertebrates		Soil Plants*		Log K_{ow}		Soil Vertebrate Prey		Sediment Vertebrate Prey	
Metals												
Arsenic	0.52	1	0.69	3	1.1	4	NA		0.015	6a	0.015	6a
Lead	1.5	1	0.61	3	0.47	4	NA		0.29	6a	0.34	6b
Organics												
Acenaphthene	0.16	2	2.30	5	0.60	7	4.0	8	2.2	6c	2.2	6c
Acenaphthylene	0.16	2	2.30	5	0.55	7	4.1	8	2.2	6c	2.2	6c
Anthracene	0.16	2	2.30	5	0.40	7	4.5	8	2.2	6c	2.2	6c
Benzo(a)anthracene	0.16	2	2.30	5	0.14	7	5.6	8	2.2	6c	2.2	6c
Benzo(a)pyrene	0.16	2	2.30	5	0.05	7	6.7	8	2.2	6c	2.2	6c
Benzo(b)fluoranthene	0.16	2	2.30	5	0.10	7	6.0	8	2.2	6c	2.2	6c
Benzo(g,h,i)perylene	0.16	2	2.30	5	0.06	7	6.5	8	2.2	6c	2.2	6c
Benzo(k)fluoranthene	0.16	2	2.30	5	0.09	7	6.1	8	2.2	6c	2.2	6c
Chrysene	0.16	2	2.30	5	0.21	7	5.2	8	2.2	6c	2.2	6c
Dibenzo(a,h)anthracene	0.16	2	2.30	5	0.05	7	6.8	8	2.2	6c	2.2	6c
Fluoranthene	0.16	2	2.30	5	0.27	7	4.9	8	2.2	6c	2.2	6c
Fluorene	0.16	2	2.30	5	0.50	7	4.2	8	2.2	6c	2.2	6c
Indeno(1,2,3-cd)pyrene	0.16	2	2.30	5	0.06	7	6.6	8	2.2	6c	2.2	6c
Naphthalene	0.16	2	2.30	5	1.10	7	3.3	8	2.2	6c	2.2	6c
Perylene	0.16	2	2.30	5	0.08	7	6.3	9	2.2	6c	2.2	6c
Phenanthrene	0.16	2	2.30	5	0.40	7	4.5	8	2.2	6c	2.2	6c
Pyrene	0.16	2	2.30	5	0.27	7	4.9	8	2.2	6c	2.2	6c

* Uptake by terrestrial plants are expected to be adequate surrogates for potential aquatic plant uptake.
1 = Sample et al., 1998a. 90th percentile values.
2 = VanBrummelen et al., 1996. 90th percentile value of 4 species and 9 PAHs converted to dry weight.
3 = Bechtel Jacobs Company LLC. 1998b. 90th percentile values.
4 = Bechtel Jacobs Company LLC. 1998a. 90th percentile values.
5 = Ingersoll et al., 2003. Steady state values converted to dry wt/dry wt.
6a = Sample et al., 1998b. 90th percentile values for general mammals.
6b = Sample et al., 1998b. 90th percentile values for insectivores.
6c = Sample et al., 1998b. 90th percentile value for general mammals - TCDD used as surrogate for PAHs.
7 = EPA, 2000b. Model in Appendix 4-1.
8 = ATSDR, 1995.
9 = Syracuse Research Corporation Phys prop database - http://esc.sy.rres.com

Table 5-1. Contact Toxicity – Soil and Sediment Benchmark Summary
San Luis Obispo Tank Farm

	Terrestrial Plant Benchmark (mg/kg- DW)			Terrestrial Invertebrate Benchmark (mg/kg- DW)			Sediment Invertebrate Benchmark (mg/kg- DW)		
	Low	High	Ref	Low	High	Ref	Low	High	Ref
Metals									
Arsenic	10	90	1a	60	N/A	1b	9.79	33.0	6
Lead	50	500	1a	500	1629	1b	35.8	128	6
Organics									
Acenaphthene	20	61*	1a/2	31	107	5	0.29	1.3	7, 8a
Acenaphthylene	3*	61*	2	23	145	5	0.16	N/A	7a
Anthracene	3*	61*	2	5	67	5	0.057	0.845	6
Benzo(a)anthracene	1.2*	3.3*	3	>980		5	0.108	1.05	6
Benzo(a)pyrene	1.2	3.3	3	>840		5	0.15	1.45	6
Benzo(b)fluoranthene	1.2*	3.3*	3	>360		5	0.0272	4.0	8b, 8c
Benzo(k)fluoranthene	1.2*	3.3*	3	>560		5	0.0272	4.0	8b, 8c
Benzo(ghi)perylene	1.2*	3.3*	3	N/A			0.17	3.2	8d
Chrysene	1.2*	3.3*	3	>1030		5	0.166	1.29	6
Dibenzo(a,h)anthracene	1.2*	3.3*	3	>780		5	0.033	N/A	6
Fluoranthene	1.2*	3.3*	3	47	51	4	0.423	2.23	6
Fluorene	3*	61*	2	7.7	39	5	0.077	0.536	6
Indeno(1,2,3-cd)pyrene	1.2*	3.3*	3	>910		5	N/A		
Naphthalene	3	61	2	20	167	5	0.176	0.561	6
Perylene	1.2*	3.3*	3	>560		5	N/A		
Phenanthrene	3*	61*	2	21	30	4	0.204	1.17	6
Pyrene	1.2*	3.3*	3	13	16	4	0.195	1.52	6
Total PAHs	N/A	N/A		N/A	N/A		1.61	22.8	6
TPH	782	4598	9	842	1163	9	842	1163	9

DW = dry weight

Italics are low molecular weight compounds (i.e., 2 or 3 carbon rings). All other individual PAHs are high molecular weight (i.e.,4 or more carbon rings)

* indicates benchmark is a surrogate. Naphthalene used for low and Benzo(a)pyrene used for high molecular weight PAHs.

References:

1a = Efroymson et al., 1997a: Low is 10th percentile of LOEC values; High is 50th percentile of LOEC values

1b = Efroymson et al., 1997b: Low is lowest LOEC values; High is second lowest LOEC value.

2 = CCME, 1999e: Low is LC25 for lettuce seed emergence; High is LC25 for radish seed emergence

3 = CCME, 1999f: Low is NOEC for rye, wheat and corn; High is NOEC for rye

4 = Sverdrup et al., 2001: Low is reproduction NOEC for Collembola; High is reproduction EC 50 for Collembola

5 = Sverdrup et al., 2002: Low is reproduction EC 10 for Collembola; High is LC 50 for Collembola.

6 = MacDonald et al, 2000: Low is Threshold Effect Concentration; High is Probable Effect Concentration.

7 = Buchman, 1999 (Upper Effect Thresholds)

8a = Jones et al., 1997 (EqP AWQC)

8b = Jones et al., 1997 (Great Lakes TEC)

8c = Jones et al., 1997 (Great Lakes NEC)

8d = Jones et al., 1997 (Ontario MOE - Low is “Low”; High is “Severe”)

9 = BBL Benchmark and BAF Memo (Appendix G)

Table 5-2. Contact Toxicity – Surface Water Benchmark Summary
San Luis Obispo Tank Farm

Detected Analytes	Low Benchmark (mg/l)	High Benchmark (mg/l)	Ref
Metals			
Arsenic	0.15	0.34	1
Barium	0.0040	0.11	2
Nickel	0.052	0.47	1
Thallium	0.012	0.11	2
Vanadium	0.02	0.28	2
Zinc	0.12	0.12	1
Organics			
Toluene	0.0098	0.12	2

1= EPA, 2002b (AWQC chronic freshwater value).

2 = Suter and Tsao, 1996: Low is secondary chronic value (SCV); High is secondary acute value (SAC).

Table 5-3. Wildlife Toxicity Reference Values
San Luis Obispo Tank Farm

	Avian TRVs (mg/kg/day)			Mammalian TRVs (mg/kg/day)		
	Low	High	Ref	Low	High	Ref
Metals						
Arsenic	5.5	22.01	1	0.32	4.7	1
Lead	0.014	8.75	1	1.0	240.64	8, 1
Organics						
Acenaphthene	32.5	325	3	175	350	9
Acenaphthylene	32.5	325	3	175	350	9
Anthracene	32.5	325	3	1000	NA	9
Benzo(a)anthracene	32.5	325	3	1[3]	10[3]	5
Benzo(a)pyrene	32.5	325	3	1	10	5
Benzo(b)fluoranthene	32.5	325	3	1[3]	10[3]	5
Benzo(k)fluoranthene	32.5	325	3	1[3]	10[3]	5
Benzo(ghi)perylene	32.5	325	3	1[3]	10[3]	5
Chrysene	32.5	325	3	1[3]	10[3]	5
Dibenzo(a,h)anthracene	32.5	325	3	1[3]	10[3]	5
Fluoranthene	32.5	325	3	125	250	9
Fluorene	32.5	325	3	125	250	9
Indeno(1,2,3-cd)pyrene	32.5	325	3	1[3]	10[3]	5
Naphthalene	26.9	269	2	50	150	4
Perylene	32.5	325	3	1[3]	10[3]	5
Phenanthrene	32.5	325	3	125[3]	250[3]	9
Pyrene	32.5	325	3	75	125	9
Total PAH	NA	NA		NA	NA	
TPH[4]	218	2180	6	197	890	7a,b

1 = EFA West, 1998 (Navy/BTAG Wildlife TRVs)[1]
2 = Wildlife International, 1985 – based on mortality endpoint
3 = Patton and Dieter, 1980[2] – based on growth and body weight endpoints
4 = Navarro et al., 1991 – based on reproductive endpoints
5 = Mackenzie and Angevine, 1981 – based on reproductive endpoints
6 = Stubblefield et al., 1995 – based on reproductive endpoint
7a = Beckett et al., 2002; 7b = Kahn et al., 1987 – based on reproductive endpoints
8 = HERD ERA Note 5, DTSC, 2002 – based on a renal effects[1]
9 = USEPA 2001 – hepatotoxicity and nephropathy endpoints

[1] BTAG and HERD TRVs are developed by considering the weight of evidence of all studies reviewed. While the low and high values selected are taken from single studies, they are developed to be protective of the range of endpoints considered.
[2] An uncertainty factor of 10 applied to benchmarks based on this study for special status species.
[3] Value is based on toxicity study conducted with a surrogate compound.
[4] TPH benchmark is for incidental soil or sediment ingestion only.

Table 6-1. Tier 1 Hazard Quotient Summary for Terrestrial Receptors
Soil Exposure (0-5 feet)
San Luis Obispo Tank Farm

		AE: T1. Plants		AE:T2. Invertebrates		AE: T3. Song Sparrow		AE: T4. California Vole		AE: T5. Western Meadowlark	
COPEC	EPC	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Metals											
Arsenic	388	39	4.3	6.5	NA	19	4.6	202	14	8.9	2.2
Lead	1151	23	2.3	2.3	0.71	12865	21	84	0.35	15183	24
Organics											
Acenaphthene	0.88	0.044	0.014	0.028	0.0082	0.0040	0.00040	0.00046	0.00023	0.0017	0.00017
Acenaphthylene	0.50	0.17	0.0082	0.022	0.0035	0.0022	0.00022	0.00024	0.00012	0.00095	0.000095
Anthracene	0.38	0.13	0.0062	0.075	0.0056	0.0012	0.00012	0.000023	NA	0.00061	0.000061
Benzo(a)anthracene	2.3	1.9	0.68	0.0023		0.0038	0.00038	0.055	0.0055	0.0027	0.00027
Benzo(a)pyrene	4.5	3.8	1.4	0.0054		0.0050	0.00050	0.051	0.0051	0.0047	0.00047
Benzo(b)fluoranthene	3.6	3.0	1.1	0.010		0.0051	0.00051	0.065	0.0065	0.0041	0.00041
Benzo(k)fluoranthene	0.8	0.63	0.23	0.0013		0.0009	0.00009	0.010	0.0010	0.0008	0.00008
Benzo(ghi)perylene	2.4	2.0	0.72	NA	NA	0.0033	0.00033	0.042	0.0042	0.00265	0.000265
Chrysene	3.9	3.2	1.2	0.0038		0.0083	0.00083	0.13	0.013	0.0051	0.00051
Dibenzo(a,h)anthracene	0.25	0.21	0.076	0.00032		0.00027	0.000027	0.0026	0.00026	0.00026	0.000026
Fluoranthene	1.4	1.1	0.42	0.029	0.027	0.0034	0.00034	0.00047	0.00024	0.0019	0.00019
Fluorene	2.8	0.92	0.045	0.36	0.071	0.011	0.0011	0.0017	0.00086	0.0050	0.00050
Indeno(1,2,3-cd)pyrene	2.1	1.8	0.64	0.0023		0.0025	0.00025	0.026	0.0026	0.0022	0.00022
Naphthalene	11	3.7	0.18	0.56	0.067	0.11	0.011	0.037	0.012	0.038	0.0038
Phenanthrene	6.4	2.1	0.10	0.30	0.21	0.021	0.0021	0.0032	0.0016	0.010	0.0010
Pyrene	5.3	4.4	1.6	0.40	0.33	0.013	0.0013	0.0030	0.0018	0.0074	0.00074
PAH - Cumulative	53	NA	NA	NA	NA	0.2	0.0	0.4	0.1	0.1	0.0
TPH (C10-C40)	337922	432	73	401	291	33	3.3	6.1	1.3	24	2.4

Notes:

HQ > 1.0

TRV not available = NA

Concentrations are mg/kg dry weight.

Wildlife HQs based on site use factor (SUF) of 1.

COPEC = Chemical of Potential Ecological Concern

PAH Cumulative = summary of individual HQs for PAHs

EPC = Exposure Point Concentration; Tier 1 EPC is sitewide maximum

HQ = Hazard Quotient

*PAH TRVs (except naph) for special status species include uncert. factor of 10.

Table 6-1. Tier 1 Hazard Quotient Summary for Terrestrial Receptors
Soil Exposure (0-5 feet)
San Luis Obispo Tank Farm

		AE: T5. Loggerhead Shrike*		AE: T6. Ornate Shrew		AE: T7. American Kestrel		AE: T7. Northern Harrier*		AE: T8. Coyote	
COPEC	EPC	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Metals											
Arsenic	388	6.0	1.5	138	9.4	1.8	0.45	0.12	0.030	5.2	0.36
Lead	1151	20564	33	364	1.5	8634	14	2760	4.4	17	0.071
Organics											
Acenaphthene	0.88	0.021	0.0021	0.00020	0.00010	0.0078	0.00078	0.069	0.0069	0.00033	0.00016
Acenaphthylene	0.50	0.012	0.0012	0.00011	0.000056	0.0045	0.00045	0.039	0.0039	0.00019	0.000093
Anthracene	0.38	0.009	0.0009	0.000015	NA	0.0033	0.00033	0.029	0.0029	0.000024	NA
Benzo(a)anthracene	2.3	0.053	0.0053	0.088	0.0088	0.020	0.0020	0.18	0.018	0.15	0.015
Benzo(a)pyrene	4.5	0.11	0.011	0.18	0.018	0.040	0.0040	0.35	0.035	0.29	0.029
Benzo(b)fluoranthene	3.6	0.085	0.0085	0.14	0.014	0.032	0.0032	0.28	0.028	0.24	0.024
Benzo(k)fluoranthene	0.8	0.018	0.0018	0.029	0.0029	0.007	0.0007	0.06	0.006	0.049	0.0049
Benzo(ghi)perylene	2.4	0.056	0.0056	0.093	0.0093	0.0212	0.00212	0.186	0.0186	0.154	0.0154
Chrysene	3.9	0.091	0.0091	0.15	0.015	0.035	0.0035	0.30	0.030	0.25	0.025
Dibenzo(a,h)anthracene	0.25	0.006	0.0006	0.010	0.0010	0.0022	0.00022	0.020	0.0020	0.016	0.0016
Fluoranthene	1.4	0.032	0.0032	0.00043	0.00022	0.012	0.0012	0.11	0.011	0.00072	0.00036
Fluorene	2.8	0.065	0.0065	0.00086	0.00043	0.025	0.0025	0.22	0.022	0.0014	0.00072
Indeno(1,2,3-cd)pyrene	2.1	0.050	0.0050	0.084	0.0084	0.019	0.0019	0.17	0.017	0.14	0.014
Naphthalene	11	0.032	0.0032	0.0087	0.0029	0.12	0.012	0.11	0.011	0.015	0.0049
Phenanthrene	6.4	0.15	0.015	0.0020	0.0010	0.057	0.0057	0.50	0.050	0.0033	0.0017
Pyrene	5.3	0.12	0.012	0.0028	0.0017	0.047	0.0047	0.41	0.041	0.0046	0.0027
PAH - Cumulative	53	0.9	0.1	0.8	0.1	0.5	0.0	3.0	0.3	1.3	0.1
TPH (C10-C40)	337922	0.0	0.0	11	2.4	0.0	0.0	0.0	0.0	1.6	0.35

HQ > 1.0

TRV not available = NA

Concentrations are mg/kg dry weight.
Wildlife HQs based on site use factor (SUF) of 1.
COPEC = Chemical of Potential Ecological Concern
PAH Cumulative = summary of individual HQs for PAHs

EPC = Exposure Point Concentration; Tier 1 EPC is sitewide maximum
HQ = Hazard Quotient
*PAH TRVs (except naph) for special status species include uncert. factor of 10.

Table 6-2. Tier 1 Hazard Quotient Summary for Wetland Receptors
Sediment Exposure (0 - 0.5 feet)
San Luis Obispo Tank Farm

		Wetland Plants AE: W1.		Sediment Invertebrates AE: W3, W4.		Mallard AE: W5.		Western Sandpiper AE: W6.		Great Blue Heron AE: W7.		Raccoon AE: W8.	
COPEC	EPC	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Metals													
Arsenic	28	2.8	0.31	2.8	0.83	0.39	0.10	1.1	0.27	0.23	0.057	2.0	0.14
Lead	1001	20	2.0	28	7.8	2617	4.2	14127	23	2889	4.6	15	0.062
Organics													
Acenaphthene	0.31	0.016	0.0051	1.1	0.24	0.0005	0.00005	0.0060	0.00060	0.0014	0.00014	0.000067	0.000033
Acenaphthylene	0.31	0.10	0.0051	2.0	NA	0.00050	0.000050	0.0060	0.00060	0.0014	0.00014	0.000065	0.000033
Anthracene	0.025	0.0083	0.00041	0.44	0.030	0.000032	0.0000032	0.00048	0.000048	0.00011	0.000011	0.00000085	NA
Benzo(a)anthracene	2.3	1.9	0.68	21	2.1	0.0017	0.00017	0.043	0.0043	0.010	0.0010	0.068	0.0068
Benzo(a)pyrene	4.5	3.8	1.4	30	3.1	0.0026	0.00026	0.086	0.0086	0.020	0.0020	0.13	0.013
Benzo(b)fluoranthene	3.6	3.0	1.1	133	0.91	0.0024	0.00024	0.069	0.0069	0.016	0.0016	0.11	0.011
Benzo(k)fluoranthene	0.75	0.63	0.23	28	0.19	0.00045	0.000045	0.014	0.0014	0.0034	0.00034	0.022	0.0022
Benzo(ghi)perylene	2.4	2.0	0.72	14	0.74	0.0016	0.00016	0.045	0.0045	0.011	0.0011	0.070	0.0070
Chrysene	3.9	3.2	1.2	23	3.0	0.0035	0.00035	0.074	0.0074	0.018	0.0018	0.12	0.012
Dibenzo(a,h)anthracene	0.025	0.021	0.0076	0.76	NA	0.000014	0.0000014	0.00048	0.000048	0.00011	0.000011	0.00072	0.000072
Fluoranthene	1.1	0.94	0.34	2.7	0.51	0.0011	0.00011	0.021	0.0021	0.0051	0.00051	0.00029	0.00014
Fluorene	1.8	0.58	0.029	23	3.3	0.0026	0.00026	0.033	0.0033	0.0080	0.00080	0.00050	0.00025
Indeno(1,2,3-cd)pyrene	2.1	1.8	0.64	NA	NA	0.0013	0.00013	0.041	0.0041	0.0097	0.00097	0.061	0.0061
Naphthalene	0.31	0.10	0.005	1.8	0.6	0.0010	0.00010	0.007	0.0007	0.0017	0.00017	0.00028	0.00009
Phenanthrene	4.3	1.4	0.070	21	3.6	0.0054	0.00054	0.081	0.0081	0.019	0.0019	0.0012	0.00058
Pyrene	2.4	2.0	0.72	12	1.6	0.0024	0.00024	0.045	0.0045	0.011	0.0011	0.0010	0.00061
Sum PAH	31	NA	NA	19	1.3	NA	NA	NA	NA	NA	NA	NA	NA
PAH Cumulative	NA	NA	NA	NA	NA	0.0271	0.0027	0.5741	0.0574	0.1366	0.0137	0.5811	0.0595
TPH (C10-C40)	51314	66	11	61	44	0.56	0.056	11	1.1	0.40	0.040	0.66	0.15

Notes:

HQ > 1.0

TRV not available = NA

Concentrations are mg/kg dry weight.

EPC = Exposure Point Concentration; Tier 1 EPC is sitewide maximum

Wildlife HQs based on site use factor (SUF) of 1.

HQ = Hazard Quotient

COPEC = Chemical of Potential Ecological Concern

*PAH TRVs for these special status species include an uncertainty factor of 10.

PAH Cumulative = summary of individual HQs for PAHs

Table 6-3. Tier 1 Hazard Quotient Summary for Riparian Plants Sediment Exposure (0-10 feet)

San Luis Obispo Tank Farm

		Riparian Plants	
COPEC	**EPC**	**Low Benchmark HQs**	**High Benchmark HQs**
Metals			
Arsenic	3.8	0.38	0.042
Lead	15	0.30	0.030
Organics			
Acenaphthene	**0.0031**	0.00016	0.000051
Acenaphthylene	**0.0031**	0.0010	0.000051
Anthracene	0.010	0.0033	0.00016
Benzo(a)anthracene	0.053	0.044	0.016
Benzo(a)pyrene	0.076	0.064	0.023
Benzo(b)fluoranthene	0.16	0.14	0.049
Benzo(k)fluoranthene	0.043	0.035	0.013
Benzo(ghi)perylene	0.044	0.037	0.013
Chrysene	0.075	0.063	0.023
Dibenzo(a,h)anthracene	0.014	0.011	0.0042
Fluoranthene	0.11	0.091	0.033
Fluorene	**0.0063**	0.0021	0.00010
Indeno(1,2,3-cd)pyrene	0.061	0.051	0.019
Naphthalene	**0.0031**	0.0010	0.000051
Phenanthrene	0.041	0.014	0.00068
Pyrene	0.11	0.094	0.034
Sum PAH	0.81	NA	NA
TPH (C10-C40)	148	0.19	0.032

Notes: HQ > 1.0

TRV not available = NA

Concentrations are mg/kg dry weight. HQ = Hazard Quotient

Bold text indicates all non-detects. Value is one-half detection limit.

EPC = Exposure Point Concentration; Tier 1 EPC is sitewide maximum

COPEC = Chemical of Potential Ecological Concern

Table 6-4. Tier 1 Hazard Quotient Summary for Aquatic Invertebrates and Amphibians (AE: W2) Surface Water Expousre

San Luis Obispo Tank Farm

COPEC	Maximum Detected Concentration*	Low Benchmark	High Benchmark	Low Benchmark HQs	High Benchmark HQs
Metals					
Arsenic	0.010	0.15	0.34	0.067	0.029
Barium	0.26	*0.0040*	*0.11*	65	2.4
Nickel	0.030	0.052	0.47	0.58	0.064
Thallium	0.013	*0.012*	*0.11*	1.1	0.12
Vanadium	0.010	*0.020*	*0.28*	0.50	0.036
Zinc	0.020	0.12	0.12	0.17	0.17
Organics					
Toluene	0.0071	*0.0098*	*0.12*	0.72	0.059

Notes:

HQ > 1.0

TRV not available = NA

Concentrations are mg/L.

* The maximum detected concentrations for the site are dissolved concentrations.

Non-italic benchmarks are Ambient Water Quality Criteria (low = chronic freshwater criteria, high = acute).

Italic benchmarks are secondary chronic (low benchmark) and acute (high benchmark) values (Suter & Tsao, 1996). AWQC not available.

HQ = Hazard Quotient

COPEC = Chemical of Potential Ecological Concern

Table 6-5. COPECs Carried Forward to Tier 2 Assessment
San Luis Obispo Tank Farm

Terrestrial	AE: T1. Plants	AE: T2. Invertebrates	AE: T3. Song Sparrow	AE: T4. California Vole	AE: T5. Western Meadowlark	AE: T5. Loggerhead Shrike*	AE: T6. Ornate Shrew	AE: T7. American Kestrel	AE:T7. Northern Harrier*	AE:T8. Coyote
COPEC	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1
Metals										
Arsenic	X	X	X	X	X	X	X	X		X
Lead	X	X	X	X	X	X	X	X	X	X
Organics										
Acenaphthene										
Acenaphthylene										
Anthracene										
Benzo(a)anthracene	X									
Benzo(a)pyrene	X									
Benzo(b)fluoranthene	X									
Benzo(k)fluoranthene										
Benzo(ghi)perylene	X	NA								
Chrysene	X									
Dibenzo(a,h)anthracene										
Fluoranthene	X									
Fluorene										
Indeno(1,2,3-cd)pyrene	X									
Naphthalene	X									
Phenanthrene	X									
Pyrene	X									
Sum PAH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH (C10-C40)	X	X	X	X	X		X			X

Notes:
TRV not available = NA

Table 6-5. COPECs Carried Forward to Tier 2 Assessment
San Luis Obispo Tank Farm

Wetland	AE: W1. Plants	AE: W3,W4. Invertebrates	AE: W5. Mallard	AE: W6. Western Sandpiper	AE: W7. Great Blue Heron	AE: W8. Raccoon
COPEC	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1	Low Benchmark HQ>1
Metals						
Arsenic	X	X		X		X
Lead	X	X	X	X	X	X
Organics						
Acenaphthene		X				
Acenaphthylene		X				
Anthracene						
Benzo(a)anthracene	X	X				
Benzo(a)pyrene	X	X				
Benzo(b)fluoranthene	X	X				
Benzo(k)fluoranthene		X				
Benzo(ghi)perylene	X	X				
Chrysene	X	X				
Dibenzo(a,h)anthracene						
Fluoranthene		X				
Fluorene		X				
Indeno(1,2,3-cd)pyrene	X	NA				
Naphthalene		X				
Phenanthrene	X	X				
Pyrene	X	X				
Sum PAH	NA	X	NA	NA	NA	NA
TPH (C10-C40)	X	X		X		

Notes:
TRV not available = NA

Table 6-6. Tier 2 Hazard Quotient Summary for Terrestrial Receptors
San Luis Obispo Tank Farm

		AE: T1. Plants		AE: T2. Invertebrates		AE: T3. Song Sparrow		AE:T4. California Vole		AE: T5. Western Meadowlark	
COPEC	EPC	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Metals											
Arsenic	15	1.5	0.17	0.25	NA	0.72	0.18	7.8	0.53	0.34	0.086
Arsenic Background	8.6	0.86	0.10	0.14	NA	0.41	0.10	4.5	0.30	0.20	0.049
Lead: Scenario 1	71	1.4	0.14	0.14	0.043	789	1.3	5.1	0.021	931	1.5
Lead: Scenario 2	68	1.4	0.14	0.14	0.041	754	1.2	4.9	0.020	890	1.4
Lead: Background	35	0.70	0.070	0.070	0.021	391	0.63	2.5	0.011	462	0.74
Organics											
Acenaphthene	0.33										
Acenaphthylene	0.30										
Anthracene	0.29										
Benzo(a)anthracene	0.50	0.42	0.15								
Benzo(a)pyrene	0.49	0.41	0.15								
Benzo(b)fluoranthene	0.45	0.38	0.14								
Benzo(k)fluoranthene	0.34										
Benzo(ghi)perylene	0.38	0.32	0.12	NA	NA						
Chrysene	0.58	0.48	0.18								
Dibenzo(a,h)anthracene	0.25										
Fluoranthene	0.52	0.44	0.16								
Fluorene	0.77										
Indeno(1,2,3-cd)pyrene	0.38	0.32	0.12								
Naphthalene	0.35	0.12	0.0057								
Phenanthrene	2.4	0.79	0.039								
Pyrene	0.91	0.76	0.28								
Sum PAH	6.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH (C10-C40): Scen 1	20300	26	4.4	24	17	2.0	0.20	0.37	0.081	1.5	0.15
TPH (C10-C40): Scen 2	10500	13	2.3	12	9.0	1.0	0.10	0.19	0.042	0.75	0.075

Notes:

HQ > 1.0

Concentrations are mg/kg dry weight.

Not carried forward to Tier 2.

Wildlife HQs based on site use factor (SUF) of 1.

COPEC = Chemical of Potential Ecological Concern

TRV not available = NA

EPC = Exposure Point Concentration; Tier 2 EPC is lower of maximum or 95% UCL based on distribution.

HQ = Hazard Quotient

*PAH TRVs (except naph) for special status species include uncert. factor of 10.

Table 6-6. Tier 2 Hazard Quotient Summary for Terrestrial Receptors
San Luis Obispo Tank Farm

		AE: T5. Loggerhead Shrike*		AE: T6. Ornate Shrew		AE: T7. American Kestrel		AE: T7. Northern Harrier*		AE: T8. Coyote	
COPEC	EPC	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Metals											
Arsenic	15	0.23	0.058	5.3	0.36	0.069	0.017			0.20	0.014
Arsenic Background	8.6	0.13	0.033	3.1	0.21	0.040	0.010			0.12	0.008
Lead: Scenario 1	71	1261	2.0	22	0.093	529	0.85	169	0.27	1.0	0.0043
Lead: Scenario 2	68	1206	1.9	21	0.089	506	0.81	162	0.26	1.0	0.0041
Lead: Background	35	625	1.0	11	0.046	262	0.42	84	0.13	0.52	0.0021
Organics											
Acenaphthene	0.33										
Acenaphthylene	0.30										
Anthracene	0.29										
Benzo(a)anthracene	0.50										
Benzo(a)pyrene	0.49										
Benzo(b)fluoranthene	0.45										
Benzo(k)fluoranthene	0.34										
Benzo(ghi)perylene	0.38										
Chrysene	0.58										
Dibenzo(a,h)anthracene	0.25										
Fluoranthene	0.52										
Fluorene	0.77										
Indeno(1,2,3-cd)pyrene	0.38										
Naphthalene	0.35										
Phenanthrene	2.4										
Pyrene	0.91										
Sum PAH	6.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH (C10-C40): Scen 1	20300			0.64	0.14					0.10	0.021
TPH (C10-C40): Scen 2	10500			0.33	0.073					0.050	0.011

HQ > 1.0
Concentrations are mg/kg dry weight.
Not carried forward to Tier 2.
Wildlife HQs based on site use factor (SUF) of 1.
COPEC = Chemical of Potential Ecological Concern

TRV not available = NA
EPC = Exposure Point Concentration; Tier 2 EPC is lower of maximum or 95% UCL based on distribution.
HQ = Hazard Quotient
*PAH TRVs (except naph) for special status species include uncert. factor of 10.

Table 6-7. Tier 2 Point-by-Point Arsenic Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Within Operation Area													
S-8-0.5	388	39	4.3					202	14				
S-21-0.5	79	7.9	0.88					41	2.8				
S-29-0.5	74	7.4	0.82					38	2.6				
S-22-0.5	64	6.4	0.71					33	2.3				
S-23-0.5	31	3.1	0.35					16	1.1				
S-12-0.5	30	3.0	0.33					16	1.1				
S-30-0.5	29	2.9	0.32					15	1.0				
S-11-0.5	26	2.6	0.29					14	0.93				
S-18-0.5	13	1.3	0.14					6.5	0.44				
S-7-0.5	12	1.2	0.13					6.2	0.42				
S-10-0.5	*8.6*	*0.86*	*0.10*					*4.5*	*0.31*				
S-24-0.5	*7.1*	*0.71*	*0.079*					*3.7*	*0.25*				
S-19-0.5	*6.5*	*0.65*	*0.072*					*3.4*	*0.23*				
S-1-0.5	*6.1*	*0.61*	*0.068*					*3.2*	*0.22*				
S-38-0.5	*5.8*	*0.58*	*0.064*					*3.0*	*0.20*				
S-15-0.5	*5.3*	*0.53*	*0.058*					*2.7*	*0.19*				
S-3-0.5	*4.8*	*0.48*	*0.053*					*2.5*	*0.17*				
S-20-0.5	*4.6*	*0.46*	*0.051*					*2.4*	*0.16*				
S-6-0.5	*4.6*	*0.46*	*0.051*					*2.4*	*0.16*				
S-28-0.5	*4.4*	*0.44*	*0.049*					*2.3*	*0.16*				
S-33-0.5	*4.3*	*0.43*	*0.047*					*2.2*	*0.15*				
S-5-0.5	*4.3*	*0.43*	*0.047*					*2.2*	*0.15*				
S-25-0.5	*4.0*	*0.40*	*0.045*					*2.1*	*0.14*				
S-17-0.5	*3.9*	*0.39*	*0.043*					*2.0*	*0.14*				
S-35-0.5	*3.8*	*0.38*	*0.042*					*2.0*	*0.13*				
S-9-0.5	*3.8*	*0.38*	*0.042*					*2.0*	*0.13*				
T-19-0.5	*3.8*	*0.38*	*0.042*					*2.0*	*0.13*				
S-27-0.5	*3.4*	*0.34*	*0.038*					*1.8*	*0.12*				
S-34-0.5	*3.4*	*0.34*	*0.038*					*1.8*	*0.12*				
B-13-5	*3.3*	*0.33*	*0.036*					*1.7*	*0.12*				
S-16-0.5	*3.3*	*0.33*	*0.036*					*1.7*	*0.12*				
S-2-0.5	*3.0*	*0.30*	*0.033*					*1.6*	*0.11*				
S-4-0.5	*2.9*	*0.29*	*0.032*					*1.5*	*0.10*				
B-7-5	*2.4*	*0.24*	*0.026*					*1.2*	*0.084*				
S-13-0.5	*2.4*	*0.24*	*0.026*					*1.2*	*0.084*				
S-26-0.5	*2.1*	*0.21*	*0.024*					*1.1*	*0.075*				
S-37-0.5	*2.1*	*0.21*	*0.024*					*1.1*	*0.075*				
B-34-5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				
S-14-0.5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				
S-31-0.5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				
S-32-0.5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				
S-36-0.5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				

Table 6-7. Tier 2 Point-by-Point Arsenic Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Outside Operation Area													
S-50-0.5	*28*	*2.8*	*0.31*					*14*	*0.98*				
B-36-2.5	*11*	*1.1*	*0.12*					*5.7*	*0.39*				
B-1-5	*7.6*	*0.76*	*0.085*					*4.0*	*0.27*				
T-2-0.5	*6.6*	*0.66*	*0.074*					*3.5*	*0.24*				
S-66-0.5	*6.4*	*0.64*	*0.071*					*3.3*	*0.23*				
S-61-2.5	*6.1*	*0.61*	*0.068*					*3.2*	*0.22*				
T-5-0.5	*6.0*	*0.60*	*0.067*					*3.1*	*0.21*				
S-63-2.5	*5.9*	*0.59*	*0.065*					*3.1*	*0.21*				
B-25-5	*5.5*	*0.55*	*0.061*					*2.9*	*0.20*				
B-35-5	*5.4*	*0.54*	*0.060*					*2.8*	*0.19*				
B-31-5	*4.9*	*0.49*	*0.054*					*2.5*	*0.17*				
S-53-2.5	*4.9*	*0.49*	*0.054*					*2.5*	*0.17*				
T-12-0.5	*4.6*	*0.46*	*0.051*					*2.4*	*0.16*				
B-11-5	*4.5*	*0.45*	*0.050*					*2.3*	*0.16*				
S-56-0.5	*4.3*	*0.43*	*0.047*					*2.2*	*0.15*				
B-42-5	*4.1*	*0.41*	*0.046*					*2.2*	*0.15*				
B-44-5	*4.0*	*0.40*	*0.045*					*2.1*	*0.14*				
B-54-0.5	*4.0*	*0.40*	*0.045*					*2.1*	*0.14*				
S-51-2.5	*3.8*	*0.38*	*0.042*					*2.0*	*0.13*				
S-54-0.5	*3.5*	*0.35*	*0.039*					*1.8*	*0.12*				
B-33-5	*3.4*	*0.34*	*0.038*					*1.8*	*0.12*				
B-46-0.5	*3.3*	*0.33*	*0.036*					*1.7*	*0.12*				
S-55-2.5	*3.1*	*0.31*	*0.035*					*1.6*	*0.11*				
B-27-0.5	*3.0*	*0.30*	*0.033*					*1.6*	*0.11*				
B-56-5	*3.0*	*0.30*	*0.033*					*1.6*	*0.11*				
MW-31-3.5	*3.0*	*0.30*	*0.033*					*1.6*	*0.11*				
B-30-0.5	*2.9*	*0.29*	*0.032*					*1.5*	*0.10*				
B-26-0.5	*2.8*	*0.28*	*0.031*					*1.4*	*0.10*				
S-44-0.5	*2.8*	*0.28*	*0.031*					*1.4*	*0.10*				
S-49-2.5	*2.8*	*0.28*	*0.031*					*1.4*	*0.10*				
B-23-0.5	*2.6*	*0.26*	*0.029*					*1.4*	*0.093*				
S-59-2.5	*2.6*	*0.26*	*0.029*					*1.4*	*0.093*				
B-43-5	*2.5*	*0.25*	*0.028*					*1.3*	*0.089*				
S-52-0.5	*2.5*	*0.25*	*0.028*					*1.3*	*0.089*				
S-58-0.5	*2.5*	*0.25*	*0.028*					*1.3*	*0.089*				
S-64-0.5	*2.5*	*0.25*	*0.028*					*1.3*	*0.089*				
B-29-0.5	*2.4*	*0.24*	*0.026*					*1.2*	*0.084*				
B-36-0.5	*2.4*	*0.24*	*0.026*					*1.2*	*0.084*				
S-62-0.5	*2.4*	*0.24*	*0.026*					*1.2*	*0.084*				
B-19-5	*2.3*	*0.23*	*0.025*					*1.2*	*0.080*				
B-32-5	*2.3*	*0.23*	*0.025*					*1.2*	*0.080*				
B-50-5	*2.3*	*0.23*	*0.025*					*1.2*	*0.080*				

Table 6-7. Tier 2 Point-by-Point Arsenic Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-40-0.5	*2.3*	*0.23*	*0.025*					*1.2*	*0.080*				
S-67-2.5	*2.3*	*0.23*	*0.025*					*1.2*	*0.080*				
S-65-2.5	*2.1*	*0.21*	*0.024*					*1.1*	*0.075*				
Sd-2-0.5	*2.1*	*0.21*	*0.024*					*1.1*	*0.075*				
B-52-5	*2.0*	*0.20*	*0.022*					*1.0*	*0.071*				
S-48-0.5	*1.9*	*0.19*	*0.021*					*0.98*	*0.067*				
B-48-5	*1.8*	*0.18*	*0.019*					*0.91*	*0.062*				
B-49-0.5	*1.8*	*0.18*	*0.019*					*0.91*	*0.062*				
S-60-0.5	*1.8*	*0.18*	*0.019*					*0.91*	*0.062*				
B-21-5	*1.6*	*0.16*	*0.018*					*0.85*	*0.058*				
B-40-5	*1.6*	*0.16*	*0.018*					*0.85*	*0.058*				
B-3-5	*1.5*	*0.15*	*0.017*					*0.78*	*0.053*				
B-38-5	*1.5*	*0.15*	*0.017*					*0.78*	*0.053*				
S-42-0.5	*1.5*	*0.15*	*0.017*					*0.78*	*0.053*				
B-17-5	*1.4*	*0.14*	*0.015*					*0.72*	*0.049*				
B-9-5	*1.4*	*0.14*	*0.015*					*0.72*	*0.049*				
S-39-2.5	*1.4*	*0.14*	*0.015*					*0.72*	*0.049*				
S-41-2.5	*1.4*	*0.14*	*0.015*					*0.72*	*0.049*				
S-57-2.5	*1.4*	*0.14*	*0.015*					*0.72*	*0.049*				
Background-1	***6.3***	*0.63*	*0.070*					*3.3*	*0.22*				
Background-3	***6.3***	*0.63*	*0.070*					*3.3*	*0.22*				
Background-6	***6.3***	*0.63*	*0.070*					*3.3*	*0.22*				
Background-7	***6.3***	*0.63*	*0.070*					*3.3*	*0.22*				
Background-8	***6.3***	*0.63*	*0.070*					*3.3*	*0.22*				
RC-13	***3.1***	*0.31*	*0.035*					*1.6*	*0.11*				
RC-14	***3.1***	*0.31*	*0.035*					*1.6*	*0.11*				
RC-16	***3.1***	*0.31*	*0.035*					*1.6*	*0.11*				
RC-18	***3.1***	*0.31*	*0.035*					*1.6*	*0.11*				
RC-9	***3.1***	*0.31*	*0.035*					*1.6*	*0.11*				
B-36-5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				
B-5-5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				
S-43-2.5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				
S-45-2.5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				
S-46-0.5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				
S-47-2.5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				
S-63-0.5	***0.63***	*0.063*	*0.0070*					*0.33*	*0.022*				

Notes:
HQ > 1 and concentration above bkgrd. 1.5
Concentrations are mg/kg dry weight.
Not carried forward to Tier 2 point-by-point.
Wildlife HQs based on site use factor (SUF) of 1.
COPEC = Chemical of Potential Ecological Concern

Bold text indicates all non-detects. Value is one-half detection limit.
Italics indicate concentration is less than background conc. of 8.6 mg/kg.
HQ = Hazard Quotient

Table 6-7. Tier 2 Point-by-Point Arsenic Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Within Operation Area									
S-8-0.5	388	138	9.4						
S-21-0.5	79	28	1.9						
S-29-0.5	74	26	1.8						
S-22-0.5	64	23	1.5						
S-23-0.5	31	11	0.76						
S-12-0.5	30	11	0.73						
S-30-0.5	29	10	0.70						
S-11-0.5	26	9.3	0.64						
S-18-0.5	13	4.4	0.30						
S-7-0.5	12	4.2	0.29						
S-10-0.5	*8.6*	*3.1*	*0.21*						
S-24-0.5	*7.1*	*2.5*	*0.17*						
S-19-0.5	*6.5*	*2.3*	*0.16*						
S-1-0.5	*6.1*	*2.2*	*0.15*						
S-38-0.5	*5.8*	*2.0*	*0.14*						
S-15-0.5	*5.3*	*1.9*	*0.13*						
S-3-0.5	*4.8*	*1.7*	*0.11*						
S-20-0.5	*4.6*	*1.6*	*0.11*						
S-6-0.5	*4.6*	*1.6*	*0.11*						
S-28-0.5	*4.4*	*1.6*	*0.11*						
S-33-0.5	*4.3*	*1.5*	*0.10*						
S-5-0.5	*4.3*	*1.5*	*0.10*						
S-25-0.5	*4.0*	*1.4*	*0.10*						
S-17-0.5	*3.9*	*1.4*	*0.094*						
S-35-0.5	*3.8*	*1.3*	*0.091*						
S-9-0.5	*3.8*	*1.3*	*0.091*						
T-19-0.5	*3.8*	*1.3*	*0.091*						
S-27-0.5	*3.4*	*1.2*	*0.082*						
S-34-0.5	*3.4*	*1.2*	*0.082*						
B-13-5	*3.3*	*1.2*	*0.079*						
S-16-0.5	*3.3*	*1.2*	*0.079*						
S-2-0.5	*3.0*	*1.1*	*0.073*						
S-4-0.5	*2.9*	*1.0*	*0.070*						
B-7-5	*2.4*	*0.84*	*0.057*						
S-13-0.5	*2.4*	*0.84*	*0.057*						
S-26-0.5	*2.1*	*0.76*	*0.051*						
S-37-0.5	*2.1*	*0.76*	*0.051*						
B-34-5	***0.63***	*0.22*	*0.015*						
S-14-0.5	***0.63***	*0.22*	*0.015*						
S-31-0.5	***0.63***	*0.22*	*0.015*						
S-32-0.5	***0.63***	*0.22*	*0.015*						
S-36-0.5	***0.63***	*0.22*	*0.015*						

Table 6-7. Tier 2 Point-by-Point Arsenic Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Outside Operation Area									
S-50-0.5	*28*	*9.8*	*0.67*						
B-36-2.5	*11*	*3.9*	*0.27*						
B-1-5	*7.6*	*2.7*	*0.18*						
T-2-0.5	*6.6*	*2.4*	*0.16*						
S-66-0.5	*6.4*	*2.3*	*0.15*						
S-61-2.5	*6.1*	*2.2*	*0.15*						
T-5-0.5	*6.0*	*2.1*	*0.15*						
S-63-2.5	*5.9*	*2.1*	*0.14*						
B-25-5	*5.5*	*2.0*	*0.13*						
B-35-5	*5.4*	*1.9*	*0.13*						
B-31-5	*4.9*	*1.7*	*0.12*						
S-53-2.5	*4.9*	*1.7*	*0.12*						
T-12-0.5	*4.6*	*1.6*	*0.11*						
B-11-5	*4.5*	*1.6*	*0.11*						
S-56-0.5	*4.3*	*1.5*	*0.10*						
B-42-5	*4.1*	*1.5*	*0.10*						
B-44-5	*4.0*	*1.4*	*0.10*						
B-54-0.5	*4.0*	*1.4*	*0.10*						
S-51-2.5	*3.8*	*1.3*	*0.091*						
S-54-0.5	*3.5*	*1.2*	*0.085*						
B-33-5	*3.4*	*1.2*	*0.082*						
B-46-0.5	*3.3*	*1.2*	*0.079*						
S-55-2.5	*3.1*	*1.1*	*0.076*						
B-27-0.5	*3.0*	*1.1*	*0.073*						
B-56-5	*3.0*	*1.1*	*0.073*						
MW-31-3.5	*3.0*	*1.1*	*0.073*						
B-30-0.5	*2.9*	*1.0*	*0.070*						
B-26-0.5	*2.8*	*0.98*	*0.067*						
S-44-0.5	*2.8*	*0.98*	*0.067*						
S-49-2.5	*2.8*	*0.98*	*0.067*						
B-23-0.5	*2.6*	*0.93*	*0.064*						
S-59-2.5	*2.6*	*0.93*	*0.064*						
B-43-5	*2.5*	*0.89*	*0.061*						
S-52-0.5	*2.5*	*0.89*	*0.061*						
S-58-0.5	*2.5*	*0.89*	*0.061*						
S-64-0.5	*2.5*	*0.89*	*0.061*						
B-29-0.5	*2.4*	*0.84*	*0.057*						
B-36-0.5	*2.4*	*0.84*	*0.057*						
S-62-0.5	*2.4*	*0.84*	*0.057*						
B-19-5	*2.3*	*0.80*	*0.054*						
B-32-5	*2.3*	*0.80*	*0.054*						
B-50-5	*2.3*	*0.80*	*0.054*						

Table 6-7. Tier 2 Point-by-Point Arsenic Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-40-0.5	*2.3*	*0.80*	*0.054*						
S-67-2.5	*2.3*	*0.80*	*0.054*						
S-65-2.5	*2.1*	*0.76*	*0.051*						
Sd-2-0.5	*2.1*	*0.76*	*0.051*						
B-52-5	*2.0*	*0.71*	*0.048*						
S-48-0.5	*1.9*	*0.67*	*0.045*						
B-48-5	*1.8*	*0.62*	*0.042*						
B-49-0.5	*1.8*	*0.62*	*0.042*						
S-60-0.5	*1.8*	*0.62*	*0.042*						
B-21-5	*1.6*	*0.58*	*0.039*						
B-40-5	*1.6*	*0.58*	*0.039*						
B-3-5	*1.5*	*0.53*	*0.036*						
B-38-5	*1.5*	*0.53*	*0.036*						
S-42-0.5	*1.5*	*0.53*	*0.036*						
B-17-5	*1.4*	*0.49*	*0.033*						
B-9-5	*1.4*	*0.49*	*0.033*						
S-39-2.5	*1.4*	*0.49*	*0.033*						
S-41-2.5	*1.4*	*0.49*	*0.033*						
S-57-2.5	*1.4*	*0.49*	*0.033*						
Background-1	***6.3***	*2.2*	*0.15*						
Background-3	***6.3***	*2.2*	*0.15*						
Background-6	***6.3***	*2.2*	*0.15*						
Background-7	***6.3***	*2.2*	*0.15*						
Background-8	***6.3***	*2.2*	*0.15*						
RC-13	***3.1***	*1.1*	*0.076*						
RC-14	***3.1***	*1.1*	*0.076*						
RC-16	***3.1***	*1.1*	*0.076*						
RC-18	***3.1***	*1.1*	*0.076*						
RC-9	***3.1***	*1.1*	*0.076*						
B-36-5	***0.63***	*0.22*	*0.015*						
B-5-5	***0.63***	*0.22*	*0.015*						
S-43-2.5	***0.63***	*0.22*	*0.015*						
S-45-2.5	***0.63***	*0.22*	*0.015*						
S-46-0.5	***0.63***	*0.22*	*0.015*						
S-47-2.5	***0.63***	*0.22*	*0.015*						
S-63-0.5	***0.63***	*0.22*	*0.015*						

Notes:
HQ > 1 and concentration above bkgrd. 1.5
Concentrations are mg/kg dry weight.
Not carried forward to Tier 2 point-by-point.
Wildlife HQs based on site use factor (SUF) of 1.
COPEC = Chemical of Potential Ecological Concern

Bold text indicates all non-detects. Value is one-half detection limit.
Italics indicate concentration is less than background conc. of 8.6 mg/kg.
HQ = Hazard Quotient

Table 6-8. Tier 2 Point-by-Point Lead Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Within Operation Area													
T-10-0.5	1001	20	2.0			11187	18	73	0.30	13203	21	17882	29
S-7-0.5	225	4.5	0.45			2517	4.0	16	0.068	2971	4.8	4023	6.4
S-30-0.5	163	3.3	0.33			1818	2.9	12	0.049	2145	3.4	2906	4.6
S-16-0.5	138	2.8	0.28			1538	2.5	10	0.042	1815	2.9	2459	3.9
S-34-0.5	138	2.8	0.28			1538	2.5	10	0.042	1815	2.9	2459	3.9
S-5-0.5	138	2.8	0.28			1538	2.5	10	0.042	1815	2.9	2459	3.9
S-22-0.5	125	2.5	0.25			1398	2.2	9.1	0.038	1650	2.6	2235	3.6
S-33-0.5	123	2.5	0.25			1370	2.2	8.9	0.037	1617	2.6	2191	3.5
S-1-0.5	111	2.2	0.22			1245	2.0	8.1	0.034	1469	2.4	1989	3.2
S-18-0.5	96	1.9	0.19			1077	1.7	7.0	0.029	1271	2.0	1721	2.8
S-28-0.5	74	1.5	0.15			825	1.3	5.4	0.022	974	1.6	1319	2.1
S-8-0.5	48	0.95	0.10			531	0.85	3.5	0.014	627	1.0	849	1.4
S-24-0.5	*35*	*0.70*	*0.070*			*392*	*0.63*	*2.5*	*0.011*	*462*	*0.74*	*626*	*1.0*
S-35-0.5	*35*	*0.70*	*0.070*			*392*	*0.63*	*2.5*	*0.011*	*462*	*0.74*	*626*	*1.0*
S-12-0.5	*34*	*0.68*	*0.068*			*378*	*0.60*	*2.5*	*0.010*	*446*	*0.71*	*604*	*0.97*
S-38-0.5	*34*	*0.68*	*0.068*			*378*	*0.60*	*2.5*	*0.010*	*446*	*0.71*	*604*	*0.97*
S-20-0.5	*30*	*0.60*	*0.060*			*336*	*0.54*	*2.2*	*0.0091*	*396*	*0.63*	*536*	*0.86*
S-3-0.5	*29*	*0.58*	*0.058*			*322*	*0.51*	*2.1*	*0.0087*	*380*	*0.61*	*514*	*0.82*
S-23-0.5	*21*	*0.43*	*0.043*			*238*	*0.38*	*1.5*	*0.0064*	*281*	*0.45*	*380*	*0.61*
S-37-0.5	*21*	*0.43*	*0.043*			*238*	*0.38*	*1.5*	*0.0064*	*281*	*0.45*	*380*	*0.61*
S-17-0.5	*20*	*0.40*	*0.040*			*224*	*0.36*	*1.5*	*0.0061*	*264*	*0.42*	*358*	*0.57*
S-19-0.5	*18*	*0.35*	*0.035*			*196*	*0.31*	*1.3*	*0.0053*	*231*	*0.37*	*313*	*0.50*
T-19-0.5	*18*	*0.35*	*0.035*			*196*	*0.31*	*1.3*	*0.0053*	*231*	*0.37*	*313*	*0.50*
S-10-0.5	*16*	*0.33*	*0.033*			*182*	*0.29*	*1.2*	*0.0049*	*215*	*0.34*	*291*	*0.46*
S-9-0.5	*14*	*0.28*	*0.028*			*154*	*0.25*	*1.0*	*0.0042*	*182*	*0.29*	*246*	*0.39*
S-15-0.5	*12*	*0.24*	*0.024*			*133*	*0.21*	*0.86*	*0.0036*	*157*	*0.25*	*212*	*0.34*
S-2-0.5	*12*	*0.24*	*0.024*			*133*	*0.21*	*0.86*	*0.0036*	*157*	*0.25*	*212*	*0.34*
S-32-0.5	*11*	*0.22*	*0.022*			*124*	*0.20*	*0.81*	*0.0034*	*147*	*0.24*	*199*	*0.32*
S-25-0.5	*11*	*0.21*	*0.021*			*119*	*0.19*	*0.77*	*0.0032*	*140*	*0.22*	*190*	*0.30*
T-20-0.5	*10*	*0.20*	*0.020*			*112*	*0.18*	*0.73*	*0.0030*	*132*	*0.21*	*179*	*0.29*
S-36-0.5	*10*	*0.20*	*0.020*			*110*	*0.18*	*0.72*	*0.0030*	*130*	*0.21*	*177*	*0.28*
S-21-0.5	*8.6*	*0.17*	*0.017*			*96*	*0.15*	*0.63*	*0.0026*	*114*	*0.18*	*154*	*0.25*
T-9-0.5	*8.0*	*0.16*	*0.016*			*89*	*0.14*	*0.58*	*0.0024*	*106*	*0.17*	*143*	*0.23*
S-29-0.5	*7.9*	*0.16*	*0.016*			*88*	*0.14*	*0.57*	*0.0024*	*104*	*0.17*	*141*	*0.23*
S-27-0.5	*7.1*	*0.14*	*0.014*			*80*	*0.13*	*0.52*	*0.0022*	*94*	*0.15*	*127*	*0.20*
S-13-0.5	*6.9*	*0.14*	*0.014*			*77*	*0.12*	*0.50*	*0.0021*	*91*	*0.15*	*123*	*0.20*
S-11-0.5	*6.5*	*0.13*	*0.013*			*73*	*0.12*	*0.47*	*0.0020*	*86*	*0.14*	*116*	*0.19*
S-4-0.5	*6.5*	*0.13*	*0.013*			*73*	*0.12*	*0.47*	*0.0020*	*86*	*0.14*	*116*	*0.19*
S-14-0.5	*6.4*	*0.13*	*0.013*			*71*	*0.11*	*0.46*	*0.0019*	*84*	*0.13*	*114*	*0.18*

Table 6-8. Tier 2 Point-by-Point Lead Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
B-13-5	6.1	0.12	0.012			69	0.11	0.45	0.0019	81	0.13	110	0.18
B-34-5	5.9	0.12	0.012			66	0.11	0.43	0.0018	78	0.12	105	0.17
B-7-5	5.1	0.10	0.010			57	0.092	0.37	0.0016	68	0.11	92	0.15
S-31-0.5	2.4	0.048	0.0048			27	0.043	0.17	0.00072	31	0.050	42	0.068
S-26-0.5	**0.63**	0.013	0.0013			7.0	0.011	0.046	0.00019	8.3	0.013	11	0.018
S-6-0.5	**0.63**	0.013	0.0013			7.0	0.011	0.046	0.00019	8.3	0.013	11	0.018
Outside Operation Area													
T-8-0.5	1151	23	2.3			12865	21	84	0.35	15183	24.3	20564	33
T-2-0.5	801	16	1.6			8950	14	58	0.24	10562	16.9	14306	23
T-17-0.5	488	9.8	0.98			5454	8.7	36	0.15	6436	10.3	8718	14
T-14-0.5	188	3.8	0.38			2098	3.4	14	0.057	2476	4.0	3353	5.4
T-16-0.5	150	3.0	0.30			1678	2.7	11	0.045	1980	3.2	2682	4.3
T-6-0.5	110	2.2	0.22			1231	2.0	8.0	0.033	1452	2.3	1967	3.1
Background-1	84	1.7	0.17			937	1.5	6.1	0.025	1106	1.8	1498	2.4
T-12-0.5	56	1.1	0.11			629	1.0	4.1	0.017	743	1.2	1006	1.6
RC-16	50	1.0	0.10			559	0.89	3.6	0.015	660	1.1	894	1.4
T-5-0.5	31	0.63	0.063			350	0.56	2.3	0.0095	413	0.66	559	0.89
T-7-0.5	31	0.63	0.063			350	0.56	2.3	0.0095	413	0.66	559	0.89
S-66-0.5	25	0.50	0.050			280	0.45	1.8	0.0076	330	0.53	447	0.72
S-46-0.5	23	0.45	0.045			252	0.40	1.6	0.0068	297	0.48	402	0.64
T-3-0.5	18	0.35	0.035			196	0.31	1.3	0.0053	231	0.37	313	0.50
S-56-0.5	16	0.33	0.033			182	0.29	1.2	0.0049	215	0.34	291	0.46
RC-18	15	0.30	0.030			168	0.27	1.1	0.0045	198	0.32	268	0.43
S-51-2.5	15	0.30	0.030			168	0.27	1.1	0.0045	198	0.32	268	0.43
B-26-0.5	14	0.28	0.028			154	0.25	1.0	0.0042	182	0.29	246	0.39
S-48-0.5	14	0.28	0.028			154	0.25	1.0	0.0042	182	0.29	246	0.39
S-67-2.5	14	0.28	0.028			154	0.25	1.0	0.0042	182	0.29	246	0.39
S-62-0.5	13	0.25	0.025			140	0.22	0.91	0.0038	165	0.26	224	0.36
T-18-0.5	13	0.25	0.025			140	0.22	0.91	0.0038	165	0.26	224	0.36
B-38-5	12	0.24	0.024			136	0.22	0.88	0.0037	160	0.26	217	0.35
B-36-0.5	12	0.24	0.024			134	0.21	0.87	0.0036	158	0.25	215	0.34
S-52-0.5	12	0.24	0.024			134	0.21	0.87	0.0036	158	0.25	215	0.34
T-4-0.5	12	0.24	0.024			134	0.21	0.87	0.0036	158	0.25	215	0.34
B-42-5	11	0.21	0.021			119	0.19	0.77	0.0032	140	0.22	190	0.30
S-39-2.5	11	0.21	0.021			117	0.19	0.76	0.0032	139	0.22	188	0.30
S-41-2.5	11	0.21	0.021			117	0.19	0.76	0.0032	139	0.22	188	0.30
T-11-0.5	10	0.21	0.021			116	0.19	0.76	0.0031	137	0.22	186	0.30
B-31-5	10	0.20	0.020			109	0.17	0.71	0.0030	129	0.21	174	0.28
B-54-0.5	10	0.19	0.019			108	0.17	0.70	0.0029	127	0.20	172	0.28
S-61-2.5	9.4	0.19	0.019			105	0.17	0.68	0.0028	124	0.20	168	0.27

Table 6-8. Tier 2 Point-by-Point Lead Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-64-0.5	*8.8*	*0.18*	*0.018*			*98*	*0.16*	*0.64*	*0.0026*	*116*	*0.18*	*156*	*0.25*
T-15-0.5	*8.8*	*0.18*	*0.018*			*98*	*0.16*	*0.64*	*0.0026*	*116*	*0.18*	*156*	*0.25*
RC-14	*8.6*	*0.17*	*0.017*			*96*	*0.15*	*0.63*	*0.0026*	*114*	*0.18*	*154*	*0.25*
B-23-0.5	*8.4*	*0.17*	*0.017*			*94*	*0.15*	*0.61*	*0.0025*	*111*	*0.18*	*150*	*0.24*
S-50-0.5	*8.4*	*0.17*	*0.017*			*94*	*0.15*	*0.61*	*0.0025*	*111*	*0.18*	*150*	*0.24*
B-27-0.5	*8.3*	*0.17*	*0.017*			*92*	*0.15*	*0.60*	*0.0025*	*109*	*0.17*	*148*	*0.24*
B-30-0.5	*8.3*	*0.17*	*0.017*			*92*	*0.15*	*0.60*	*0.0025*	*109*	*0.17*	*148*	*0.24*
S-40-0.5	*8.1*	*0.16*	*0.016*			*91*	*0.15*	*0.59*	*0.0025*	*107*	*0.17*	*145*	*0.23*
S-58-0.5	*7.8*	*0.16*	*0.016*			*87*	*0.14*	*0.56*	*0.0023*	*102*	*0.16*	*139*	*0.22*
T-1-0.5	*7.8*	*0.16*	*0.016*			*87*	*0.14*	*0.56*	*0.0023*	*102*	*0.16*	*139*	*0.22*
B-1-5	*7.5*	*0.15*	*0.015*			*84*	*0.13*	*0.55*	*0.0023*	*99*	*0.16*	*134*	*0.21*
B-46-0.5	*7.5*	*0.15*	*0.015*			*84*	*0.13*	*0.55*	*0.0023*	*99*	*0.16*	*134*	*0.21*
S-53-2.5	*7.5*	*0.15*	*0.015*			*84*	*0.13*	*0.55*	*0.0023*	*99*	*0.16*	*134*	*0.21*
S-59-2.5	*7.4*	*0.15*	*0.015*			*83*	*0.13*	*0.54*	*0.0022*	*97*	*0.16*	*132*	*0.21*
B-29-0.5	*7.3*	*0.15*	*0.015*			*81*	*0.13*	*0.53*	*0.0022*	*96*	*0.15*	*130*	*0.21*
B-44-5	*7.3*	*0.15*	*0.015*			*81*	*0.13*	*0.53*	*0.0022*	*96*	*0.15*	*130*	*0.21*
B-48-5	*7.1*	*0.14*	*0.014*			*80*	*0.13*	*0.52*	*0.0022*	*94*	*0.15*	*127*	*0.20*
B-52-5	*7.1*	*0.14*	*0.014*			*80*	*0.13*	*0.52*	*0.0022*	*94*	*0.15*	*127*	*0.20*
B-36-2.5	*7.0*	*0.14*	*0.014*			*78*	*0.13*	*0.51*	*0.0021*	*92*	*0.15*	*125*	*0.20*
B-43-5	*7.0*	*0.14*	*0.014*			*78*	*0.13*	*0.51*	*0.0021*	*92*	*0.15*	*125*	*0.20*
S-54-0.5	*7.0*	*0.14*	*0.014*			*78*	*0.13*	*0.51*	*0.0021*	*92*	*0.15*	*125*	*0.20*
B-11-5	*6.9*	*0.14*	*0.014*			*77*	*0.12*	*0.50*	*0.0021*	*91*	*0.15*	*123*	*0.20*
S-47-2.5	*6.9*	*0.14*	*0.014*			*77*	*0.12*	*0.50*	*0.0021*	*91*	*0.15*	*123*	*0.20*
B-33-5	*6.8*	*0.14*	*0.014*			*76*	*0.12*	*0.49*	*0.0020*	*89*	*0.14*	*121*	*0.19*
B-35-5	*6.8*	*0.14*	*0.014*			*76*	*0.12*	*0.49*	*0.0020*	*89*	*0.14*	*121*	*0.19*
B-5-5	*6.8*	*0.14*	*0.014*			*76*	*0.12*	*0.49*	*0.0020*	*89*	*0.14*	*121*	*0.19*
B-36-5	*6.6*	*0.13*	*0.013*			*74*	*0.12*	*0.48*	*0.0020*	*87*	*0.14*	*118*	*0.19*
B-49-0.5	*6.6*	*0.13*	*0.013*			*74*	*0.12*	*0.48*	*0.0020*	*87*	*0.14*	*118*	*0.19*
S-42-0.5	*6.6*	*0.13*	*0.013*			*74*	*0.12*	*0.48*	*0.0020*	*87*	*0.14*	*118*	*0.19*
B-21-5	*6.5*	*0.13*	*0.013*			*73*	*0.12*	*0.47*	*0.0020*	*86*	*0.14*	*116*	*0.19*
S-63-0.5	*6.5*	*0.13*	*0.013*			*73*	*0.12*	*0.47*	*0.0020*	*86*	*0.14*	*116*	*0.19*
T-13-0.5	*6.5*	*0.13*	*0.013*			*73*	*0.12*	*0.47*	*0.0020*	*86*	*0.14*	*116*	*0.19*
S-49-2.5	*6.4*	*0.13*	*0.013*			*71*	*0.11*	*0.46*	*0.0019*	*84*	*0.13*	*114*	*0.18*
S-43-2.5	*6.3*	*0.13*	*0.013*			*70*	*0.11*	*0.46*	*0.0019*	*83*	*0.13*	*112*	*0.18*
S-55-2.5	*6.3*	*0.13*	*0.013*			*70*	*0.11*	*0.46*	*0.0019*	*83*	*0.13*	*112*	*0.18*
RC-13	*6.1*	*0.12*	*0.012*			*69*	*0.11*	*0.45*	*0.0019*	*81*	*0.13*	*110*	*0.18*
S-44-0.5	*6.1*	*0.12*	*0.012*			*69*	*0.11*	*0.45*	*0.0019*	*81*	*0.13*	*110*	*0.18*
S-65-2.5	*6.1*	*0.12*	*0.012*			*69*	*0.11*	*0.45*	*0.0019*	*81*	*0.13*	*110*	*0.18*
B-19-5	*5.9*	*0.12*	*0.012*			*66*	*0.11*	*0.43*	*0.0018*	*78*	*0.12*	*105*	*0.17*
S-60-0.5	*5.9*	*0.12*	*0.012*			*66*	*0.11*	*0.43*	*0.0018*	*78*	*0.12*	*105*	*0.17*

Table 6-8. Tier 2 Point-by-Point Lead Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-63-2.5	*5.6*	*0.11*	*0.011*			*63*	*0.10*	*0.41*	*0.0017*	*74*	*0.12*	*101*	*0.16*
B-56-5	*5.4*	*0.11*	*0.011*			*60*	*0.10*	*0.39*	*0.0016*	*71*	*0.11*	*96*	*0.15*
B-32-5	*5.3*	*0.11*	*0.011*			*59*	*0.09*	*0.38*	*0.0016*	*69*	*0.11*	*94*	*0.15*
B-40-5	*5.3*	*0.11*	*0.011*			*59*	*0.09*	*0.38*	*0.0016*	*69*	*0.11*	*94*	*0.15*
B-50-5	*5.1*	*0.10*	*0.010*			*57*	*0.09*	*0.37*	*0.0016*	*68*	*0.11*	*92*	*0.15*
MW-31-3.5	*5.1*	*0.10*	*0.010*			*57*	*0.09*	*0.37*	*0.0016*	*68*	*0.11*	*92*	*0.15*
S-57-2.5	*5.1*	*0.10*	*0.010*			*57*	*0.09*	*0.37*	*0.0016*	*68*	*0.11*	*92*	*0.15*
B-25-5	*4.9*	*0.10*	*0.010*			*55*	*0.09*	*0.36*	*0.0015*	*64*	*0.10*	*87*	*0.14*
B-17-5	*4.8*	*0.10*	*0.010*			*53*	*0.09*	*0.35*	*0.0014*	*63*	*0.10*	*85*	*0.14*
Sd-2-0.5	*4.3*	*0.09*	*0.009*			*48*	*0.08*	*0.31*	*0.0013*	*56*	*0.09*	*76*	*0.12*
RC-9	*2.8*	*0.06*	*0.006*			*31*	*0.05*	*0.20*	*0.0008*	*36*	*0.06*	*49*	*0.08*
Background-3	***6.3***	*0.13*	*0.013*			*70*	*0.11*	*0.46*	*0.0019*	*83*	*0.13*	*112*	*0.18*
Background-6	***6.3***	*0.13*	*0.013*			*70*	*0.11*	*0.46*	*0.0019*	*83*	*0.13*	*112*	*0.18*
Background-7	***6.3***	*0.13*	*0.013*			*70*	*0.11*	*0.46*	*0.0019*	*83*	*0.13*	*112*	*0.18*
Background-8	***6.3***	*0.13*	*0.013*			*70*	*0.11*	*0.46*	*0.0019*	*83*	*0.13*	*112*	*0.18*
B-3-5	***0.63***	*0.013*	*0.0013*			*7.0*	*0.011*	*0.046*	*0.00019*	*8.3*	*0.013*	*11*	*0.018*
B-9-5	***0.63***	*0.013*	*0.0013*			*7.0*	*0.011*	*0.046*	*0.00019*	*8.3*	*0.013*	*11*	*0.018*
S-45-2.5	***0.63***	*0.013*	*0.0013*			*7.0*	*0.011*	*0.046*	*0.00019*	*8.3*	*0.013*	*11*	*0.018*

Notes:

HQ > 1 and concentration above bkgrd. = 1.5

Concentrations are mg/kg dry weight.

Not carried forward to Tier 2 point-by-point.

Wildlife HQs based on site use factor (SUF) of 1.

COPEC = Chemical of Potential Ecological Concern

Bold text indicates all non-detects. Value is one-half detection limit.

Italics indicate concentration is less than background concentration of 35 mg/kg.

HQ = Hazard Quotient

Table 6-8. Tier 2 Point-by-Point Lead Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Within Operation Area									
T-10-0.5	1001	316	1.3	7508	12	2400	3.8		
S-7-0.5	225	71	0.30	1689	2.7	540	0.86		
S-30-0.5	163	51	0.21	1220	2.0	390	0.62		
S-16-0.5	138	44	0.18	1032	1.7	330	0.53		
S-34-0.5	138	44	0.18	1032	1.7	330	0.53		
S-5-0.5	138	44	0.18	1032	1.7	330	0.53		
S-22-0.5	125	40	0.16	938	1.5	300	0.48		
S-33-0.5	123	39	0.16	920	1.5	294	0.47		
S-1-0.5	111	35	0.15	835	1.3	267	0.43		
S-18-0.5	96	30	0.13	723	1.2	231	0.37		
S-28-0.5	74	23	0.097	554	0.89	177	0.28		
S-8-0.5	48	15	0.062	357	0.57	114	0.18		
S-24-0.5	*35*	*11*	*0.046*	*263*	*0.42*	*84*	*0.13*		
S-35-0.5	*35*	*11*	*0.046*	*263*	*0.42*	*84*	*0.13*		
S-12-0.5	*34*	*11*	*0.044*	*253*	*0.41*	*81*	*0.13*		
S-38-0.5	*34*	*11*	*0.044*	*253*	*0.41*	*81*	*0.13*		
S-20-0.5	*30*	*9.5*	*0.039*	*225*	*0.36*	*72*	*0.12*		
S-3-0.5	*29*	*9.1*	*0.038*	*216*	*0.35*	*69*	*0.11*		
S-23-0.5	*21*	*6.7*	*0.028*	*160*	*0.26*	*51*	*0.082*		
S-37-0.5	*21*	*6.7*	*0.028*	*160*	*0.26*	*51*	*0.082*		
S-17-0.5	*20*	*6.3*	*0.026*	*150*	*0.24*	*48*	*0.077*		
S-19-0.5	*18*	*5.5*	*0.023*	*131*	*0.21*	*42*	*0.067*		
T-19-0.5	*18*	*5.5*	*0.023*	*131*	*0.21*	*42*	*0.067*		
S-10-0.5	*16*	*5.1*	*0.021*	*122*	*0.20*	*39*	*0.062*		
S-9-0.5	*14*	*4.4*	*0.018*	*103*	*0.17*	*33*	*0.053*		
S-15-0.5	*12*	*3.8*	*0.016*	*89*	*0.14*	*29*	*0.046*		
S-2-0.5	*12*	*3.8*	*0.016*	*89*	*0.14*	*29*	*0.046*		
S-32-0.5	*11*	*3.5*	*0.015*	*84*	*0.13*	*27*	*0.043*		
S-25-0.5	*11*	*3.4*	*0.014*	*80*	*0.13*	*26*	*0.041*		
T-20-0.5	*10*	*3.2*	*0.013*	*75*	*0.12*	*24*	*0.038*		
S-36-0.5	*10*	*3.1*	*0.013*	*74*	*0.12*	*24*	*0.038*		
S-21-0.5	*8.6*	*2.7*	*0.011*	*65*	*0.10*	*21*	*0.033*		
T-9-0.5	*8.0*	*2.5*	*0.011*	*60*	*0.10*	*19*	*0.031*		
S-29-0.5	*7.9*	*2.5*	*0.010*	*59*	*0.095*	*19*	*0.030*		
S-27-0.5	*7.1*	*2.3*	*0.0094*	*53*	*0.086*	*17*	*0.027*		
S-13-0.5	*6.9*	*2.2*	*0.0090*	*52*	*0.083*	*17*	*0.026*		
S-11-0.5	*6.5*	*2.1*	*0.0085*	*49*	*0.078*	*16*	*0.025*		
S-4-0.5	*6.5*	*2.1*	*0.0085*	*49*	*0.078*	*16*	*0.025*		
S-14-0.5	*6.4*	*2.0*	*0.0084*	*48*	*0.077*	*15*	*0.024*		

Table 6-8. Tier 2 Point-by-Point Lead Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
B-13-5	6.1	1.9	0.0081	46	0.074	15	0.024		
B-34-5	5.9	1.9	0.0077	44	0.071	14	0.023		
B-7-5	5.1	1.6	0.0067	38	0.062	12	0.020		
S-31-0.5	2.4	0.75	0.0031	18	0.029	5.7	0.0091		
S-26-0.5	**0.63**	0.20	0.00082	4.7	0.0075	1.5	0.0024		
S-6-0.5	**0.63**	0.20	0.00082	4.7	0.0075	1.5	0.0024		
Outside Operation Are									
T-8-0.5	1151	364	1.5	8634	14	2760	4.4		
T-2-0.5	801	253	1.1	6006	9.6	1920	3.1		
T-17-0.5	488	154	0.64	3660	5.9	1170	1.9		
T-14-0.5	188	59	0.25	1408	2.3	450	0.72		
T-16-0.5	150	47	0.20	1126	1.8	360	0.58		
T-6-0.5	110	35	0.14	826	1.3	264	0.42		
Background-1	84	27	0.11	629	1.0	201	0.32		
T-12-0.5	56	18	0.074	422	0.68	135	0.22		
RC-16	50	16	0.066	375	0.60	120	0.19		
T-5-0.5	31	10	0.041	235	0.38	75	0.12		
T-7-0.5	31	10	0.041	235	0.38	75	0.12		
S-66-0.5	25	7.9	0.033	188	0.30	60	0.10		
S-46-0.5	23	7.1	0.030	169	0.27	54	0.086		
T-3-0.5	18	5.5	0.023	131	0.21	42	0.067		
S-56-0.5	16	5.1	0.021	122	0.20	39	0.062		
RC-18	15	4.7	0.020	113	0.18	36	0.058		
S-51-2.5	15	4.7	0.020	113	0.18	36	0.058		
B-26-0.5	14	4.4	0.018	103	0.17	33	0.053		
S-48-0.5	14	4.4	0.018	103	0.17	33	0.053		
S-67-2.5	14	4.4	0.018	103	0.17	33	0.053		
S-62-0.5	13	4.0	0.016	94	0.15	30	0.048		
T-18-0.5	13	4.0	0.016	94	0.15	30	0.048		
B-38-5	12	3.8	0.016	91	0.15	29	0.047		
B-36-0.5	12	3.8	0.016	90	0.14	29	0.046		
S-52-0.5	12	3.8	0.016	90	0.14	29	0.046		
T-4-0.5	12	3.8	0.016	90	0.14	29	0.046		
B-42-5	11	3.4	0.014	80	0.13	26	0.041		
S-39-2.5	11	3.3	0.014	79	0.13	25	0.040		
S-41-2.5	11	3.3	0.014	79	0.13	25	0.040		
T-11-0.5	10	3.3	0.014	78	0.12	25	0.040		
B-31-5	10	3.1	0.013	73	0.12	23	0.037		
B-54-0.5	10	3.0	0.013	72	0.12	23	0.037		
S-61-2.5	9.4	3.0	0.012	70	0.11	23	0.036		

Table 6-8. Tier 2 Point-by-Point Lead Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-64-0.5	*8.8*	*2.8*	*0.012*	*66*	*0.11*	*21*	*0.034*		
T-15-0.5	*8.8*	*2.8*	*0.012*	*66*	*0.11*	*21*	*0.034*		
RC-14	*8.6*	*2.7*	*0.011*	*65*	*0.10*	*21*	*0.033*		
B-23-0.5	*8.4*	*2.7*	*0.011*	*63*	*0.10*	*20*	*0.032*		
S-50-0.5	*8.4*	*2.7*	*0.011*	*63*	*0.10*	*20*	*0.032*		
B-27-0.5	*8.3*	*2.6*	*0.011*	*62*	*0.10*	*20*	*0.032*		
B-30-0.5	*8.3*	*2.6*	*0.011*	*62*	*0.10*	*20*	*0.032*		
S-40-0.5	*8.1*	*2.6*	*0.011*	*61*	*0.10*	*20*	*0.031*		
S-58-0.5	*7.8*	*2.5*	*0.010*	*58*	*0.093*	*19*	*0.030*		
T-1-0.5	*7.8*	*2.5*	*0.010*	*58*	*0.093*	*19*	*0.030*		
B-1-5	*7.5*	*2.4*	*0.010*	*56*	*0.090*	*18*	*0.029*		
B-46-0.5	*7.5*	*2.4*	*0.010*	*56*	*0.090*	*18*	*0.029*		
S-53-2.5	*7.5*	*2.4*	*0.010*	*56*	*0.090*	*18*	*0.029*		
S-59-2.5	*7.4*	*2.3*	*0.010*	*55*	*0.089*	*18*	*0.028*		
B-29-0.5	*7.3*	*2.3*	*0.010*	*54*	*0.087*	*17*	*0.028*		
B-44-5	*7.3*	*2.3*	*0.010*	*54*	*0.087*	*17*	*0.028*		
B-48-5	*7.1*	*2.3*	*0.0094*	*53*	*0.086*	*17*	*0.027*		
B-52-5	*7.1*	*2.3*	*0.0094*	*53*	*0.086*	*17*	*0.027*		
B-36-2.5	*7.0*	*2.2*	*0.0092*	*53*	*0.084*	*17*	*0.027*		
B-43-5	*7.0*	*2.2*	*0.0092*	*53*	*0.084*	*17*	*0.027*		
S-54-0.5	*7.0*	*2.2*	*0.0092*	*53*	*0.084*	*17*	*0.027*		
B-11-5	*6.9*	*2.2*	*0.0090*	*52*	*0.083*	*17*	*0.026*		
S-47-2.5	*6.9*	*2.2*	*0.0090*	*52*	*0.083*	*17*	*0.026*		
B-33-5	*6.8*	*2.1*	*0.0089*	*51*	*0.081*	*16*	*0.026*		
B-35-5	*6.8*	*2.1*	*0.0089*	*51*	*0.081*	*16*	*0.026*		
B-5-5	*6.8*	*2.1*	*0.0089*	*51*	*0.081*	*16*	*0.026*		
B-36-5	*6.6*	*2.1*	*0.0087*	*50*	*0.080*	*16*	*0.025*		
B-49-0.5	*6.6*	*2.1*	*0.0087*	*50*	*0.080*	*16*	*0.025*		
S-42-0.5	*6.6*	*2.1*	*0.0087*	*50*	*0.080*	*16*	*0.025*		
B-21-5	*6.5*	*2.1*	*0.0085*	*49*	*0.078*	*16*	*0.025*		
S-63-0.5	*6.5*	*2.1*	*0.0085*	*49*	*0.078*	*16*	*0.025*		
T-13-0.5	*6.5*	*2.1*	*0.0085*	*49*	*0.078*	*16*	*0.025*		
S-49-2.5	*6.4*	*2.0*	*0.0084*	*48*	*0.077*	*15*	*0.024*		
S-43-2.5	*6.3*	*2.0*	*0.0082*	*47*	*0.075*	*15*	*0.024*		
S-55-2.5	*6.3*	*2.0*	*0.0082*	*47*	*0.075*	*15*	*0.024*		
RC-13	*6.1*	*1.9*	*0.0081*	*46*	*0.074*	*15*	*0.024*		
S-44-0.5	*6.1*	*1.9*	*0.0081*	*46*	*0.074*	*15*	*0.024*		
S-65-2.5	*6.1*	*1.9*	*0.0081*	*46*	*0.074*	*15*	*0.024*		
B-19-5	*5.9*	*1.9*	*0.0077*	*44*	*0.071*	*14*	*0.023*		
S-60-0.5	*5.9*	*1.9*	*0.0077*	*44*	*0.071*	*14*	*0.023*		

Table 6-8. Tier 2 Point-by-Point Lead Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-63-2.5	*5.6*	*1.8*	*0.0074*	*42*	*0.068*	*14*	*0.022*		
B-56-5	*5.4*	*1.7*	*0.0071*	*40*	*0.065*	*13*	*0.021*		
B-32-5	*5.3*	*1.7*	*0.0069*	*39*	*0.063*	*13*	*0.020*		
B-40-5	*5.3*	*1.7*	*0.0069*	*39*	*0.063*	*13*	*0.020*		
B-50-5	*5.1*	*1.6*	*0.0067*	*38*	*0.062*	*12*	*0.020*		
MW-31-3.5	*5.1*	*1.6*	*0.0067*	*38*	*0.062*	*12*	*0.020*		
S-57-2.5	*5.1*	*1.6*	*0.0067*	*38*	*0.062*	*12*	*0.020*		
B-25-5	*4.9*	*1.5*	*0.0064*	*37*	*0.059*	*12*	*0.019*		
B-17-5	*4.8*	*1.5*	*0.0062*	*36*	*0.057*	*11*	*0.018*		
Sd-2-0.5	*4.3*	*1.3*	*0.0056*	*32*	*0.051*	*10*	*0.016*		
RC-9	*2.8*	*0.87*	*0.0036*	*21*	*0.033*	*6.6*	*0.011*		
Background-3	***6.3***	*2.0*	*0.0082*	*47*	*0.075*	*15*	*0.024*		
Background-6	***6.3***	*2.0*	*0.0082*	*47*	*0.075*	*15*	*0.024*		
Background-7	***6.3***	*2.0*	*0.0082*	*47*	*0.075*	*15*	*0.024*		
Background-8	***6.3***	*2.0*	*0.0082*	*47*	*0.075*	*15*	*0.024*		
B-3-5	***0.63***	*0.20*	*0.00082*	*4.7*	*0.0075*	*1.5*	*0.0024*		
B-9-5	***0.63***	*0.20*	*0.00082*	*4.7*	*0.0075*	*1.5*	*0.0024*		
S-45-2.5	***0.63***	*0.20*	*0.00082*	*4.7*	*0.0075*	*1.5*	*0.0024*		

HQ > 1 and concentration above bkgrd. = 1.5

Concentrations are mg/kg dry weight.

Not carried forward to Tier 2 point-by-point.

Wildlife HQs based on site use factor (SUF) of 1.

COPEC = Chemical of Potential Ecological Concern

Bold text indicates all non-detects. Value is one-half detection limit.

Italics indicate concentration is less than background concentration of 35 mg/kg.

HQ = Hazard Quotient

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Within Operations Area													
S-25-0.5	10638	14	2.3	13	9.1	1.1	0.11			0.76	0.076		
S-18-2.5	8511	11	1.9	10	7.3	0.84	0.084			0.61	0.061		
B-73-5	8423	11	1.8	10	7.2	0.83	0.083			0.61	0.061		
S-16-2.5	7384	9.4	1.6	8.8	6.3	0.73	0.073			0.53	0.053		
S-19-2.5	7384	9.4	1.6	8.8	6.3	0.73	0.073			0.53	0.053		
S-17-0.5	6758	8.6	1.5	8.0	5.8	0.67	0.067			0.49	0.049		
S-25-2.5	4243	5.4	0.92	5.0	3.6	0.42	0.042			0.30	0.030		
S-17-2.5	3980	5.1	0.87	4.7	3.4	0.39	0.039			0.29	0.029		
S-32-0.5	3880	5.0	0.84	4.6	3.3	0.38	0.038			0.28	0.028		
S-5-0.5	3504	4.5	0.76	4.2	3.0	0.35	0.035			0.25	0.025		
S-28-0.5	3066	3.9	0.67	3.6	2.6	0.30	0.030			0.22	0.022		
S-15-2.5	2491	3.2	0.54	3.0	2.1	0.25	0.025			0.18	0.018		
S-23-2.5	2340	3.0	0.51	2.8	2.0	0.23	0.023			0.17	0.017		
S-18-0.5	2290	2.9	0.50	2.7	2.0	0.23	0.023			0.16	0.016		
S-16-0.5	2078	2.7	0.45	2.5	1.8	0.21	0.021			0.15	0.015		
S-24-2.5	1952	2.5	0.42	2.3	1.7	0.19	0.019			0.14	0.014		
S-32-2.5	1665	2.1	0.36	2.0	1.4	0.16	0.016			0.12	0.012		
S-12-0.5	1564	2.0	0.34	1.9	1.3	0.15	0.015			0.11	0.011		
S-20-0.5	1564	2.0	0.34	1.9	1.3	0.15	0.015			0.11	0.011		
S-7-0.5	1452	1.9	0.32	1.7	1.2	0.14	0.014			0.10	0.010		
S-30-0.5	1126	1.4	0.24	1.3	0.97	0.11	0.011			0.081	0.0081		
S-31-0.5	1051	1.3	0.23	1.2	0.90	0.10	0.010			0.076	0.0076		
S-33-2.5	951	1.2	0.21	1.1	0.82	0.094	0.0094			0.068	0.0068		
T-19-2.5	788	1.0	0.17	0.94	0.68	0.078	0.0078			0.057	0.0057		
S-11-0.5	776	0.99	0.17	0.92	0.67	0.077	0.0077			0.056	0.0056		
S-19-0.5	751	0.96	0.16	0.89	0.65	0.074	0.0074			0.054	0.0054		
S-24-0.5	738	0.94	0.16	0.88	0.63	0.073	0.0073			0.053	0.0053		
S-38-0.5	502	0.64	0.11	0.60	0.43	0.050	0.0050			0.036	0.0036		
S-12-2.5	488	0.62	0.11	0.58	0.42	0.048	0.0048			0.035	0.0035		
S-2-0.5	476	0.61	0.10	0.56	0.41	0.047	0.0047			0.034	0.0034		
S-36-2.5	375	0.48	0.082	0.45	0.32	0.037	0.0037			0.027	0.0027		
S-33-0.5	372	0.48	0.081	0.44	0.32	0.037	0.0037			0.027	0.0027		
S-3-0.5	340	0.44	0.074	0.40	0.29	0.034	0.0034			0.024	0.0024		
S-36-0.5	338	0.43	0.073	0.40	0.29	0.033	0.0033			0.024	0.0024		
S-8-0.5	324	0.41	0.070	0.38	0.28	0.032	0.0032			0.023	0.0023		
S-10-0.5	308	0.39	0.067	0.37	0.26	0.030	0.0030			0.022	0.0022		
S-34-0.5	295	0.38	0.064	0.35	0.25	0.029	0.0029			0.021	0.0021		
T-19-0.5	278	0.36	0.060	0.33	0.24	0.027	0.0027			0.020	0.0020		
S-30-2.5	275	0.35	0.060	0.33	0.24	0.027	0.0027			0.020	0.0020		
S-37-2.5	269	0.34	0.059	0.32	0.23	0.027	0.0027			0.019	0.0019		

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-35-0.5	244	0.31	0.053	0.29	0.21	0.024	0.0024			0.018	0.0018		
S-37-0.5	230	0.29	0.050	0.27	0.20	0.023	0.0023			0.017	0.0017		
S-10-2.5	183	0.23	0.040	0.22	0.16	0.018	0.0018			0.013	0.0013		
S-11-2.5	131	0.17	0.029	0.16	0.11	0.013	0.0013			0.0094	0.00094		
S-9-0.5	110	0.14	0.024	0.13	0.095	0.011	0.0011			0.0079	0.00079		
S-5-2.5	105	0.13	0.023	0.12	0.090	0.010	0.0010			0.0076	0.00076		
S-35-2.5	90	0.12	0.020	0.11	0.077	0.0089	0.00089			0.0065	0.00065		
S-9-2.5	90	0.12	0.020	0.11	0.077	0.0089	0.00089			0.0065	0.00065		
S-22-0.5	86	0.11	0.019	0.10	0.074	0.0085	0.00085			0.0062	0.00062		
S-23-0.5	85	0.11	0.019	0.10	0.073	0.0084	0.00084			0.0061	0.00061		
S-1-0.5	79	0.10	0.017	0.094	0.068	0.0078	0.00078			0.0057	0.00057		
S-31-2.5	71	0.091	0.016	0.085	0.061	0.0071	0.00071			0.0051	0.00051		
S-29-2.5	69	0.088	0.015	0.082	0.059	0.0068	0.00068			0.0049	0.00049		
S-29-0.5	40	0.051	0.0087	0.048	0.034	0.0040	0.00040			0.0029	0.00029		
S-13-0.5	39	0.050	0.0084	0.046	0.033	0.0038	0.00038			0.0028	0.00028		
S-15-0.5	36	0.046	0.0079	0.043	0.031	0.0036	0.00036			0.0026	0.00026		
S-26-0.5	31	0.040	0.0068	0.037	0.027	0.0031	0.00031			0.0022	0.00022		
B-34-5	21	0.027	0.0046	0.025	0.018	0.0021	0.00021			0.0015	0.00015		
B-13-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-20-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-22-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-7-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-8-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-1-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-13-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-14-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-14-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-2-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-20-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-21-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-21-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-22-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-26-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-27-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-27-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-28-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-3-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-34-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-38-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-4-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-4-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-6-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-6-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-7-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-8-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
SLOW 12A	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
Outside Operations Area													
Trench-3-2	337922	432	73	401	291	33	3.3			24	2.4		
S-43-0.5	111389	142	24	132	96	11	1.1			8.0	0.80		
S-63-0.5	51314	66	11	61	44	5.1	0.51			3.7	0.37		
Trench-2-3	41302	53	9.0	49	36	4.1	0.41			3.0	0.30		
B-23-0.5	38799	50	8.4	46	33	3.8	0.38			2.8	0.28		
Trench-6-2	33792	43	7.3	40	29	3.3	0.33			2.4	0.24		
B-28-5	31289	40	6.8	37	27	3.1	0.31			2.2	0.22		
B-31-5	27284	35	5.9	32	23	2.7	0.27			2.0	0.20		
B-30-5	24030	31	5.2	29	21	2.4	0.24			1.7	0.17		
S-41-0.5	23655	30	5.1	28	20	2.3	0.23			1.7	0.17		
B-52-5	18648	24	4.1	22	16	1.8	0.18			1.3	0.13		
B-30-0.5	17146	22	3.7	20	15	1.7	0.17			1.2	0.12		
B-32-5	17146	22	3.7	20	15	1.7	0.17			1.2	0.12		
Trench-3-1	15895	20	3.5	19	14	1.6	0.16			1.1	0.11		
S-59-2.5	14143	18	3.1	17	12	1.4	0.14			1.0	0.10		
B-47-5	13267	17	2.9	16	11	1.3	0.13			0.95	0.10		
S-39-2.5	12891	16	2.8	15	11	1.3	0.13			0.93	0.093		
B-30-2.5	12015	15	2.6	14	10	1.2	0.12			0.86	0.086		
S-62-2.5	11640	15	2.5	14	10	1.2	0.12			0.84	0.084		
B-23-2.5	11389	15	2.5	14	10	1.1	0.11			0.82	0.082		
B-43-5	11264	14	2.4	13	10	1.1	0.11			0.81	0.081		
B-28-2.5	11139	14	2.4	13	10	1.1	0.11			0.80	0.080		
B-3-5	10638	14	2.3	13	9.1	1.1	0.11			0.76	0.076		
B-35-5	10388	13	2.3	12	8.9	1.0	0.10			0.75	0.075		
Trench-6-3	9387	12	2.0	11	8.1	0.93	0.093			0.67	0.067		
S-54-2.5	8135	10	1.8	10	7.0	0.80	0.080			0.58	0.058		
S-41-2.5	7635	10	1.7	9.1	6.6	0.76	0.076			0.55	0.055		
S-53-0.5	4043	5.2	0.88	4.8	3.5	0.40	0.040			0.29	0.029		
B-28-0.5	3967	5.1	0.86	4.7	3.4	0.39	0.039			0.29	0.029		
B-38-5	3780	4.8	0.82	4.5	3.2	0.37	0.037			0.27	0.027		
B-21-5	3317	4.2	0.72	3.9	2.9	0.33	0.033			0.24	0.024		
B-71-5	3029	3.9	0.66	3.6	2.6	0.30	0.030			0.22	0.022		
B-29-2.5	2979	3.8	0.65	3.5	2.6	0.29	0.029			0.21	0.021		
B-29-0.5	2290	2.9	0.50	2.7	2.0	0.23	0.023			0.16	0.016		
SP-4-5	1990	2.5	0.43	2.4	1.7	0.20	0.020			0.14	0.014		

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-58-2.5	1877	2.4	0.41	2.2	1.6	0.19	0.019			0.13	0.013		
S-62-0.5	1589	2.0	0.35	1.9	1.4	0.16	0.016			0.11	0.011		
RC-2	1539	2.0	0.33	1.8	1.3	0.15	0.015			0.11	0.011		
B-12-5	1414	1.8	0.31	1.7	1.2	0.14	0.014			0.10	0.010		
RC-3	1402	1.8	0.30	1.7	1.2	0.14	0.014			0.10	0.010		
S-52-2.5	1402	1.8	0.30	1.7	1.2	0.14	0.014			0.10	0.010		
S-59-0.5	1364	1.7	0.30	1.6	1.2	0.13	0.013			0.10	0.010		
S-58-0.5	914	1.2	0.20	1.1	0.79	0.090	0.0090			0.066	0.0066		
S-57-2.5	814	1.0	0.18	0.97	0.70	0.080	0.0080			0.058	0.0058		
S-39-0.5	785	1.0	0.17	0.93	0.67	0.078	0.0078			0.056	0.0056		
B-15-5	763	0.98	0.17	0.91	0.66	0.076	0.0076			0.055	0.0055		
B-23-5	726	0.93	0.16	0.86	0.62	0.072	0.0072			0.052	0.0052		
B-72-5	688	0.88	0.15	0.82	0.59	0.068	0.0068			0.049	0.0049		
B-27-0.5	660	0.84	0.14	0.78	0.57	0.065	0.0065			0.047	0.0047		
B-27-2.5	613	0.78	0.13	0.73	0.53	0.061	0.0061			0.044	0.0044		
S-57-0.5	479	0.61	0.10	0.57	0.41	0.047	0.0047			0.034	0.0034		
T-2-0.5	426	0.54	0.093	0.51	0.37	0.042	0.0042			0.031	0.0031		
S-53-2.5	378	0.48	0.082	0.45	0.32	0.037	0.0037			0.027	0.0027		
S-52-0.5	377	0.48	0.082	0.45	0.32	0.037	0.0037			0.027	0.0027		
S-66-0.5	339	0.43	0.074	0.40	0.29	0.034	0.0034			0.024	0.0024		
S-44-0.5	329	0.42	0.072	0.39	0.28	0.033	0.0033			0.024	0.0024		
B-53-5	283	0.36	0.062	0.34	0.24	0.028	0.0028			0.020	0.0020		
B-14-5	275	0.35	0.060	0.33	0.24	0.027	0.0027			0.020	0.0020		
S-49-0.5	238	0.30	0.052	0.28	0.20	0.024	0.0024			0.017	0.0017		
S-44-2.5	202	0.26	0.044	0.24	0.17	0.020	0.0020			0.014	0.0014		
S-54-0.5	166	0.21	0.036	0.20	0.14	0.016	0.0016			0.012	0.0012		
S-43-2.5	156	0.20	0.034	0.19	0.13	0.015	0.0015			0.011	0.0011		
S-51-2.5	148	0.19	0.032	0.18	0.13	0.015	0.0015			0.011	0.0011		
S-42-0.5	145	0.19	0.032	0.17	0.12	0.014	0.0014			0.010	0.0010		
S-45-0.5	144	0.18	0.031	0.17	0.12	0.014	0.0014			0.010	0.0010		
S-67-0.5	144	0.18	0.031	0.17	0.12	0.014	0.0014			0.010	0.0010		
Trench-2-2	126	0.16	0.027	0.15	0.11	0.013	0.0013			0.0091	0.00091		
B-25-5	116	0.15	0.025	0.14	0.10	0.012	0.0012			0.0084	0.00084		
S-48-2.5	104	0.13	0.023	0.12	0.089	0.010	0.0010			0.0075	0.00075		
S-51-0.5	89	0.11	0.019	0.11	0.076	0.0088	0.00088			0.0064	0.00064		
S-65-0.5	88	0.11	0.019	0.10	0.075	0.0087	0.00087			0.0063	0.00063		
S-67-2.5	54	0.069	0.012	0.064	0.046	0.0053	0.00053			0.0039	0.00039		
S-46-0.5	53	0.067	0.011	0.062	0.045	0.0052	0.00052			0.0038	0.00038		
T-12-0.5	38	0.048	0.008	0.045	0.032	0.0037	0.00037			0.0027	0.00027		
Sd-2-0.5	35	0.045	0.008	0.042	0.030	0.0035	0.00035			0.0025	0.00025		
S-64-0.5	30	0.038	0.007	0.036	0.026	0.0030	0.00030			0.0022	0.00022		

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
T-5-0.5	30	0.038	0.007	0.036	0.026	0.0030	0.00030			0.0022	0.00022		
B-42-5	28	0.035	0.006	0.033	0.024	0.0027	0.00027			0.0020	0.00020		
RC-1	26	0.034	0.006	0.031	0.023	0.0026	0.00026			0.0019	0.00019		
Trench-3-3	24	0.030	0.005	0.028	0.020	0.0024	0.00024			0.0017	0.00017		
B-48-5	23	0.029	0.005	0.027	0.019	0.0022	0.00022			0.0016	0.00016		
S-61-0.5	23	0.029	0.005	0.027	0.019	0.0022	0.00022			0.0016	0.00016		
S-48-0.5	19	0.024	0.004	0.022	0.016	0.0019	0.00019			0.0013	0.00013		
B-1-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-10-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-11-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-16-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-17-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-18-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-19-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-2-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-24-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-26-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-26-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-27-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-29-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-33-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-36-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-39-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-4-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-40-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-41-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-44-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-45-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-46-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-46-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-49-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-49-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-5-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-50-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-51-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-54-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-54-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-56-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-6-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-62-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
B-63-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors

San Luis Obispo Tank Farm

		Terrestrail Plants AE: T1.		Terrestrial Invertebrates AE: T2.		Song Sparrow AE: T3.		California Vole AE: T4.		Western Meadowlark AE: T5.		Loggerhead Shrike* AE: T5.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
B-9-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
MW-55-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
PW-5-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-40-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-40-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-42-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-45-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-46-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-47-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-47-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-49-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-50-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-50-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-55-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-55-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-56-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-56-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-60-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-60-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-61-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-63-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-64-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-65-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
S-66-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
SP-6-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
T-12-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
T-2-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
T-5-2.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
GB-9-5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
MW-31-3.5	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
MW-48D 3-4'	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
MW-48D 4-6'	**6.3**	0.0080	0.0014	0.0074	0.0054	0.00062	0.000062			0.00045	0.000045		
ESB-13-5	**3.1**	0.0040	0.00068	0.0037	0.0027	0.00031	0.000031			0.00022	0.000022		
ESB-28-5	**3.1**	0.0040	0.00068	0.0037	0.0027	0.00031	0.000031			0.00022	0.000022		

Notes:

HQ > 1.0

Concentrations are mg/kg dry weight.

Not carried forward to Tier 2 point-by-point.

Wildlife HQs based on site use factor (SUF) of 1.

COPEC = Chemical of Potential Ecological Concern

Bold text indicates all non-detects. Value is one-half detection limit.

HQ = Hazard Quotient

*PAH TRVs for these special status species include and uncertainty factor of 10.

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Within Operations Area									
S-25-0.5	10638								
S-18-2.5	8511								
B-73-5	8423								
S-16-2.5	7384								
S-19-2.5	7384								
S-17-0.5	6758								
S-25-2.5	4243								
S-17-2.5	3980								
S-32-0.5	3880								
S-5-0.5	3504								
S-28-0.5	3066								
S-15-2.5	2491								
S-23-2.5	2340								
S-18-0.5	2290								
S-16-0.5	2078								
S-24-2.5	1952								
S-32-2.5	1665								
S-12-0.5	1564								
S-20-0.5	1564								
S-7-0.5	1452								
S-30-0.5	1126								
S-31-0.5	1051								
S-33-2.5	951								
T-19-2.5	788								
S-11-0.5	776								
S-19-0.5	751								
S-24-0.5	738								
S-38-0.5	502								
S-12-2.5	488								
S-2-0.5	476								
S-36-2.5	375								
S-33-0.5	372								
S-3-0.5	340								
S-36-0.5	338								
S-8-0.5	324								
S-10-0.5	308								
S-34-0.5	295								
T-19-0.5	278								
S-30-2.5	275								
S-37-2.5	269								

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-35-0.5	244								
S-37-0.5	230								
S-10-2.5	183								
S-11-2.5	131								
S-9-0.5	110								
S-5-2.5	105								
S-35-2.5	90								
S-9-2.5	90								
S-22-0.5	86								
S-23-0.5	85								
S-1-0.5	79								
S-31-2.5	71								
S-29-2.5	69								
S-29-0.5	40								
S-13-0.5	39								
S-15-0.5	36								
S-26-0.5	31								
B-34-5	21								
B-13-5	**6.3**								
B-20-5	**6.3**								
B-22-5	**6.3**								
B-7-5	**6.3**								
B-8-5	**6.3**								
S-1-2.5	**6.3**								
S-13-2.5	**6.3**								
S-14-0.5	**6.3**								
S-14-2.5	**6.3**								
S-2-2.5	**6.3**								
S-20-2.5	**6.3**								
S-21-0.5	**6.3**								
S-21-2.5	**6.3**								
S-22-2.5	**6.3**								
S-26-2.5	**6.3**								
S-27-0.5	**6.3**								
S-27-2.5	**6.3**								
S-28-2.5	**6.3**								
S-3-2.5	**6.3**								
S-34-2.5	**6.3**								
S-38-2.5	**6.3**								
S-4-0.5	**6.3**								
S-4-2.5	**6.3**								

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-6-0.5	**6.3**								
S-6-2.5	**6.3**								
S-7-2.5	**6.3**								
S-8-2.5	**6.3**								
SLOW 12A	**6.3**								
Outside Operations Area									
Trench-3-2	337922								
S-43-0.5	111389								
S-63-0.5	51314								
Trench-2-3	41302								
B-23-0.5	38799								
Trench-6-2	33792								
B-28-5	31289								
B-31-5	27284								
B-30-5	24030								
S-41-0.5	23655								
B-52-5	18648								
B-30-0.5	17146								
B-32-5	17146								
Trench-3-1	15895								
S-59-2.5	14143								
B-47-5	13267								
S-39-2.5	12891								
B-30-2.5	12015								
S-62-2.5	11640								
B-23-2.5	11389								
B-43-5	11264								
B-28-2.5	11139								
B-3-5	10638								
B-35-5	10388								
Trench-6-3	9387								
S-54-2.5	8135								
S-41-2.5	7635								
S-53-0.5	4043								
B-28-0.5	3967								
B-38-5	3780								
B-21-5	3317								
B-71-5	3029								
B-29-2.5	2979								
B-29-0.5	2290								
SP-4-5	1990								

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-58-2.5	1877								
S-62-0.5	1589								
RC-2	1539								
B-12-5	1414								
RC-3	1402								
S-52-2.5	1402								
S-59-0.5	1364								
S-58-0.5	914								
S-57-2.5	814								
S-39-0.5	785								
B-15-5	763								
B-23-5	726								
B-72-5	688								
B-27-0.5	660								
B-27-2.5	613								
S-57-0.5	479								
T-2-0.5	426								
S-53-2.5	378								
S-52-0.5	377								
S-66-0.5	339								
S-44-0.5	329								
B-53-5	283								
B-14-5	275								
S-49-0.5	238								
S-44-2.5	202								
S-54-0.5	166								
S-43-2.5	156								
S-51-2.5	148								
S-42-0.5	145								
S-45-0.5	144								
S-67-0.5	144								
Trench-2-2	126								
B-25-5	116								
S-48-2.5	104								
S-51-0.5	89								
S-65-0.5	88								
S-67-2.5	54								
S-46-0.5	53								
T-12-0.5	38								
Sd-2-0.5	35								
S-64-0.5	30								

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
T-5-0.5	30								
B-42-5	28								
RC-1	26								
Trench-3-3	24								
B-48-5	23								
S-61-0.5	23								
S-48-0.5	19								
B-1-5	**6.3**								
B-10-5	**6.3**								
B-11-5	**6.3**								
B-16-5	**6.3**								
B-17-5	**6.3**								
B-18-5	**6.3**								
B-19-5	**6.3**								
B-2-5	**6.3**								
B-24-5	**6.3**								
B-26-2.5	**6.3**								
B-26-5	**6.3**								
B-27-5	**6.3**								
B-29-5	**6.3**								
B-33-5	**6.3**								
B-36-5	**6.3**								
B-39-5	**6.3**								
B-4-5	**6.3**								
B-40-5	**6.3**								
B-41-5	**6.3**								
B-44-5	**6.3**								
B-45-5	**6.3**								
B-46-2.5	**6.3**								
B-46-5	**6.3**								
B-49-0.5	**6.3**								
B-49-2.5	**6.3**								
B-5-5	**6.3**								
B-50-5	**6.3**								
B-51-5	**6.3**								
B-54-2.5	**6.3**								
B-54-5	**6.3**								
B-56-5	**6.3**								
B-6-5	**6.3**								
B-62-5	**6.3**								
B-63-5	**6.3**								

Table 6-9. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Terrestrial Receptors
San Luis Obispo Tank Farm

		Ornate Shrew AE: T6.		American Kestrel AE: T7.		Northern Harrier* AE: T7.		Coyote AE: T8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
B-9-5	**6.3**								
MW-55-5	**6.3**								
PW-5-5	**6.3**								
S-40-0.5	**6.3**								
S-40-2.5	**6.3**								
S-42-2.5	**6.3**								
S-45-2.5	**6.3**								
S-46-2.5	**6.3**								
S-47-0.5	**6.3**								
S-47-2.5	**6.3**								
S-49-2.5	**6.3**								
S-50-0.5	**6.3**								
S-50-2.5	**6.3**								
S-55-0.5	**6.3**								
S-55-2.5	**6.3**								
S-56-0.5	**6.3**								
S-56-2.5	**6.3**								
S-60-0.5	**6.3**								
S-60-2.5	**6.3**								
S-61-2.5	**6.3**								
S-63-2.5	**6.3**								
S-64-2.5	**6.3**								
S-65-2.5	**6.3**								
S-66-2.5	**6.3**								
SP-6-5	**6.3**								
T-12-2.5	**6.3**								
T-2-2.5	**6.3**								
T-5-2.5	**6.3**								
GB-9-5	**6.3**								
MW-31-3.5	**6.3**								
MW-48D 3-4'	**6.3**								
MW-48D 4-6'	**6.3**								
ESB-13-5	**3.1**								
ESB-28-5	**3.1**								

Notes:
HQ > 1.0
Concentrations are mg/kg dry weight.
Not carried forward to Tier 2 point-by-point.
Wildlife HQs based on site use factor (SUF) of 1.
COPEC = Chemical of Potential Ecological Concern

Bold text indicates all non-detects. Value is one-half detection limit.
HQ = Hazard Quotient
*PAH TRVs for these special status species include and uncertainty factor of 10.

Table 6-10. Tier 2 Terrestrial Receptor Hazard Quotient Summary
San Luis Obispo Tank Farm

		Max Conc >?		95% UCL Conc >?		# Scenario 1 Samples >		# Scenario 2 Samples >	
Receptor	COPEC	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark
AE: T1. Plants	Arsenic**	Yes	Yes	Yes	No	12/12	1/12	NA	NA
	Lead***	Yes	Yes	Yes	No	19/21	3/21	8/9	2/9
	Acenaphthene	No	No						
	Acenaphthylene	No	No						
	Anthracene	No	No						
	Benzo(a)anthracene	Yes	No	No	No				
	Benzo(a)pyrene	Yes	Yes	No	No				
	Benzo(b)fluoranthene	Yes	Yes	No	No				
	Benzo(k)fluoranthene	No	No						
	Benzo(ghi)perylene	Yes	No	No	No				
	Chrysene	Yes	Yes	No	No				
	Dibenzo(a,h)anthracene	No	No						
	Fluoranthene	Yes	No	No	No				
	Fluorene	No	No						
	Indeno(1,2,3-cd)pyrene	Yes	No	No	No				
	Naphthalene	Yes	No	No	No				
	Phenanthrene	Yes	No	No	No				
	Pyrene	Yes	Yes	No	No				
	Sum PAH	NA	NA	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	Yes	Yes	Yes	Yes	66/237	33/237	43/151	27/151
AE: T2. Invertebrates	Arsenic**	Yes	NA	No	NA		NA		NA
	Lead***	Yes	No	No	No				
	Acenaphthene	No	No						
	Acenaphthylene	No	No						
	Anthracene	No	No						
	Benzo(a)anthracene	No	No						
	Benzo(a)pyrene	No	No						
	Benzo(b)fluoranthene	No	No						
	Benzo(k)fluoranthene	No	No						
	Benzo(ghi)perylene	NA	NA	NA	NA	NA	NA	NA	NA
	Chrysene	No	No						
	Dibenzo(a,h)anthracene	No	No						
	Fluoranthene	No	No						
	Fluorene	No	No						
	Indeno(1,2,3-cd)pyrene	No	No						
	Naphthalene	No	No						
	Phenanthrene	No	No						
	Pyrene	No	No						
	Sum PAH	NA	NA	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	Yes	Yes	Yes	Yes	66/237	62/237	43/151	42/151

Table 6-10. Tier 2 Terrestrial Receptor Hazard Quotient Summary
San Luis Obispo Tank Farm

		Max Conc >?		95% UCL Conc >?		# Scenario 1 Samples >		# Scenario 2 Samples >	
Receptor	COPEC	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark
AE: T3. Song Sparrow	Arsenic**	Yes	Yes	No	No				
	Lead***	Yes	Yes	Yes	Yes	21/21	18/21	9/9	7/9
	Acenaphthene	No	No						
	Acenaphthylene	No	No						
	Anthracene	No	No						
	Benzo(a)anthracene	No	No						
	Benzo(a)pyrene	No	No						
	Benzo(b)fluoranthene	No	No						
	Benzo(k)fluoranthene	No	No						
	Benzo(ghi)perylene	No	No						
	Chrysene	No	No						
	Dibenzo(a,h)anthracene	No	No						
	Fluoranthene	No	No						
	Fluorene	No	No						
	Indeno(1,2,3-cd)pyrene	No	No						
	Naphthalene	No	No						
	Phenanthrene	No	No						
	Pyrene	No	No						
	Sum PAH	NA	NA	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	Yes	Yes	Yes	No	24/237	2/237	23/151	2/151
AE: T4. California Vole	Arsenic**	Yes	Yes	Yes	No	12/12	6/12	NA	NA
	Lead***	Yes	No	Yes	No	21/21	0/21	9/9	0/9
	Acenaphthene	No	No						
	Acenaphthylene	No	No						
	Anthracene	No	NA		NA		NA		NA
	Benzo(a)anthracene	No	No						
	Benzo(a)pyrene	No	No						
	Benzo(b)fluoranthene	No	No						
	Benzo(k)fluoranthene	No	No						
	Benzo(ghi)perylene	No	No						
	Chrysene	No	No						
	Dibenzo(a,h)anthracene	No	No						
	Fluoranthene	No	No						
	Fluorene	No	No						
	Indeno(1,2,3-cd)pyrene	No	No						
	Naphthalene	No	No						
	Phenanthrene	No	No						
	Pyrene	No	No						
	Sum PAH	NA	NA	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	Yes	Yes	No	No				

Table 6-10. Tier 2 Terrestrial Receptor Hazard Quotient Summary
San Luis Obispo Tank Farm

		Max Conc >?		95% UCL Conc >?		# Scenario 1 Samples >		# Scenario 2 Samples >	
Receptor	COPEC	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark
AE: T5. Western Meadowlark	Arsenic**	Yes	Yes	No	No				
	Lead***	Yes	Yes	Yes	Yes	21/21	20/21	9/9	9/9
	Acenaphthene	No	No						
	Acenaphthylene	No	No						
	Anthracene	No	No						
	Benzo(a)anthracene	No	No						
	Benzo(a)pyrene	No	No						
	Benzo(b)fluoranthene	No	No						
	Benzo(k)fluoranthene	No	No						
	Benzo(ghi)perylene	No	No						
	Chrysene	No	No						
	Dibenzo(a,h)anthracene	No	No						
	Fluoranthene	No	No						
	Fluorene	No	No						
	Indeno(1,2,3-cd)pyrene	No	No						
	Naphthalene	No	No						
	Phenanthrene	No	No						
	Pyrene	No	No						
	Sum PAH	NA	NA	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	Yes	Yes	Yes	No	14/237	1/237	14/151	1/151
AE: T5. Loggerhead Shrike*	Arsenic**	Yes	Yes	No	No				
	Lead***	Yes	Yes	Yes	Yes	21/21	21/21	9/9	9/9
	Acenaphthene	No	No						
	Acenaphthylene	No	No						
	Anthracene	No	No						
	Benzo(a)anthracene	No	No						
	Benzo(a)pyrene	No	No						
	Benzo(b)fluoranthene	No	No						
	Benzo(k)fluoranthene	No	No						
	Benzo(ghi)perylene	No	No						
	Chrysene	No	No						
	Dibenzo(a,h)anthracene	No	No						
	Fluoranthene	No	No						
	Fluorene	No	No						
	Indeno(1,2,3-cd)pyrene	No	No						
	Naphthalene	No	No						
	Phenanthrene	No	No						
	Pyrene	No	No						
	Sum PAH	NA	NA	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	No	No						

Table 6-10. Tier 2 Terrestrial Receptor Hazard Quotient Summary
San Luis Obispo Tank Farm

		Max Conc >?		95% UCL Conc >?		# Scenario 1 Samples >		# Scenario 2 Samples >	
Receptor	COPEC	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark
AE: T6. Ornate Shrew	Arsenic**	Yes	Yes	Yes	No	12/12	4/12	NA	NA
	Lead***	Yes	Yes	Yes	No	21/21	3/21	9/9	2/9
	Acenaphthene	No	No						
	Acenaphthylene	No	No						
	Anthracene	No	NA		NA		NA		NA
	Benzo(a)anthracene	No	No						
	Benzo(a)pyrene	No	No						
	Benzo(b)fluoranthene	No	No						
	Benzo(k)fluoranthene	No	No						
	Benzo(ghi)perylene	No	No						
	Chrysene	No	No						
	Dibenzo(a,h)anthracene	No	No						
	Fluoranthene	No	No						
	Fluorene	No	No						
	Indeno(1,2,3-cd)pyrene	No	No						
	Naphthalene	No	No						
	Phenanthrene	No	No						
	Pyrene	No	No						
	Sum PAH	NA	NA	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	Yes	Yes	No	No				
AE: T7. American Kestrel	Arsenic**	Yes	No	No	No				
	Lead***	Yes	Yes	Yes	No	21/21	16/21	9/9	6/9
	Acenaphthene	No	No						
	Acenaphthylene	No	No						
	Anthracene	No	No						
	Benzo(a)anthracene	No	No						
	Benzo(a)pyrene	No	No						
	Benzo(b)fluoranthene	No	No						
	Benzo(k)fluoranthene	No	No						
	Benzo(ghi)perylene	No	No						
	Chrysene	No	No						
	Dibenzo(a,h)anthracene	No	No						
	Fluoranthene	No	No						
	Fluorene	No	No						
	Indeno(1,2,3-cd)pyrene	No	No						
	Naphthalene	No	No						
	Phenanthrene	No	No						
	Pyrene	No	No						
	Sum PAH	NA	NA	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	No	No						

Table 6-10. Tier 2 Terrestrial Receptor Hazard Quotient Summary
San Luis Obispo Tank Farm

		Max Conc >?		95% UCL Conc >?		# Scenario 1 Samples >		# Scenario 2 Samples >	
Receptor	COPEC	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark
AE: T7. Northern Harrier*	Arsenic**	No	No						
	Lead***	Yes	Yes	Yes	No	21/21	4/21	9/9	3/9
	Acenaphthene	No	No						
	Acenaphthylene	No	No						
	Anthracene	No	No						
	Benzo(a)anthracene	No	No						
	Benzo(a)pyrene	No	No						
	Benzo(b)fluoranthene	No	No						
	Benzo(k)fluoranthene	No	No						
	Benzo(ghi)perylene	No	No						
	Chrysene	No	No						
	Dibenzo(a,h)anthracene	No	No						
	Fluoranthene	No	No						
	Fluorene	No	No						
	Indeno(1,2,3-cd)pyrene	No	No						
	Naphthalene	No	No	No	No				
	Phenanthrene	No	No						
	Pyrene	No	No						
	Sum PAH	NA	NA	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	No	No						
AE: T8. Coyote	Arsenic**	Yes	No	No	No				
	Lead***	Yes	No	No	No				
	Acenaphthene	No	No						
	Acenaphthylene	No	No						
	Anthracene	No	NA		NA		NA		NA
	Benzo(a)anthracene	No	No						
	Benzo(a)pyrene	No	No						
	Benzo(b)fluoranthene	No	No						
	Benzo(k)fluoranthene	No	No						
	Benzo(ghi)perylene	No	No						
	Chrysene	No	No						
	Dibenzo(a,h)anthracene	No	No						
	Fluoranthene	No	No						
	Fluorene	No	No						
	Indeno(1,2,3-cd)pyrene	No	No						
	Naphthalene	No	No						
	Phenanthrene	No	No						
	Pyrene	No	No						
	Sum PAH	NA	NA	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	Yes	No	No	No				

Table 6-10. Tier 2 Terrestrial Receptor Hazard Quotient Summary
San Luis Obispo Tank Farm

		Max Conc >?		95% UCL Conc >?		# Scenario 1 Samples >		# Scenario 2 Samples >	
Receptor	**COPEC**	**Low Benchmark**	**High Benchmark**	**Low Benchmark**	**High Benchmark**	**Low Benchmark**	**High Benchmark**	**Low Benchmark**	**High Benchmark**

Notes:
Wildlife hazard quotients based on site use factor (SUF) of 1.
COPEC = Chemical of Potential Ecological Concern
*PAH TRVs (except naph) for special status species include uncert. factor of 10.
**For arsenic, 108/120 samples in Scenario 1 are equal to or less than the background concentration of 8.6 mg/kg dry weight.

***For lead, 115/136 samples in Scenario 1, and 82/91 samples in Scenario 2 are equal to or less than background (35 mg/kg dry weight).
Not carried forward to Tier 2.

Table 6-11. Tier 2 Hazard Quotient Summary for Wetland Receptors
San Luis Obispo Tank Farm

		Wetland Plants AE: W1.		Sediment Invertebrates AE: W3, W4.		Mallard AE: W5.		Western Sandpiper AE: W6.		Great Blue Heron AE: W7.		Raccoon AE: W8.	
COPEC	EPC	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Metals													
Arsenic	6.4	0.64	0.071	0.65	0.19			0.25	0.063			0.47	0.032
Arsenic Background	8.6	0.86	0.096	0.88	0.26			0.34	0.085			0.62	0.043
Lead	190	3.8	0.38	5.3	1.5	497	0.79	2681	4.3	548	0.88	2.9	0.012
Lead Background	35	0.70	0.070	0.98	0.27	91	0.15	494	0.79	101	0.16	0.53	0.002
Organics													
Acenaphthene	0.31			1.1	0.24								
Acenaphthylene	0.31			2.0	NA								
Anthracene	0.025												
Benzo(a)anthracene	0.49	0.41	0.15	4.5	0.46								
Benzo(a)pyrene	4.5	3.8	1.4	30	3.1								
Benzo(b)fluoranthene	3.6	3.0	1.1	133	0.91								
Benzo(k)fluoranthene	0.20			7.2	0.049								
Benzo(ghi)perylene	2.4	2.0	0.72	14	0.74								
Chrysene	0.82	0.68	0.25	4.9	0.64								
Dibenzo(a,h)anthracene	0.025				NA								
Fluoranthene	0.28			0.67	0.13								
Fluorene	0.39			5.0	0.72								
Indeno(1,2,3-cd)pyrene	2.1	1.8	0.64	NA	NA								
Naphthalene	0.31			1.8	0.6								
Phenanthrene	0.93	0.31	0.015	4.6	0.80								
Pyrene	2.4	2.0	0.72	12	1.6								
Sum PAH	31	NA	NA	19	1.3	NA	NA	NA	NA	NA	NA	NA	NA
TPH (C10-C40)	51314	66	11	61	44			11	1.1				

Notes:

HQ > 1.0

TRV not available = NA

Concentrations are mg/kg dry weight.

EPC = Exposure Point Concentration; Tier 2 EPC is lower of maximum or 95% UCL based on distribution.

Not carried forward to Tier 2.

HQ = Hazard Quotient

Wildlife HQs based on site use factor (SUF) of 1.

*PAH TRVs for these special status species include and uncertainty factor of 10.

COPEC = Chemical of Potential Ecological Concern

Table 6-12. Tier 2 Point-by-Point Lead Hazard Quotients for Wetland Receptors
San Luis Obispo Tank Farm

		Wetland Plants AE: W1.		Sediment Invertebrates AE: W3, W4.		Mallard AE: W5.		Western Sandpiper AE: W6.		Great Blue Heron AE: W7.		Raccoon AE: W8.	
Station ID	**Conc.**	**Low Benchmark HQs**	**High Benchmark HQs**	**Low Benchmark HQs**	**High Benchmark HQs**	**Low Benchmark HQs**	**High Benchmark HQs**	**Low Benchmark HQs**	**High Benchmark HQs**	**Low Benchmark HQs**	**High Benchmark HQs**	**Low Benchmark HQs**	**High Benchmark HQs**
Within Operation Area													
T-10-0.5	1001	20	2.0	28	7.8	2617	4.2	14127	23	2889	4.6	15	0.062
T-9-0.5	*8.0*	*0.16*	*0.016*	*0.22*	*0.063*	*21*	*0.033*	*113*	*0.18*	*23*	*0.037*	*0.12*	*0.00050*
Outside Operation Area													
T-2-0.5	801	16	1.6	22	6.3	2094	3.3	11302	18	2311	3.7	12	0.050
T-17-0.5	488	9.8	0.98	14	3.8	1276	2.0	6887	11	1409	2.3	7.3	0.030
T-16-0.5	150	3.0	0.30	4.2	1.2	393	0.63	2119	3.4	433	0.69	2.3	0.0094
T-12-0.5	56	1.1	0.11	1.6	0.44	147	0.24	795	1.3	163	0.26	0.85	0.0035
S-66-0.5	*25*	*0.50*	*0.050*	*0.70*	*0.20*	*65*	*0.10*	*353*	*0.57*	*72*	*0.12*	*0.38*	*0.0016*
S-46-0.5	*23*	*0.45*	*0.045*	*0.63*	*0.18*	*59*	*0.094*	*318*	*0.51*	*65*	*0.10*	*0.34*	*0.0014*
S-56-0.5	*16*	*0.33*	*0.033*	*0.45*	*0.13*	*43*	*0.068*	*230*	*0.37*	*47*	*0.075*	*0.24*	*0.0010*
S-48-0.5	*14*	*0.28*	*0.028*	*0.38*	*0.11*	*36*	*0.058*	*194*	*0.31*	*40*	*0.064*	*0.21*	*0.00086*
S-62-0.5	*13*	*0.25*	*0.025*	*0.35*	*0.10*	*33*	*0.052*	*177*	*0.28*	*36*	*0.058*	*0.19*	*0.00078*
B-36-0.5	*12*	*0.24*	*0.024*	*0.34*	*0.094*	*31*	*0.050*	*170*	*0.27*	*35*	*0.055*	*0.18*	*0.00075*
T-11-0.5	*10*	*0.21*	*0.021*	*0.29*	*0.081*	*27*	*0.043*	*147*	*0.23*	*30*	*0.048*	*0.16*	*0.00065*
S-64-0.5	*8.8*	*0.18*	*0.018*	*0.24*	*0.068*	*23*	*0.037*	*124*	*0.20*	*25*	*0.040*	*0.13*	*0.00055*
B-23-0.5	*8.4*	*0.17*	*0.017*	*0.23*	*0.066*	*22*	*0.035*	*118*	*0.19*	*24*	*0.039*	*0.13*	*0.00052*
S-50-0.5	*8.4*	*0.17*	*0.017*	*0.23*	*0.066*	*22*	*0.035*	*118*	*0.19*	*24*	*0.039*	*0.13*	*0.00052*
S-40-0.5	*8.1*	*0.16*	*0.016*	*0.23*	*0.064*	*21*	*0.034*	*115*	*0.18*	*23*	*0.038*	*0.12*	*0.00051*
S-58-0.5	*7.8*	*0.16*	*0.016*	*0.22*	*0.061*	*20*	*0.032*	*109*	*0.18*	*22*	*0.036*	*0.12*	*0.00048*
T-1-0.5	*7.8*	*0.16*	*0.016*	*0.22*	*0.061*	*20*	*0.032*	*109*	*0.18*	*22*	*0.036*	*0.12*	*0.00048*
B-46-0.5	*7.5*	*0.15*	*0.015*	*0.21*	*0.059*	*20*	*0.031*	*106*	*0.17*	*22*	*0.035*	*0.11*	*0.00047*
S-54-0.5	*7.0*	*0.14*	*0.014*	*0.20*	*0.055*	*18*	*0.029*	*99*	*0.16*	*20*	*0.032*	*0.11*	*0.00044*
S-63-0.5	*6.5*	*0.13*	*0.013*	*0.18*	*0.051*	*17*	*0.027*	*92*	*0.15*	*19*	*0.030*	*0.10*	*0.00041*
S-44-0.5	*6.1*	*0.12*	*0.012*	*0.17*	*0.048*	*16*	*0.026*	*87*	*0.14*	*18*	*0.028*	*0.092*	*0.00038*
S-60-0.5	*5.9*	*0.12*	*0.012*	*0.16*	*0.046*	*15*	*0.025*	*83*	*0.13*	*17*	*0.027*	*0.088*	*0.00037*
Sd-2-0.5	*4.3*	*0.085*	*0.0085*	*0.12*	*0.033*	*11*	*0.018*	*60*	*0.10*	*12*	*0.020*	*0.064*	*0.00027*

Notes:
HQ > 1 and concentration above bkgrd. 1.0
Concentrations are reported in mg/kg on a dry weight basis.
Wildlife hazard quotients based on site use factor (SUF) of 1.
HQ = Hazard Quotient
Italics indicate concentration is less than background conc. of 35 mg/kg.
COPEC = Chemical of Potential Ecological Concern

Table 6-13. Tier 2 Point-by-Point PAH Hazard Quotients for Wetland Receptors
San Luis Obispo Tank Farm

		Wetland Plants AE: W1.		Sediment Invertebrates AE: W3, W4.		Mallard AE: W5.		Western Sandpiper AE: W6.		Great Blue Heron AE: W7.		Raccoon AE: W8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Acenaphthene													
S-41-0.5	**0.31**			1.1	0.24								
S-63-0.5	**0.31**			1.1	0.24								
S-53-0.5	**0.063**			0.22	0.048								
S-45-0.5	**0.031**			0.11	0.024								
S-58-0.5	**0.031**			0.11	0.024								
S-59-0.5	**0.031**			0.11	0.024								
S-62-0.5	**0.031**			0.11	0.024								
S-57-0.5	**0.013**			0.043	0.010								
T-2-0.5	**0.0063**			0.022	0.0048								
S-44-0.5	**0.0063**			0.022	0.0048								
S-66-0.5	**0.0063**			0.022	0.0048								
S-67-0.5	**0.0063**			0.022	0.0048								
Sd-2-0.5	**0.0063**			0.022	0.0048								
Acenaphthylene													
S-41-0.5	**0.31**			2.0	NA								
S-63-0.5	**0.31**			2.0	NA								
S-53-0.5	**0.063**			0.39	NA								
S-45-0.5	**0.031**			0.20	NA								
S-58-0.5	**0.031**			0.20	NA								
S-59-0.5	**0.031**			0.20	NA								
S-62-0.5	**0.031**			0.20	NA								
S-57-0.5	**0.013**			0.078	NA								
T-2-0.5	**0.0063**			0.039	NA								
S-44-0.5	**0.0063**			0.039	NA								
S-66-0.5	**0.0063**			0.039	NA								
S-67-0.5	**0.0063**			0.039	NA								
Sd-2-0.5	**0.0063**			0.039	NA								
Benzo(a)Anthracene													
S-63-0.5	2.3			21	2.1								
T-2-0.5	0.075			0.70	0.072								
S-67-0.5	0.053			0.49	0.050								
S-41-0.5	**0.31**			2.9	0.30								
S-53-0.5	**0.063**			0.58	0.060								
S-45-0.5	**0.031**			0.29	0.030								

Table 6-13. Tier 2 Point-by-Point PAH Hazard Quotients for Wetland Receptors
San Luis Obispo Tank Farm

		Wetland Plants AE: W1.		Sediment Invertebrates AE: W3, W4.		Mallard AE: W5.		Western Sandpiper AE: W6.		Great Blue Heron AE: W7.		Raccoon AE: W8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-58-0.5	**0.031**			0.29	0.030								
S-59-0.5	**0.031**			0.29	0.030								
S-62-0.5	**0.031**			0.29	0.030								
S-57-0.5	**0.013**			0.12	0.012								
S-44-0.5	**0.0031**			0.029	0.0030								
S-66-0.5	**0.0031**			0.029	0.0030								
Sd-2-0.5	**0.0031**			0.029	0.0030								
Benzo(a)Pyrene													
S-63-0.5	4.5	3.8	1.4	30	3.1								
S-53-0.5	0.38	0.31	0.11	2.5	0.26								
T-2-0.5	0.15	0.13	0.046	1.0	0.10								
S-67-0.5	0.076	0.064	0.023	0.51	0.053								
S-45-0.5	0.063	0.052	0.019	0.42	0.043								
S-57-0.5	0.025	0.021	0.0076	0.17	0.017								
S-66-0.5	0.0088	0.007	0.0027	0.058	0.0060								
S-41-0.5	**0.31**	0.261	0.095	2.1	0.22								
S-58-0.5	**0.031**	0.026	0.0095	0.21	0.022								
S-59-0.5	**0.031**	0.026	0.0095	0.21	0.022								
S-62-0.5	**0.031**	0.026	0.0095	0.21	0.022								
S-44-0.5	**0.0031**	0.0026	0.00095	0.021	0.0022								
Sd-2-0.5	**0.0031**	0.0026	0.00095	0.021	0.0022								
Benzo(b)Fluoranthene													
S-63-0.5	3.6	3.0	1.1	133	0.91								
S-53-0.5	0.25	0.21	0.076	9.2	0.063								
T-2-0.5	0.25	0.21	0.076	9.2	0.063								
S-67-0.5	0.16	0.14	0.049	6.0	0.041								
S-45-0.5	0.13	0.10	0.038	4.6	0.031								
S-57-0.5	0.038	0.031	0.011	1.4	0.0094								
S-66-0.5	0.013	0.010	0.0038	0.46	0.0031								
S-44-0.5	0.0075	0.0063	0.0023	0.28	0.0019								
S-41-0.5	**0.31**	0.26	0.095	12	0.078								
S-58-0.5	**0.031**	0.026	0.0095	1.2	0.0078								
S-59-0.5	**0.031**	0.026	0.0095	1.2	0.0078								
S-62-0.5	**0.031**	0.026	0.0095	1.2	0.0078								
Sd-2-0.5	**0.0031**	0.0026	0.00095	0.12	0.00078								

Table 6-13. Tier 2 Point-by-Point PAH Hazard Quotients for Wetland Receptors
San Luis Obispo Tank Farm

		Wetland Plants AE: W1.		Sediment Invertebrates AE: W3, W4.		Mallard AE: W5.		Western Sandpiper AE: W6.		Great Blue Heron AE: W7.		Raccoon AE: W8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Benzo(k)Fluoranthene													
S-63-0.5	0.75			28	0.19								
T-2-0.5	0.075			2.8	0.019								
S-67-0.5	0.043			1.6	0.011								
S-41-0.5	**0.31**			12	0.078								
S-53-0.5	**0.063**			2.3	0.016								
S-45-0.5	**0.031**			1.2	0.0078								
S-58-0.5	**0.031**			1.2	0.0078								
S-59-0.5	**0.031**			1.2	0.0078								
S-62-0.5	**0.031**			1.2	0.0078								
S-57-0.5	**0.013**			0.46	0.0031								
S-44-0.5	**0.0031**			0.12	0.00078								
S-66-0.5	**0.0031**			0.12	0.00078								
Sd-2-0.5	**0.0031**			0.12	0.00078								
Benzo(ghi)Perylene													
S-63-0.5	2.4	2.0	0.72	14	0.74								
S-53-0.5	0.25	0.21	0.076	1.5	0.078								
S-57-0.5	0.075	0.063	0.023	0.44	0.023								
T-2-0.5	0.075	0.063	0.023	0.44	0.023								
S-67-0.5	0.044	0.037	0.013	0.26	0.014								
S-66-0.5	0.0063	0.0052	0.0019	0.037	0.0020								
S-41-0.5	**0.31**	0.26	0.095	1.8	0.10								
S-45-0.5	**0.031**	0.026	0.0095	0.18	0.010								
S-58-0.5	**0.031**	0.026	0.0095	0.18	0.010								
S-59-0.5	**0.031**	0.026	0.0095	0.18	0.010								
S-62-0.5	**0.031**	0.026	0.0095	0.18	0.010								
S-44-0.5	**0.0031**	0.0026	0.00095	0.018	0.0010								
Sd-2-0.5	**0.0031**	0.0026	0.00095	0.018	0.0010								
Chrysene													
S-63-0.5	3.9			23	3.0								
S-45-0.5	0.088			0.53	0.068								
S-67-0.5	0.075			0.45	0.058								
T-2-0.5	0.063			0.38	0.049								
S-41-0.5	**0.31**			1.9	0.24								
S-53-0.5	**0.063**			0.38	0.049								

Table 6-13. Tier 2 Point-by-Point PAH Hazard Quotients for Wetland Receptors
San Luis Obispo Tank Farm

		Wetland Plants AE: W1.		Sediment Invertebrates AE: W3, W4.		Mallard AE: W5.		Western Sandpiper AE: W6.		Great Blue Heron AE: W7.		Raccoon AE: W8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-58-0.5	**0.031**			0.19	0.024								
S-59-0.5	**0.031**			0.19	0.024								
S-62-0.5	**0.031**			0.19	0.024								
S-57-0.5	**0.013**			0.075	0.010								
S-44-0.5	**0.0031**			0.019	0.0024								
S-66-0.5	**0.0031**			0.019	0.0024								
Sd-2-0.5	**0.0031**			0.019	0.0024								
Fluorene													
S-63-0.5	1.75			23	3.3								
S-41-0.5	**0.31**			4.1	0.58								
S-53-0.5	**0.063**			0.81	0.12								
S-45-0.5	**0.031**			0.41	0.058								
S-58-0.5	**0.031**			0.41	0.058								
S-59-0.5	**0.031**			0.41	0.058								
S-62-0.5	**0.031**			0.41	0.058								
S-57-0.5	**0.013**			0.16	0.023								
T-2-0.5	**0.0063**			0.081	0.012								
S-44-0.5	**0.0063**			0.081	0.012								
S-66-0.5	**0.0063**			0.081	0.012								
S-67-0.5	**0.0063**			0.081	0.012								
Sd-2-0.5	**0.0063**			0.081	0.012								
Ideno(123-cd)Pyrene													
S-63-0.5	2.1	1.8	0.64	NA	NA								
S-53-0.5	0.25	0.21	0.076	NA	NA								
T-2-0.5	0.088	0.073	0.027	NA	NA								
S-57-0.5	0.063	0.052	0.019	NA	NA								
S-67-0.5	0.061	0.051	0.019	NA	NA								
S-66-0.5	0.0063	0.005	0.0019	NA	NA								
S-41-0.5	**0.31**	0.261	0.095	NA	NA								
S-45-0.5	**0.031**	0.026	0.0095	NA	NA								
S-58-0.5	**0.031**	0.026	0.0095	NA	NA								
S-59-0.5	**0.031**	0.026	0.0095	NA	NA								
S-62-0.5	**0.031**	0.026	0.0095	NA	NA								
S-44-0.5	**0.0031**	0.0026	0.00095	NA	NA								
Sd-2-0.5	**0.0031**	0.0026	0.00095	NA	NA								

Table 6-13. Tier 2 Point-by-Point PAH Hazard Quotients for Wetland Receptors
San Luis Obispo Tank Farm

		Wetland Plants AE: W1.		Sediment Invertebrates AE: W3, W4.		Mallard AE: W5.		Western Sandpiper AE: W6.		Great Blue Heron AE: W7.		Raccoon AE: W8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
Naphthalene													
S-41-0.5	**0.31**			1.8	0.56								
S-63-0.5	**0.31**			1.8	0.56								
S-53-0.5	**0.063**			0.36	0.11								
S-45-0.5	**0.031**			0.18	0.056								
S-58-0.5	**0.031**			0.18	0.056								
S-59-0.5	**0.031**			0.18	0.056								
S-62-0.5	**0.031**			0.18	0.056								
S-57-0.5	**0.013**			0.071	0.022								
T-2-0.5	**0.0063**			0.036	0.011								
S-44-0.5	**0.0063**			0.036	0.011								
S-66-0.5	**0.0063**			0.036	0.011								
S-67-0.5	**0.0063**			0.036	0.011								
Sd-2-0.5	**0.0063**			0.036	0.011								
Phenanthrene													
S-63-0.5	4.26			21	3.6								
S-41-0.5	1.0			4.9	0.86								
T-2-0.5	0.10			0.49	0.086								
S-67-0.5	0.041			0.20	0.035								
S-53-0.5	**0.063**			0.31	0.053								
S-45-0.5	**0.031**			0.15	0.027								
S-58-0.5	**0.031**			0.15	0.027								
S-59-0.5	**0.031**			0.15	0.027								
S-62-0.5	**0.031**			0.15	0.027								
S-57-0.5	**0.013**			0.061	0.011								
S-44-0.5	**0.0031**			0.015	0.0027								
S-66-0.5	**0.0031**			0.015	0.0027								
Sd-2-0.5	**0.0031**			0.015	0.0027								
Pyrene													
S-63-0.5	2.4	2.0	0.72	12	1.6								
S-41-0.5	0.88	0.73	0.27	4.5	0.58								
T-2-0.5	0.16	0.14	0.049	0.83	0.11								
S-53-0.5	0.13	0.10	0.038	0.64	0.082								
S-67-0.5	0.11	0.094	0.034	0.58	0.074								
S-45-0.5	0.063	0.052	0.019	0.32	0.041								

Table 6-13. Tier 2 Point-by-Point PAH Hazard Quotients for Wetland Receptors
San Luis Obispo Tank Farm

		Wetland Plants AE: W1.		Sediment Invertebrates AE: W3, W4.		Mallard AE: W5.		Western Sandpiper AE: W6.		Great Blue Heron AE: W7.		Raccoon AE: W8.	
Station ID	Conc.	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs	Low Benchmark HQs	High Benchmark HQs
S-66-0.5	0.0088	0.0073	0.0027	0.045	0.0058								
S-58-0.5	**0.031**	0.026	0.0095	0.16	0.021								
S-59-0.5	**0.031**	0.026	0.0095	0.16	0.021								
S-62-0.5	**0.031**	0.026	0.0095	0.16	0.021								
S-57-0.5	**0.013**	0.010	0.0038	0.064	0.0082								
S-44-0.5	**0.0031**	0.0026	0.00095	0.016	0.0021								
Sd-2-0.5	**0.0031**	0.0026	0.00095	0.016	0.0021								
Sum PAH													
S-63-0.5	31	NA	NA	19	1.3	NA	NA	NA	NA	NA	NA	NA	NA
S-41-0.5	6.3	NA	NA	3.9	0.27	NA	NA	NA	NA	NA	NA	NA	NA
S-53-0.5	1.9	NA	NA	1.2	0.085	NA	NA	NA	NA	NA	NA	NA	NA
T-2-0.5	1.3	NA	NA	0.80	0.057	NA	NA	NA	NA	NA	NA	NA	NA
S-67-0.5	0.81	NA	NA	0.51	0.036	NA	NA	NA	NA	NA	NA	NA	NA
S-45-0.5	0.76	NA	NA	0.47	0.033	NA	NA	NA	NA	NA	NA	NA	NA
S-57-0.5	0.35	NA	NA	0.22	0.015	NA	NA	NA	NA	NA	NA	NA	NA
S-66-0.5	0.081	NA	NA	0.051	0.0036	NA	NA	NA	NA	NA	NA	NA	NA
S-44-0.5	0.054	NA	NA	0.034	0.0024	NA	NA	NA	NA	NA	NA	NA	NA
S-58-0.5	**0.25**	NA	NA	0.16	0.011	NA	NA	NA	NA	NA	NA	NA	NA
S-59-0.5	**0.25**	NA	NA	0.16	0.011	NA	NA	NA	NA	NA	NA	NA	NA
S-62-0.5	**0.25**	NA	NA	0.16	0.011	NA	NA	NA	NA	NA	NA	NA	NA
Sd-2-0.5	**0.025**	NA	NA	0.016	0.0011	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

HQ > 1.0

TRV not available = NA

Concentrations are reported in mg/kg on a dry weight basis.

Bold text indicates all non-detects. Value is one-half detection limit.

Wildlife hazard quotients based on site use factor (SUF) of 1.

HQ = Hazard Quotient

*PAH TRVs for these special status species include and uncertainty factor of 10.

Not carried forward to Tier 2 point-by-point.

Table 6-14. Tier 2 Point-by-Point TPH (C10-C40) Hazard Quotients for Wetland Receptors
San Luis Obispo Tank Farm

		Wetland Plants AE: W1.		Sediment Invertebrates AE: W3, W4.		Mallard AE: W5.		Western Sandpiper AE: W6.		Great Blue Heron AE: W7.		Raccoon AE: W8.	
Station ID	**Conc.**	**Low Benchmark HQs**	**High Benchmark HQs**	**Low Benchmark HQs**	**High Benchmark HQs**	**Low Benchmark HQs**	**High Benchmark HQs**	**Low Benchmark HQs**	**High Benchmark HQs**	**Low Benchmark HQs**	**High Benchmark HQs**	**Low Benchmark HQs**	**High Benchmark HQs**
Scenario 1													
S-63-0.5	51314	66	11	61	44			11	1.1				
B-23-0.5	38799	50	8	46	33			8.0	0.80				
S-41-0.5	23655	30	5.1	28	20			4.9	0.49				
S-53-0.5	4043	5.2	0.88	4.8	3.5			0.83	0.083				
S-62-0.5	1589	2.0	0.35	1.9	1.4			0.33	0.033				
S-59-0.5	1364	1.7	0.30	1.6	1.2			0.28	0.028				
S-58-0.5	914	1.2	0.20	1.1	0.79			0.19	0.019				
S-39-0.5	785	1.0	0.17	0.93	0.67			0.16	0.016				
S-57-0.5	479	0.61	0.10	0.57	0.41			0.10	0.010				
T-2-0.5	426	0.54	0.09	0.51	0.37			0.088	0.0088				
S-66-0.5	339	0.43	0.074	0.40	0.29			0.070	0.0070				
S-44-0.5	329	0.42	0.072	0.39	0.28			0.068	0.0068				
S-54-0.5	166	0.21	0.036	0.20	0.14			0.034	0.0034				
S-45-0.5	144	0.18	0.031	0.17	0.12			0.030	0.0030				
S-67-0.5	144	0.18	0.031	0.17	0.12			0.030	0.0030				
S-51-0.5	89	0.11	0.019	0.11	0.076			0.018	0.0018				
S-65-0.5	88	0.11	0.019	0.10	0.075			0.018	0.0018				
S-46-0.5	53	0.067	0.011	0.062	0.045			0.011	0.0011				
T-12-0.5	38	0.048	0.0082	0.045	0.032			0.0078	0.00078				
Sd-2-0.5	35	0.045	0.0076	0.042	0.030			0.0072	0.00072				
S-64-0.5	30	0.038	0.0065	0.036	0.026			0.0062	0.00062				
S-61-0.5	23	0.029	0.0049	0.027	0.019			0.0047	0.00047				
S-48-0.5	19	0.024	0.0041	0.022	0.016			0.0039	0.00039				
S-40-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054			0.0013	0.00013				
S-47-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054			0.0013	0.00013				
S-50-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054			0.0013	0.00013				
S-55-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054			0.0013	0.00013				
S-56-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054			0.0013	0.00013				
S-60-0.5	**6.3**	0.0080	0.0014	0.0074	0.0054			0.0013	0.00013				

Notes: HQ > 1.0
Concentrations are reported in mg/kg on a dry weight basis.
Bold text indicates all non-detects. Value is one-half detection limit.
Wildlife hazard quotients based on site use factor (SUF) of 1.

HQ = Hazard Quotient
*PAH TRVs for these special status species include and uncertainty factor of 10.
Not carried forward to Tier 2 point-by-point.

Table 6-15. Tier 2 Wetland Receptor Hazard Quotient Summary

San Luis Obispo Tank Farm

		Max Conc >?		95% UCL Conc >?		# Sitewide Samples >	
Receptor	COPEC	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark
AE: W1. Plants	Arsenic	Yes	No	No	No		
	Lead*	Yes	Yes	Yes	No	5/5	2/5
	Acenaphthene	No	No				
	Acenaphthylene	No	No				
	Anthracene	No	No				
	Benzo(a)anthracene	Yes	No	No	No		
	Benzo(a)pyrene	Yes	Yes	Yes	Yes	1/13	1/13
	Benzo(b)fluoranthene	Yes	Yes	Yes	Yes	1/13	1/13
	Benzo(k)fluoranthene	No	No				
	Benzo(ghi)perylene	Yes	No	Yes	No	1/13	0/13
	Chrysene	Yes	Yes	No	No		
	Dibenzo(a,h)anthracene	No	No				
	Fluoranthene	No	No				
	Fluorene	No	No				
	Indeno(1,2,3-cd)pyrene	Yes	No	Yes	No	1/13	0/13
	Naphthalene	No	No				
	Phenanthrene	Yes	No	No	No		
	Pyrene	Yes	No	Yes	No	1/13	0/13
	Sum PAH	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	Yes	Yes	Yes	Yes	7/29	3/29
AE: W3, W4. Invertebrates	Arsenic	Yes	No	No	No		
	Lead*	Yes	Yes	Yes	Yes	5/5	4/5
	Acenaphthene	Yes	No	Yes	No	2/13	0/13
	Acenaphthylene	Yes	NA	Yes	NA	2/13	NA
	Anthracene	No	No				
	Benzo(a)anthracene	Yes	Yes	Yes	No	2/13	1/13
	Benzo(a)pyrene	Yes	Yes	Yes	Yes	3/13	1/13
	Benzo(b)fluoranthene	Yes	No	Yes	No	10/13	0/13
	Benzo(k)fluoranthene	Yes	No	Yes	No	9/13	0/13
	Benzo(ghi)perylene	Yes	No	Yes	No	3/13	0/13
	Chrysene	Yes	Yes	Yes	No	2/13	1/13
	Dibenzo(a,h)anthracene	No	NA		NA		NA
	Fluoranthene	Yes	No	No	No		
	Fluorene	Yes	Yes	Yes	No	2/13	1/13
	Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
	Naphthalene	Yes	No	Yes	No	2/13	0/13
	Phenanthrene	Yes	Yes	Yes	No	2/13	1/13
	Pyrene	Yes	Yes	Yes	Yes	2/13	1/13
	Sum PAH	Yes	Yes	Yes	Yes	3/13	1/13
	TPH (C10-C40)	Yes	Yes	Yes	Yes	7/29	6/29

Table 6-15. Tier 2 Wetland Receptor Hazard Quotient Summary
San Luis Obispo Tank Farm

		Max Conc >?		95% UCL Conc >?		# Sitewide Samples >	
Receptor	COPEC	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark
AE: W5. Mallard	Arsenic	No	No				
	Lead*	Yes	Yes	Yes	No	5/5	3/5
	Acenaphthene	No	No				
	Acenaphthylene	No	No				
	Anthracene	No	No				
	Benzo(a)anthracene	No	No				
	Benzo(a)pyrene	No	No				
	Benzo(b)fluoranthene	No	No				
	Benzo(k)fluoranthene	No	No				
	Benzo(ghi)perylene	No	No				
	Chrysene	No	No				
	Dibenzo(a,h)anthracene	No	No				
	Fluoranthene	No	No				
	Fluorene	No	No				
	Indeno(1,2,3-cd)pyrene	No	No				
	Naphthalene	No	No				
	Phenanthrene	No	No				
	Pyrene	No	No				
	Sum PAH	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	No	No				
AE: W6. Western Sandpiper	Arsenic	Yes	No				
	Lead*	Yes	Yes	Yes	Yes	5/5	5/5
	Acenaphthene	No	No				
	Acenaphthylene	No	No				
	Anthracene	No	No				
	Benzo(a)anthracene	No	No				
	Benzo(a)pyrene	No	No				
	Benzo(b)fluoranthene	No	No				
	Benzo(k)fluoranthene	No	No				
	Benzo(ghi)perylene	No	No				
	Chrysene	No	No				
	Dibenzo(a,h)anthracene	No	No				
	Fluoranthene	No	No				
	Fluorene	No	No				
	Indeno(1,2,3-cd)pyrene	No	No				
	Naphthalene	No	No				
	Phenanthrene	No	No				
	Pyrene	No	No				
	Sum PAH	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	Yes	Yes	Yes	Yes	3/29	1/29

Table 6-15. Tier 2 Wetland Receptor Hazard Quotient Summary
San Luis Obispo Tank Farm

		Max Conc >?		95% UCL Conc >?		# Sitewide Samples >	
Receptor	COPEC	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark	Low Benchmark	High Benchmark
AE: W7. Great Blue Heron	Arsenic	No	No				
	Lead*	Yes	Yes	Yes	No	5/5	3/5
	Acenaphthene	No	No				
	Acenaphthylene	No	No				
	Anthracene	No	No				
	Benzo(a)anthracene	No	No				
	Benzo(a)pyrene	No	No				
	Benzo(b)fluoranthene	No	No				
	Benzo(k)fluoranthene	No	No				
	Benzo(ghi)perylene	No	No				
	Chrysene	No	No				
	Dibenzo(a,h)anthracene	No	No				
	Fluoranthene	No	No				
	Fluorene	No	No				
	Indeno(1,2,3-cd)pyrene	No	No				
	Naphthalene	No	No				
	Phenanthrene	No	No				
	Pyrene	No	No				
	Sum PAH	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	No	No				
AE: W8. Raccoon	Arsenic	Yes	No	No	No		
	Lead*	Yes	No	Yes	No	4/5	0/5
	Acenaphthene	No	No				
	Acenaphthylene	No	No				
	Anthracene	No	NA		NA		NA
	Benzo(a)anthracene	No	No				
	Benzo(a)pyrene	No	No				
	Benzo(b)fluoranthene	No	No				
	Benzo(k)fluoranthene	No	No				
	Benzo(ghi)perylene	No	No				
	Chrysene	No	No				
	Dibenzo(a,h)anthracene	No	No				
	Fluoranthene	No	No				
	Fluorene	No	No				
	Indeno(1,2,3-cd)pyrene	No	No				
	Naphthalene	No	No				
	Phenanthrene	No	No				
	Pyrene	No	No				
	Sum PAH	NA	NA	NA	NA	NA	NA
	TPH (C10-C40)	No	No				

Notes:
Wildlife hazard quotients based on site use factor (SUF) of 1. TRV not available = NA
COPEC = Chemical of Potential Ecological Concern
Not carried forward to Tier 2.
*For lead, 20/25 samples in Scenario 1, and 4/23 samples in Scenario 2 are equal to or less than the background value of 35 mg/kg dry weight.

Table 7-1. Measured and Estimated Wetland PAH Concentrations

San Luis Obispo Tank Farm

Station ID	TPH Concentration	Measured BaP Concentration	Estimated BaP Concentration
S-63-0.5	51314	4.5	2.0
B-23-0.5	38799		1.6
S-41-0.5	23655	**0.31**	1.1
S-53-0.5	4043	0.38	0.26
S-62-0.5	1589	**0.031**	0.12
S-59-0.5	1364	**0.031**	0.11
S-58-0.5	914	**0.031**	0.077
S-39-0.5	785		0.068
S-57-0.5	479	0.025	0.046
T-2-0.5	426	0.15	0.042
S-66-0.5	339	0.0088	0.035
S-44-0.5	329	**0.0031**	0.034
S-54-0.5	166		0.020
S-45-0.5	144	0.063	0.017
S-67-0.5	144	0.076	0.017
S-51-0.5	89		0.012
S-65-0.5	88		0.012
S-46-0.5	53		0.0077
T-12-0.5	38		0.0059
Sd-2-0.5	35	**0.0031**	0.0056
S-64-0.5	30		0.0049
S-61-0.5	23		0.0039
S-48-0.5	19		0.0034
S-40-0.5	**6.3**		0.0014
S-47-0.5	**6.3**		0.0014
S-50-0.5	**6.3**		0.0014
S-55-0.5	**6.3**		0.0014
S-56-0.5	**6.3**		0.0014
S-60-0.5	**6.3**		0.0014

Notes:
Concentrations are reported in mg/kg on a dry weight basis.
Bold text indicates all non-detects. Value is one-half detection limit.

Table 8-1. Tier 2 Terrestrial Risk Summary of Site-Wide and Individual Sample Point Risk Estimates
San Luis Obispo Tank Farm

	Plants AE: T1.	Invertebrates AE: T2.	Song Sparrow AE: T3.	California Vole AE: T4.	Western Meadowlark AE: T5.	Loggerhead Shrike AE: T5.	Ornate Shrew AE: T6.	American Kestrel AE: T7.	Northern Harrier AE: T7.	Coyote AE: T8.
Arsenic[1,2]	**(12/12 - 1/12)**	***de minimus***	***de minimus***	**(12/12 - 6/12)**	***de minimus***	***de minimus***	**(12/12 - 4/12)**	***de minimus***	***de minimus***	***de minimus***
Lead: Scenario 1[2,5]	**(19/21 - 3/21)**	***de minimus***	**(21/21 - 18/21)**	**(21/21 - 0/21)**	**(21/21 - 20/21)**	**(21/21 - 21/21)**	**(21/21 - 3/21)**	**(21/21 - 16/21)**	**(21/21 - 4/21)**	***de minimus***
Lead: Scenario 2[2,6]	**(8/9 - 2/9)**	***de minimus***	**(9/9 - 7/9)**	**(9/9 - 0/9)**	**(9/9 - 9/9)**	**(9/9 - 9/9)**	**(9/9 - 2/9)**	**(9/9 - 6/9)**	**(9/9 - 3/9)**	***de minimus***
PAHs[3,4]	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***
Sum PAH[3,4]	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
TPH: Scenario 1[4,5]	**(66/237 - 33/237)**	**(66/237 - 62/237)**	**(24/237 - 2/237)**	***de minimus***	**(14/237 - 1/237)**	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***
TPH: Scenario 2[4,6]	**(43/151 - 27/151)**	**(43/151 - 42/151)**	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***

NA = Analyte not assessed because no benchmark available.
[1] Arsenic was not identified as a COPEC for Scenario 2 as concentrations outside of the former operations area are generally below background.
[2] Risk summaries represent only stations with concentrations greater than background.
[3] PAHs were not evaluated for Scenario 2 because Scenario 1 indicated *de minimus* risk for all terrestrial receptors.
[4] Risk summaries represent all stations where COPEC was measured.
[5]Scenario 1 = Exposure estimated using data from the whole site
[6]Scenario 2 = Exposure estimated using data from the whole site minus the former operations area

Site-Wide Risk Estimates
*** Risk category (i.e., color) determination is based on the site-wide hazard quotients as listed in Table 6-6, calculated by dividing the 95% UCL on the mean (or maximum if lower) by the low toxicity reference value.**

	de minimus (Low Benchmark HQ < 1)
	Risk is categorized as Level 1 (Low benchmark site-wide HQ > 1 < High benchmark site-wide HQ)
	Risk is Categorized as Level 2 (High benchmark site-wide HQ > 1)

Individual Sample Point - Spatial Assessment of Risk

*** Numbers in boxes (12/12 - 1/12) =** (first set of numbers indicates the number of individual sample HQs >1 for the low benchmark **/** total number of sample locations above background concentrations; the second set of numbers indicates the number of individual point exceedances of the high benchmark **/** total number of sample locations above background concentrations.
For example: The site-wide risk from arsenic to plants is identified as Level 1 as indicated by the green color. The numbers in the box indicate that 12 samples had concentrations greater than background concentrations and of those, 12 exceeded the low benchmark and 1 exceeded the high benchmark.

Table 8-2. Tier 2 Wetland Risk Summary of Site-Wide and Individual Sample Point Risk Estimates[1]
San Luis Obispo Tank Farm

	Plants AE: W1.	Invertebrates AE: W3, W4.	Mallard AE: W5.	Western Sandpiper AE: W6.	Great Blue Heron AE: W7.	Raccoon AE: W8.
Arsenic[2]	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***	***de minimus***
Lead[2]	**(5/5 - 2/5)**	**(5/5 - 4/5)**	**(5/5 - 3/5)**	**(5/5 - 5/5)**	**(5/5 - 3/5)**	**(4/5 - 0/5)**
PAHs[3,4]	**(1/13 - 1/13)**	**(3/13 - 1/13)**	***de minimus***	***de minimus***	***de minimus***	***de minimus***
Sum PAH[3]	**NA**	**(3/13 - 1/13)**	**NA**	**NA**	**NA**	**NA**
Sum TPH[3]	**(7/29 - 3/29)**	**(7/29 - 6/29)**	***de minimus***	**(3/29 - 1/29)**	***de minimus***	***de minimus***

NA = Analyte not assessed because no benchmark available.
[1] Summarizes Scenario 1 results as majority of wetlands are outside of the former operations area.
[2] Risk summaries represent only stations with concentrations greater than background.
[3] Risk summaries represent all stations where COPEC was measured.
[4]Benzo(a)pyrene exceedances presented for PAHs.

Site-wide Risk Summary
*** Risk category (i.e., color) determination is based on the hazard quotients as listed in Table 6-11, calculated by dividing the 95% UCL on the mean (or maximum if lower) by the low and high toxicity reference values.**

	de minimus (Low Benchmark HQ < 1)
	Risk is categorized as Level 1 (Low benchmark site-wide HQ > 1 < High benchmark site-wide HQ)
	Risk is Categorized as Level 2 (High benchmark site-wide HQ > 1)

Individual Sample Point - Spatial Assessment of Risk
*** Numbers in boxes (5/5 - 2/5) =** (first set of numbers indicates the number of individual sample HQs >1 for the low benchmark **/** total number of sample locations above background concentrations; the second set of numbers indicates the number of individual point exceedances of the high benchmark **/** total number of sample locations above background concentrations.

For example: The site-wide risk from lead to plants is identified as Level 1 as indicated by the green color. The numbers in the box indicate that 5 samples within site wetlands had concentrations greater than background concentrations and of those, 5 exceeded the low benchmark and 2 exceeded the high benchmark.

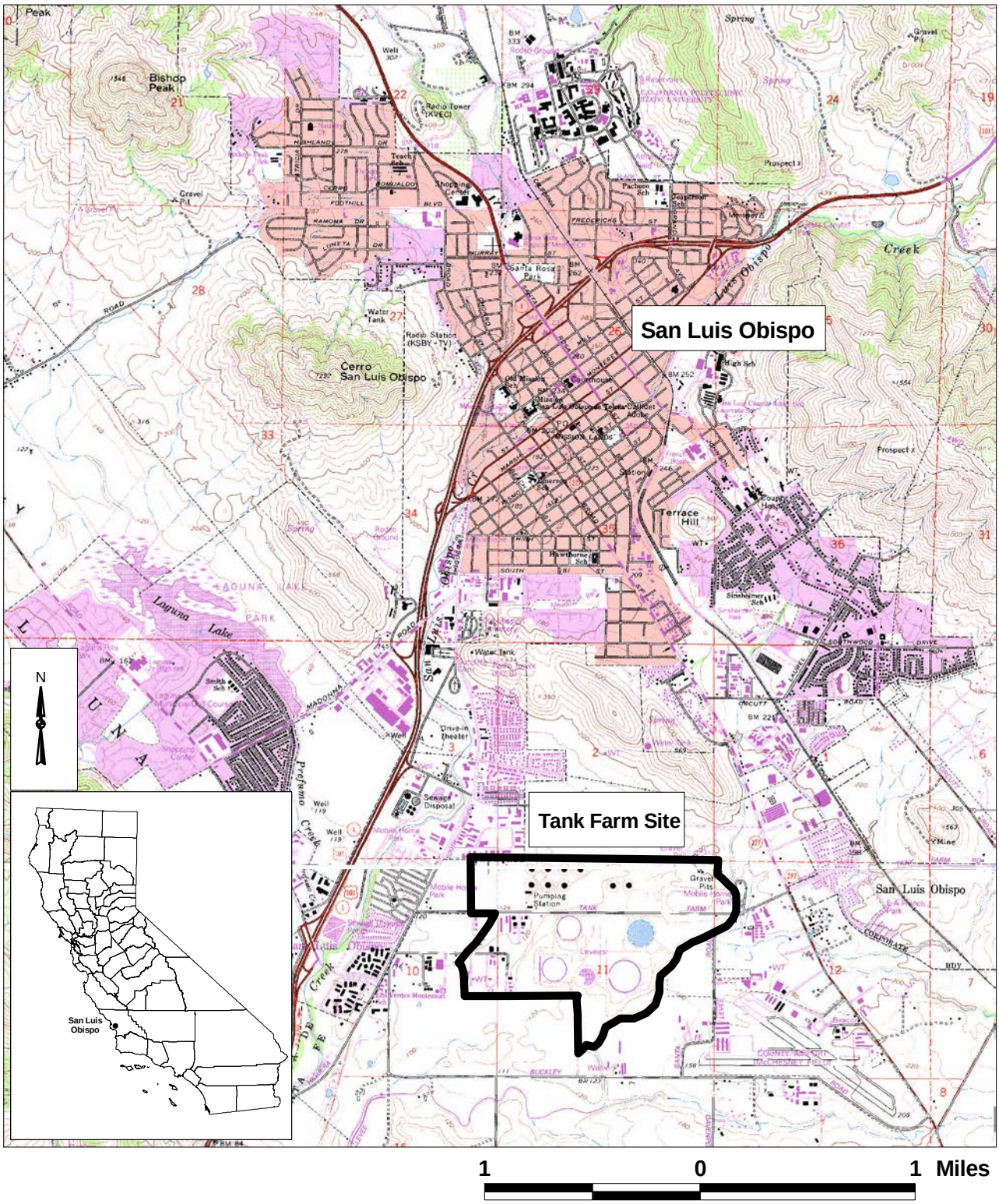

Figure 1-1

San Luis Obispo Tank Farm Site Location

Digital topographic map courtesy of:
California Spatial Information Library
http://www.gis.ca.gov/

San Luis Obispo Tank Farm
Predictive Ecological Risk Assessment - Version 2.0
May 25, 2004

g:\gis\unocal_tankfarm\era_site_location.apr

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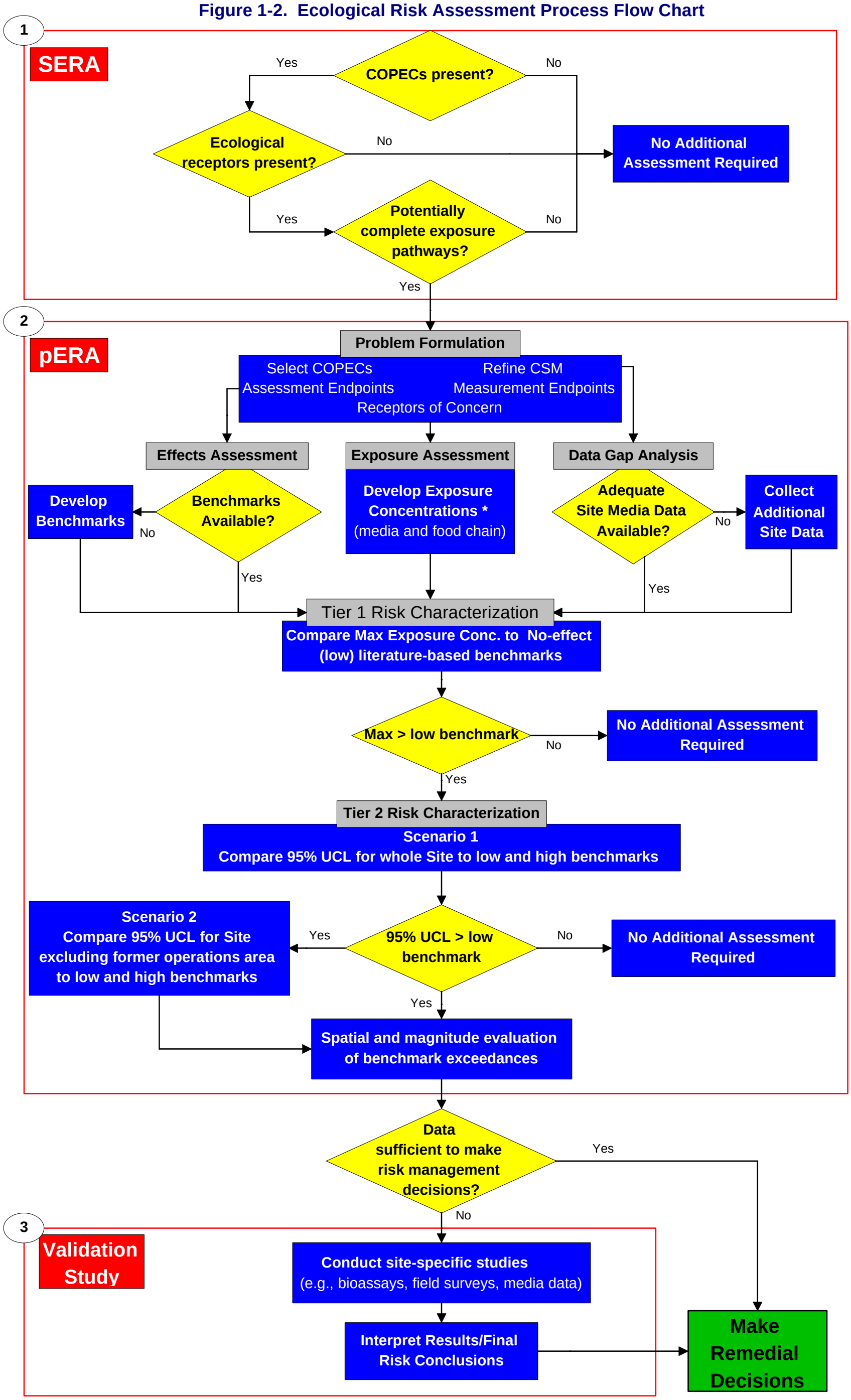
Figure 1-2. Ecological Risk Assessment Process Flow Chart



* Exposure estimates developed for Tier 1, Tier 2-Scenario 1 and Tier 2-Scenario 2

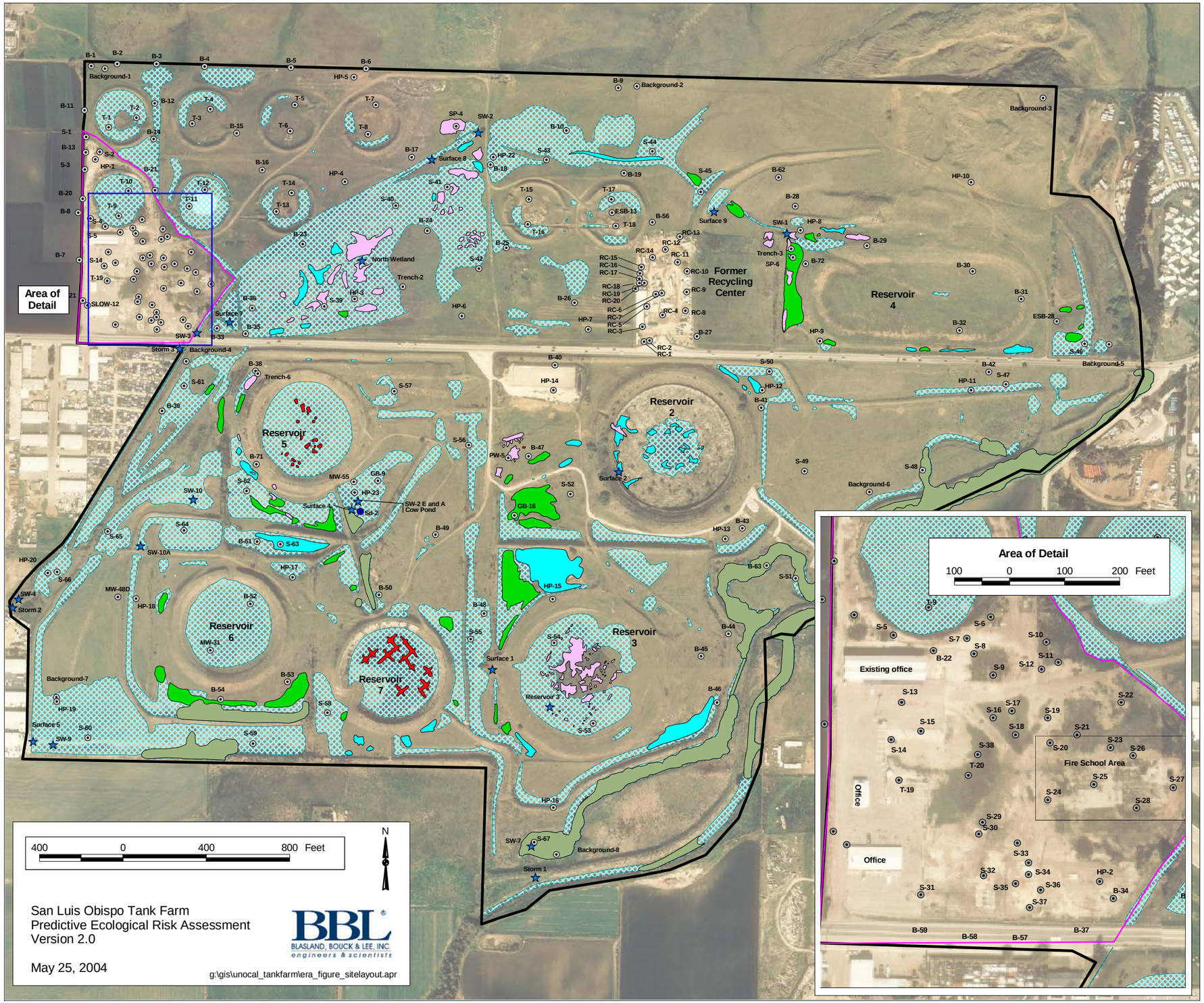


Figure 1-3

Site Features and Sample Locations for pERA

Legend

Sample locations

- Sediment samples
- Soil samples
- Surface water samples

- Site boundary
- Operations Area
- Federal and State delineated wetlands
- Riparian areas

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

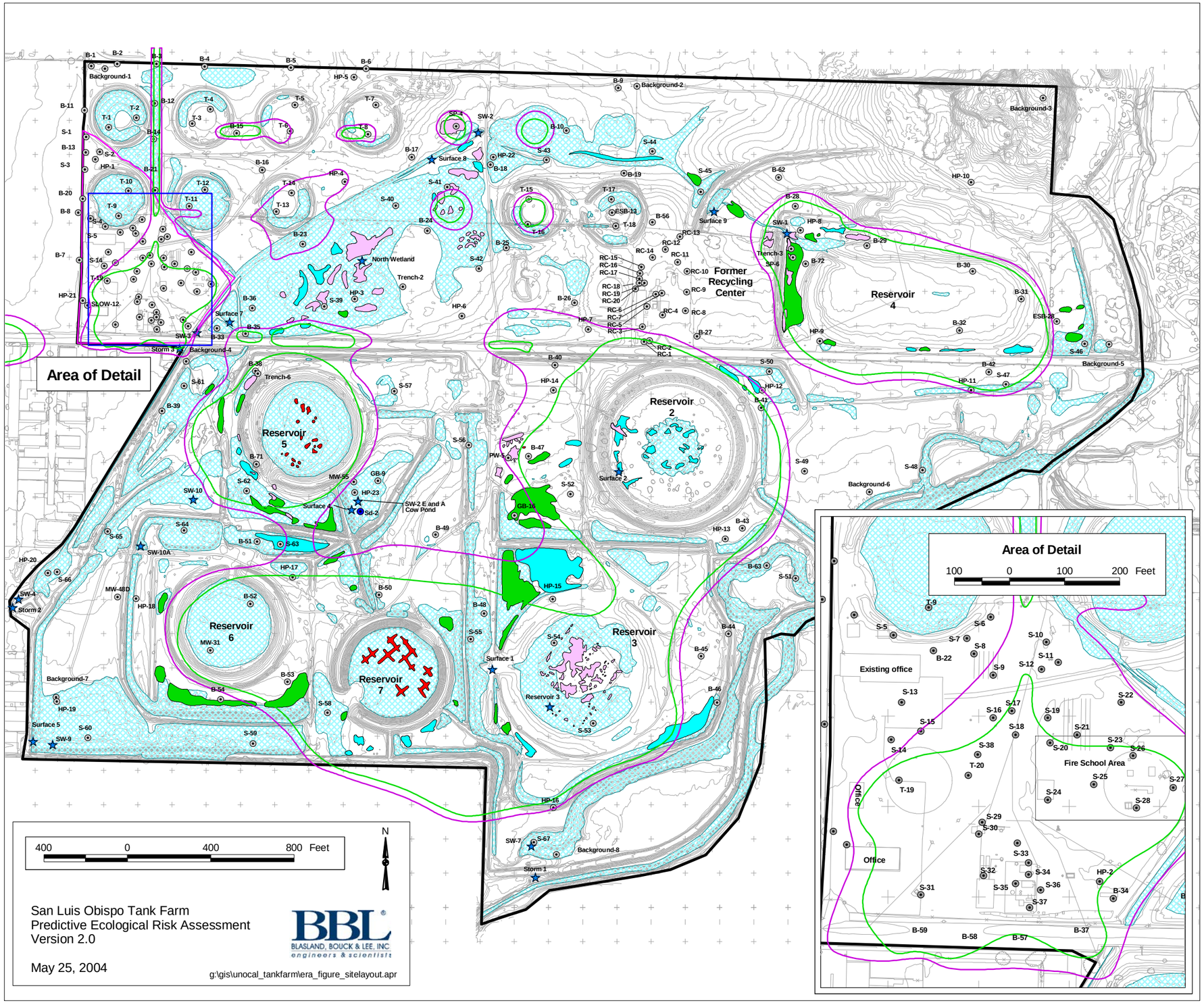


Figure 2-1

Subsurface Petroleum Plume

Legend

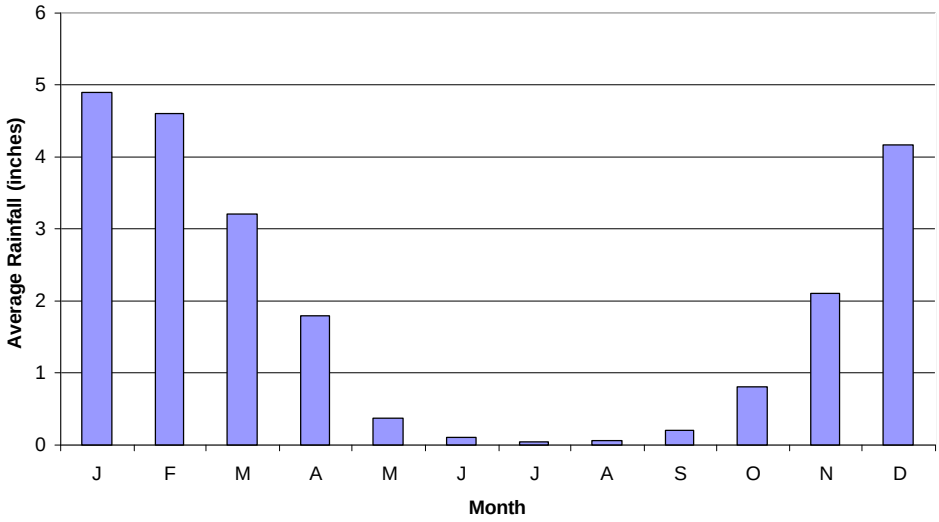
Sample locations

- Sediment samples
- Soil samples
- Surface water samples
- Area with TPH concentrations 100-1000 ppm TPH at depths > 5 ft
- Area with TPH concentrations >1000 ppm at depths > 5 ft
- Site boundary
- Federal and State delineated wetlands

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

Figure 2-2. Rainfall Data for San Luis Obispo County*



*Based on Data from California Department of Water Resources (www.cdec.water.gov) from 2002.

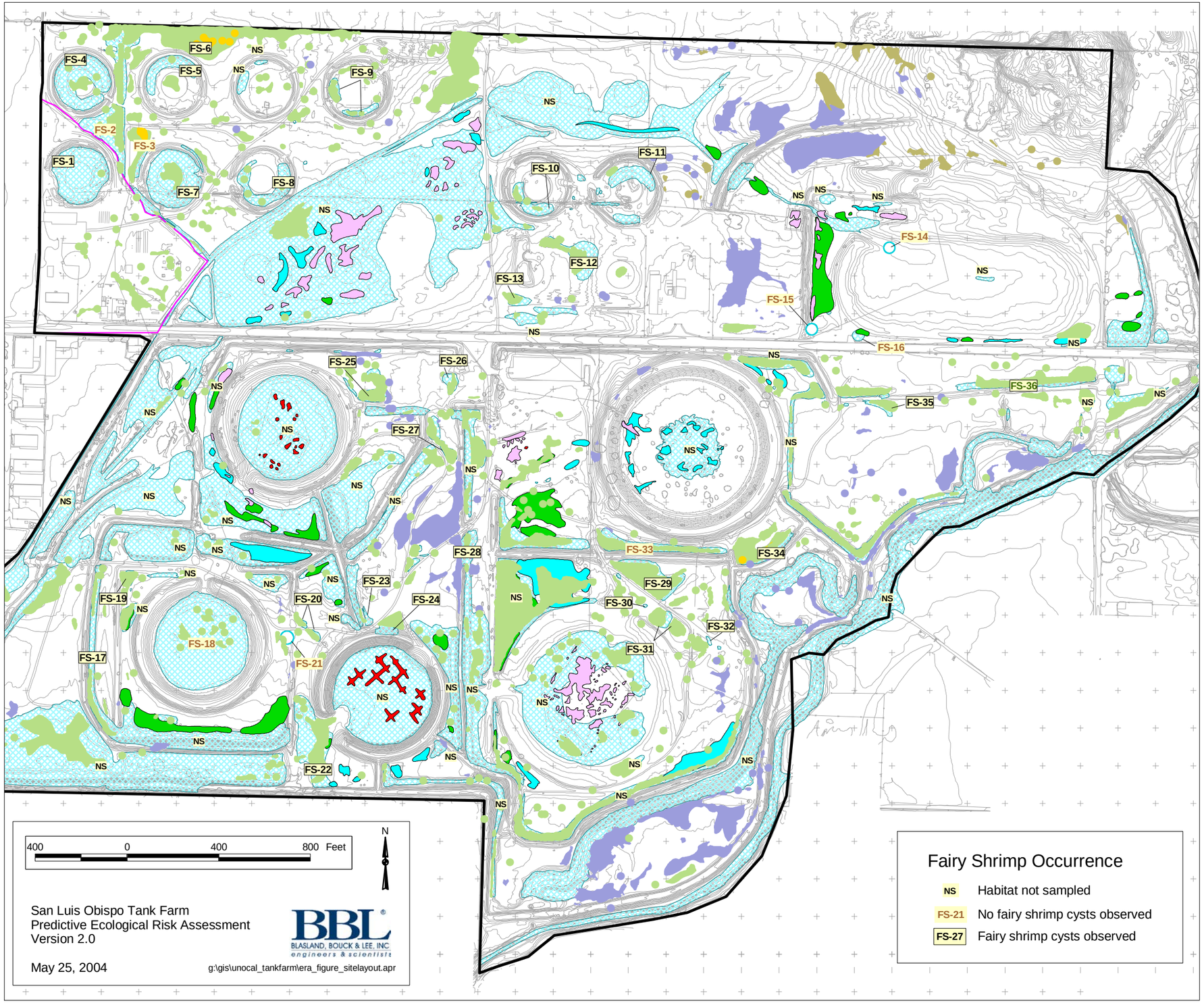


Figure 2-3

Special Status Plants
and Fairy Shrimp Cyst Distributions

Legend

- Site boundary
- Federal and State delineated wetlands

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

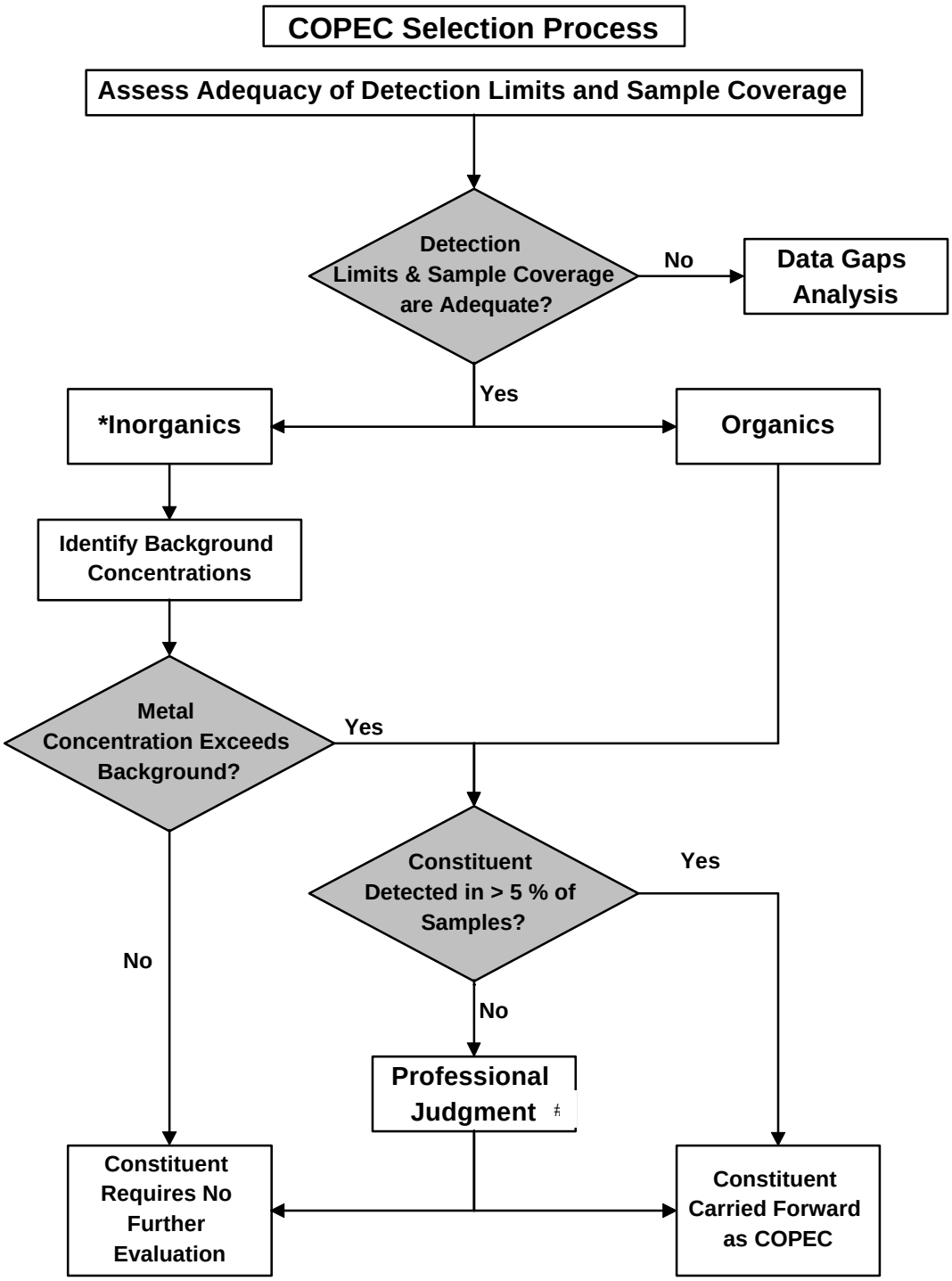
Plant communities with < 100 individuals

- Congdon's tarplant
- Hoover's button celery
- Purple needle grass
- SLO morning glory

Plant communities with > 100 individuals

- Congdon's tarplant
- Hoover's button celery
- Purple needle grass
- SLO morning glory

Figure 3-1. COPEC Selection Process



*** Inorganic background screen includes soil and sediment only**

 # Professional judgment includes evaluation of potential hot spots

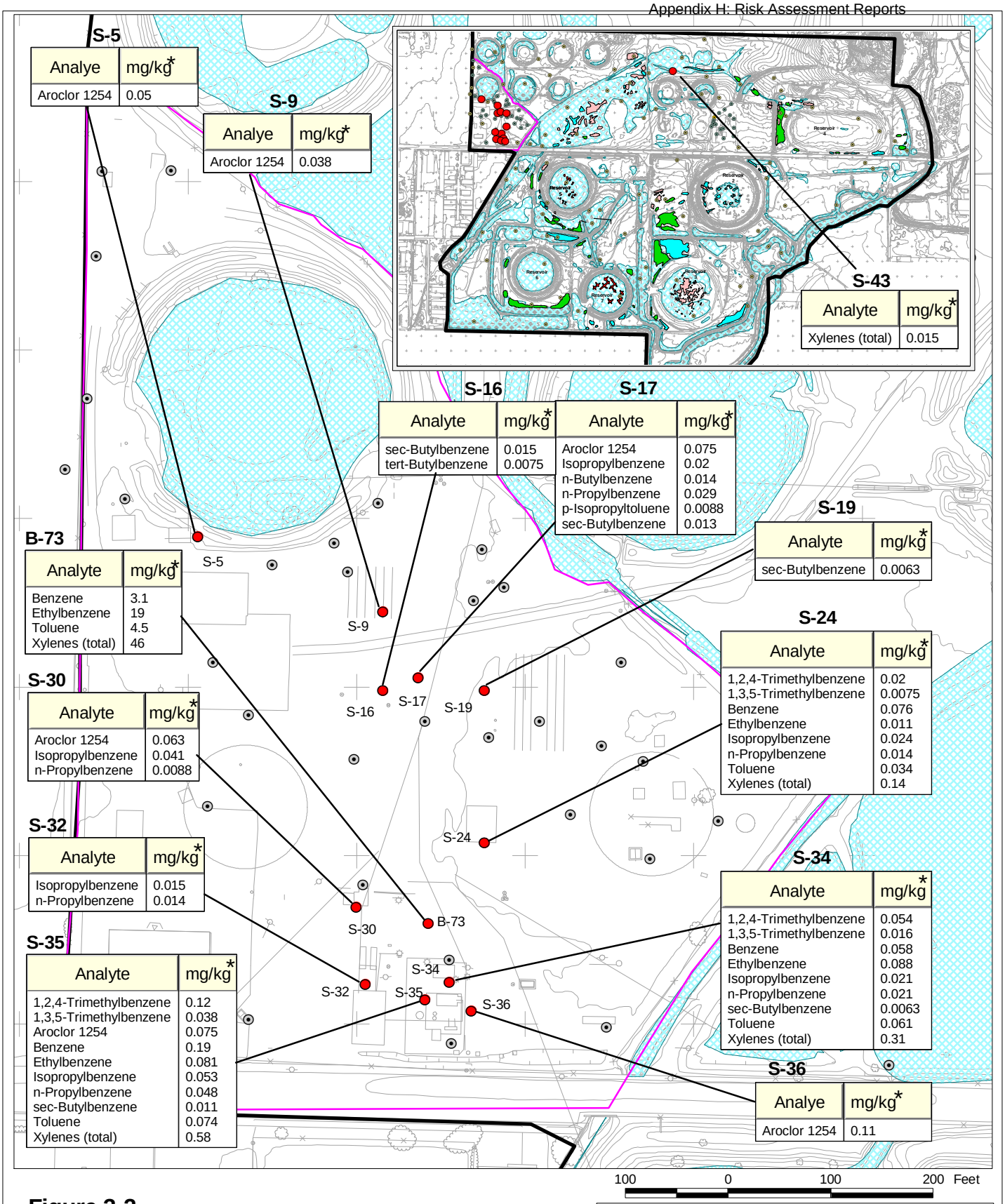


Figure 3-2.

Summary of VOC and PCB Concentrations in Shallow Soil

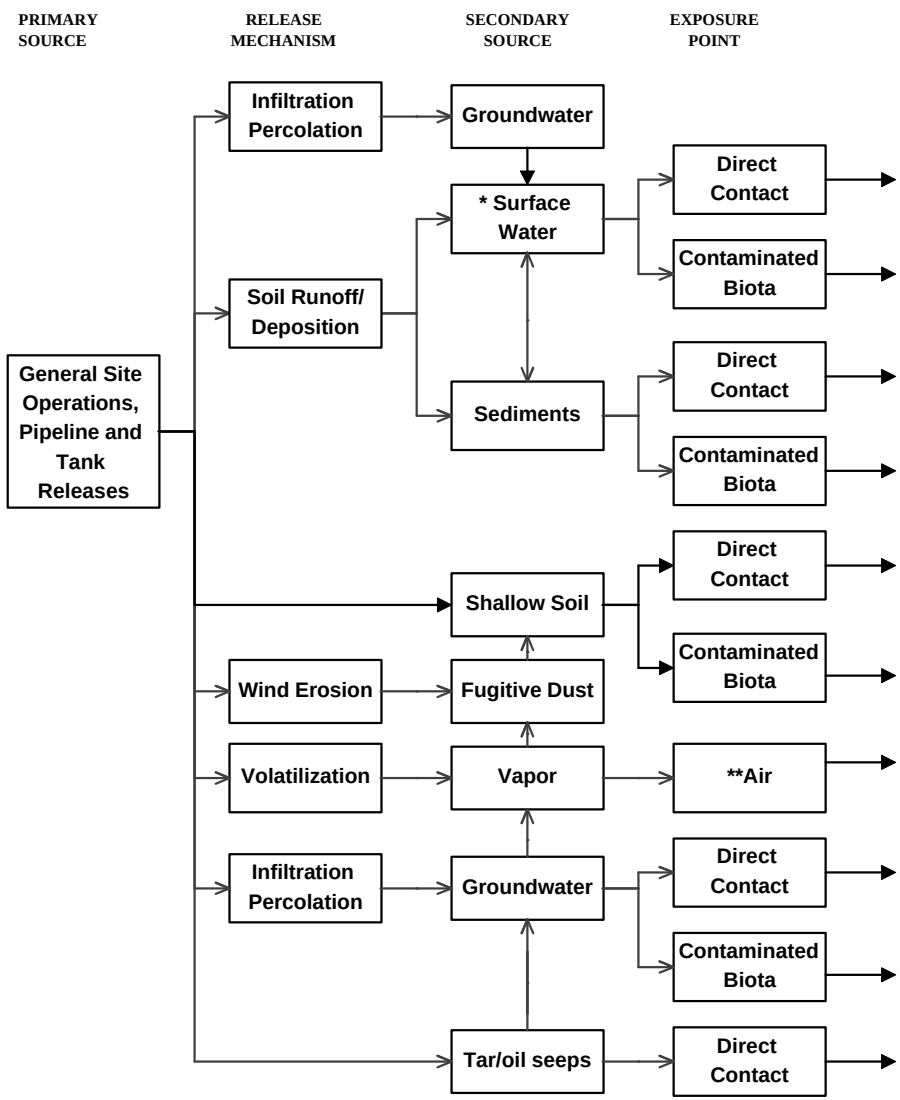
* all results are mg/kg dry weight

San Luis Obispo Tank Farm
Predictive Ecological Risk Assessment - Version 2.0
May 25, 2004

BBL BLASLAND, BOUCK & LEE, INC engineers & scientists

g:\gis\unocal_tankfarm\era_figure_voc_pcb.apr

Figure 3-3
Conceptual Site Model for SLO Tank Farm pERA



EXPOSURE ROUTE(S)	Wetland					Terrestrial			Riparian
	Plants	Aquatic inverts	Benthic inverts	Amphibians	Birds/ Mammals	Plants	Soil inverts	Birds/ Mammals	Plants
Uptake	?	?		?					
Ingestion					?			?	
Dermal Contact					?			?	
Ingestion					?				
Uptake	?		?						
Ingestion					?				
Dermal Contact					?				
Ingestion					?				
Uptake						?	?		?
Ingestion								?	
Dermal Contact								?	
Ingestion								?	
Inhalation								?	
Uptake	?					?			?
Ingestion					?			?	
Physical entrapment					?			?	
Barrier	?	?	?			?	?		

Legend:

? =Potentially complete exposure pathway

? =Potentially complete exposure pathway only in cases of petroleum sheen or free product

? =Potentially complete exposure pathway, media data indicate no contaminants present

Notes:

Uptake is defined as all exposure routes (i.e., absorption, ingestion and inhalation)

* For dissolved phase COPECs only

** Air Inhalation exposure is for burrowing animals only

Figure 3-4. Terrestrial Food Web for San Luis Obispo Tank Farm

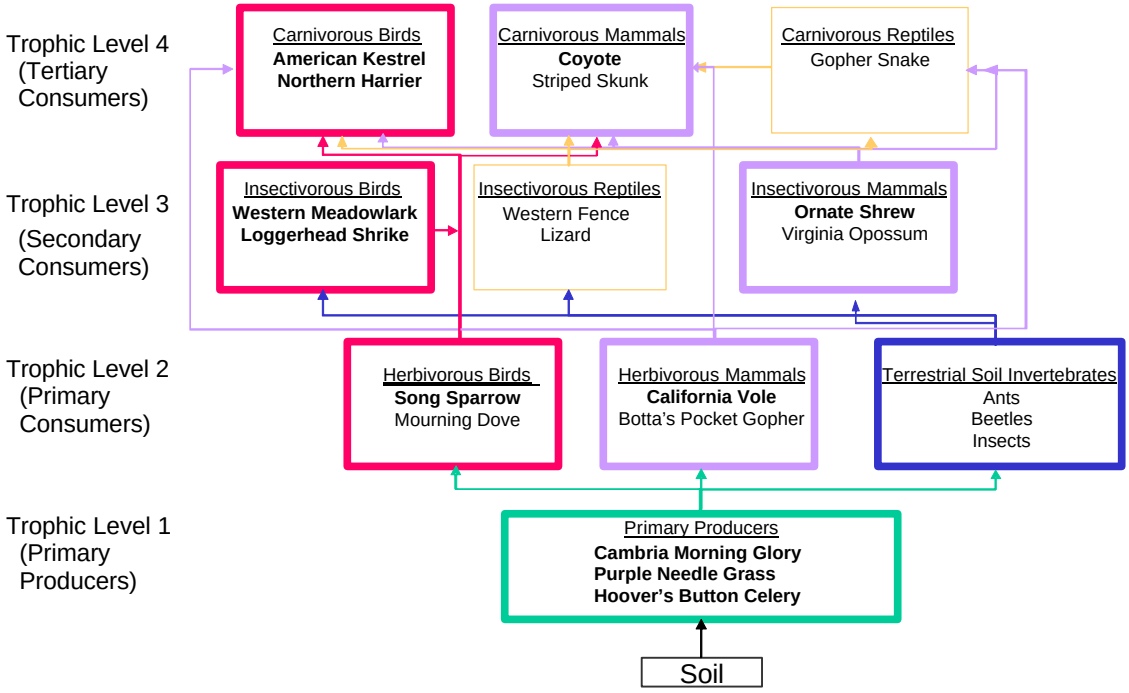
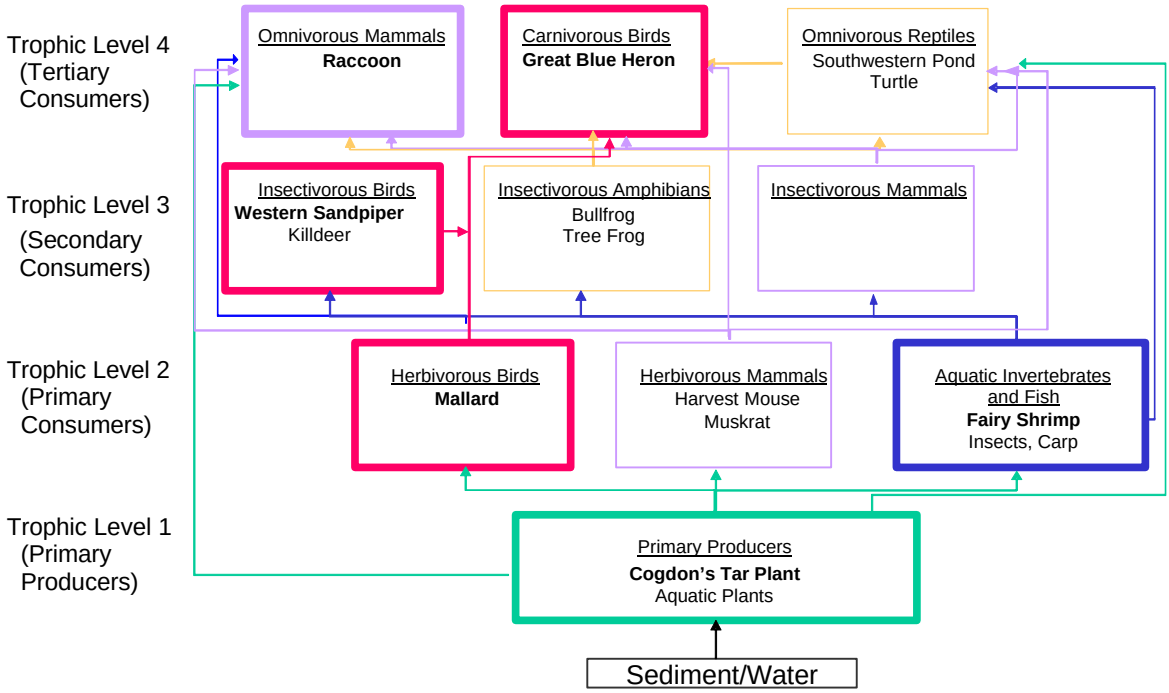


Figure 3-5. Wetland Food Web for San Luis Obispo Tank Farm



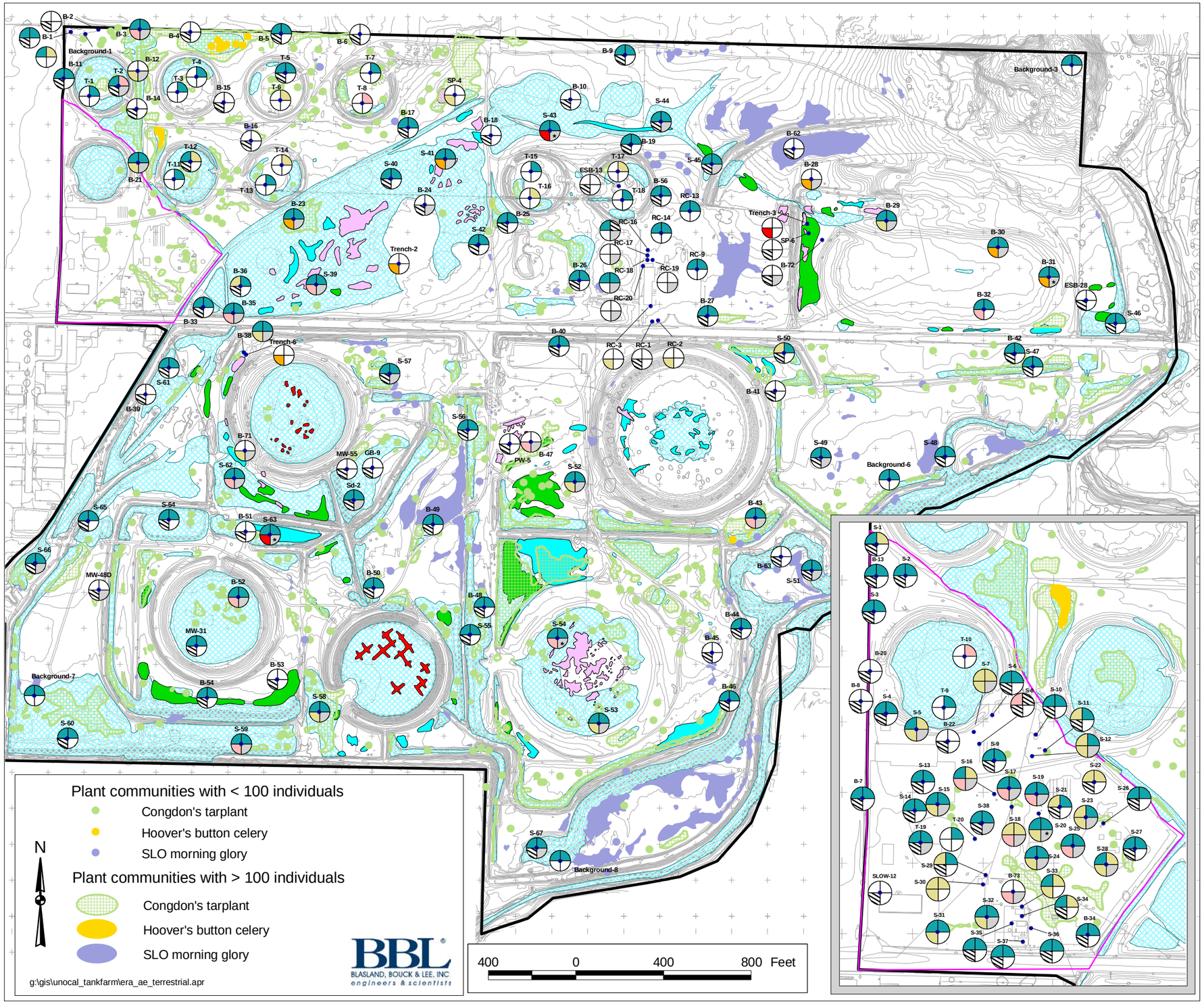


Figure 6-1

Tier 2 Hazard Quotient Summary
for Terrestrial Plants (AE: T1)

San Luis Obispo Tank Farm
Predictive Ecological Risk Assessment
Version 2.0

May 25, 2004

Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Arsenic	Lead
Sum TPH	PAH (pyrene)

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

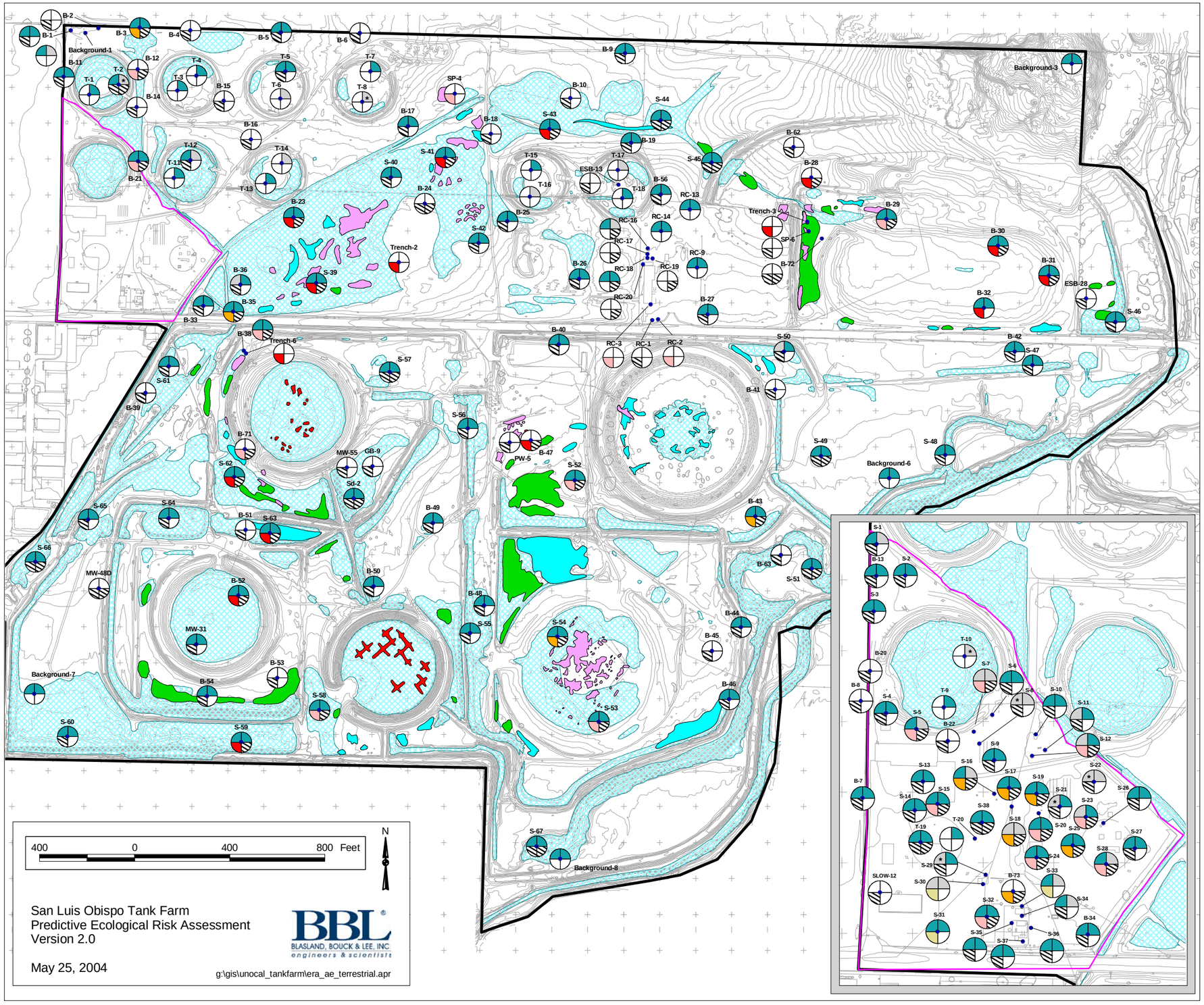


Figure 6-2

Tier 2 Hazard Quotient Summary
for Soil Invertebrates (AE: T2)

Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Arsenic	Lead
Sum TPH	PAH (pyrene)

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

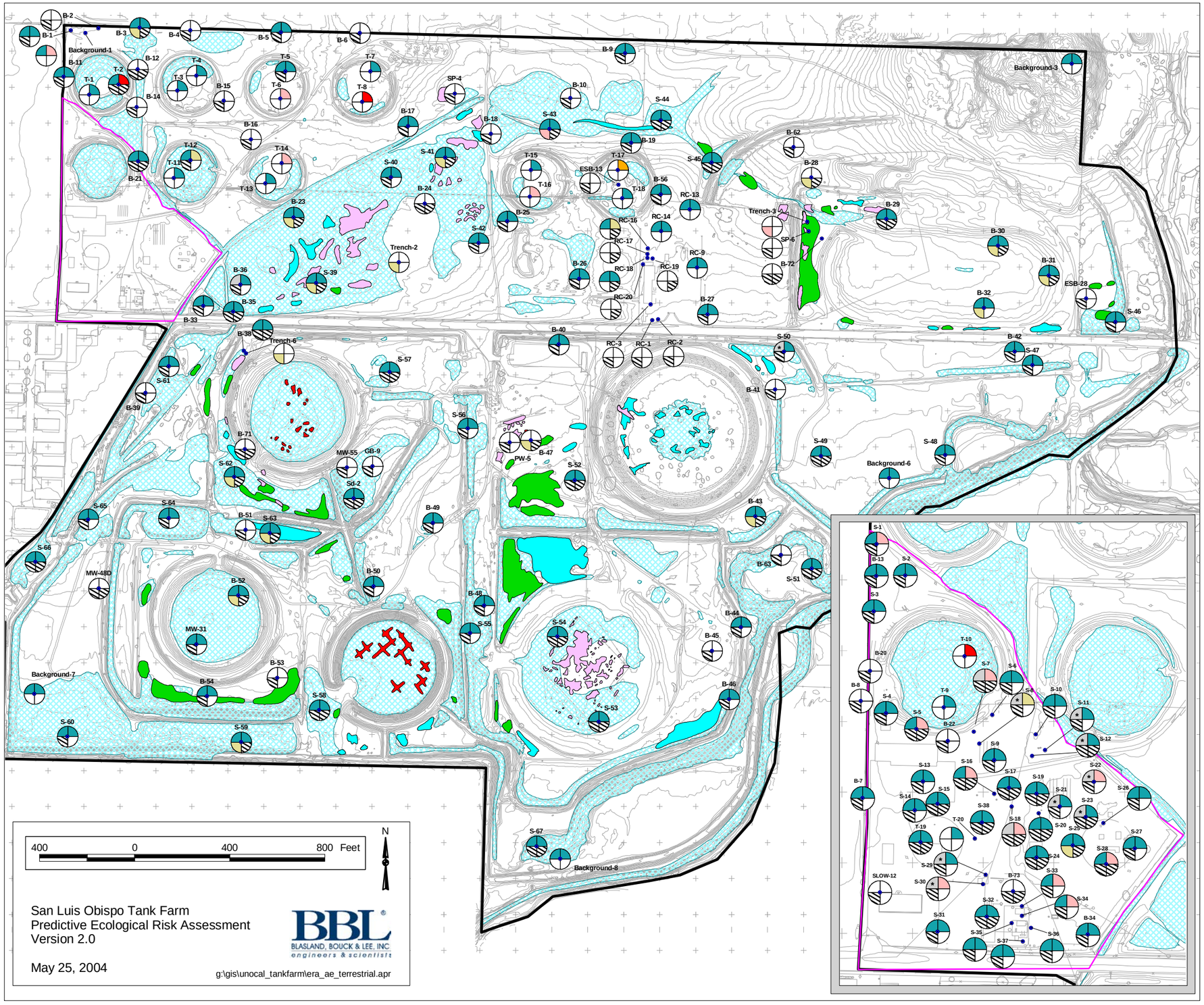


Figure 6-3

Tier 2 Hazard Quotient Summary
for the Song Sparrow (AE: T3)

Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Arsenic	Lead
Sum TPH	PAH (pyrene)

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

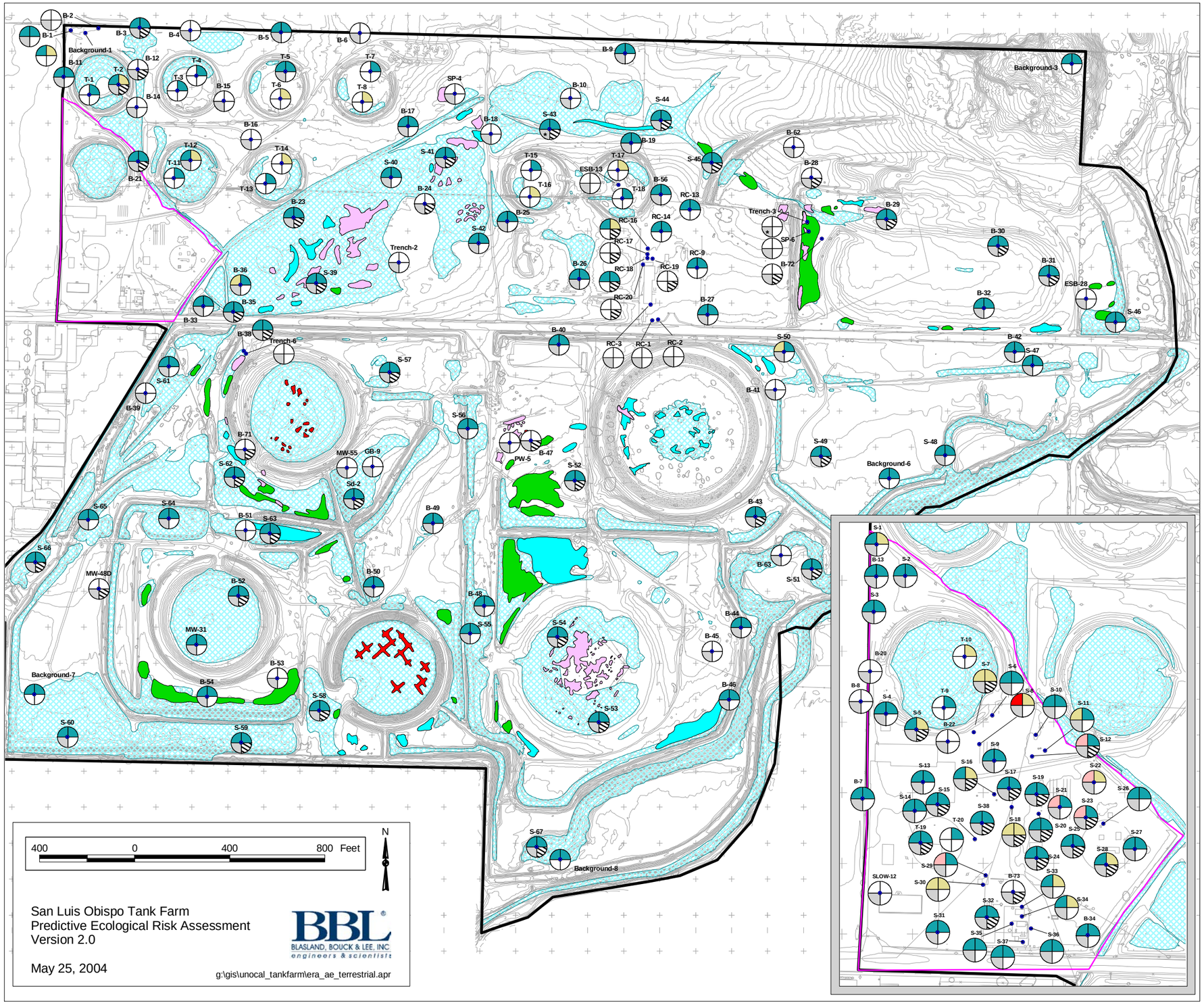


Figure 6-4

Tier 2 Hazard Quotient Summary
for the California Vole (AE: T4)

Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Arsenic	Lead
Sum TPH	PAH (pyrene)

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

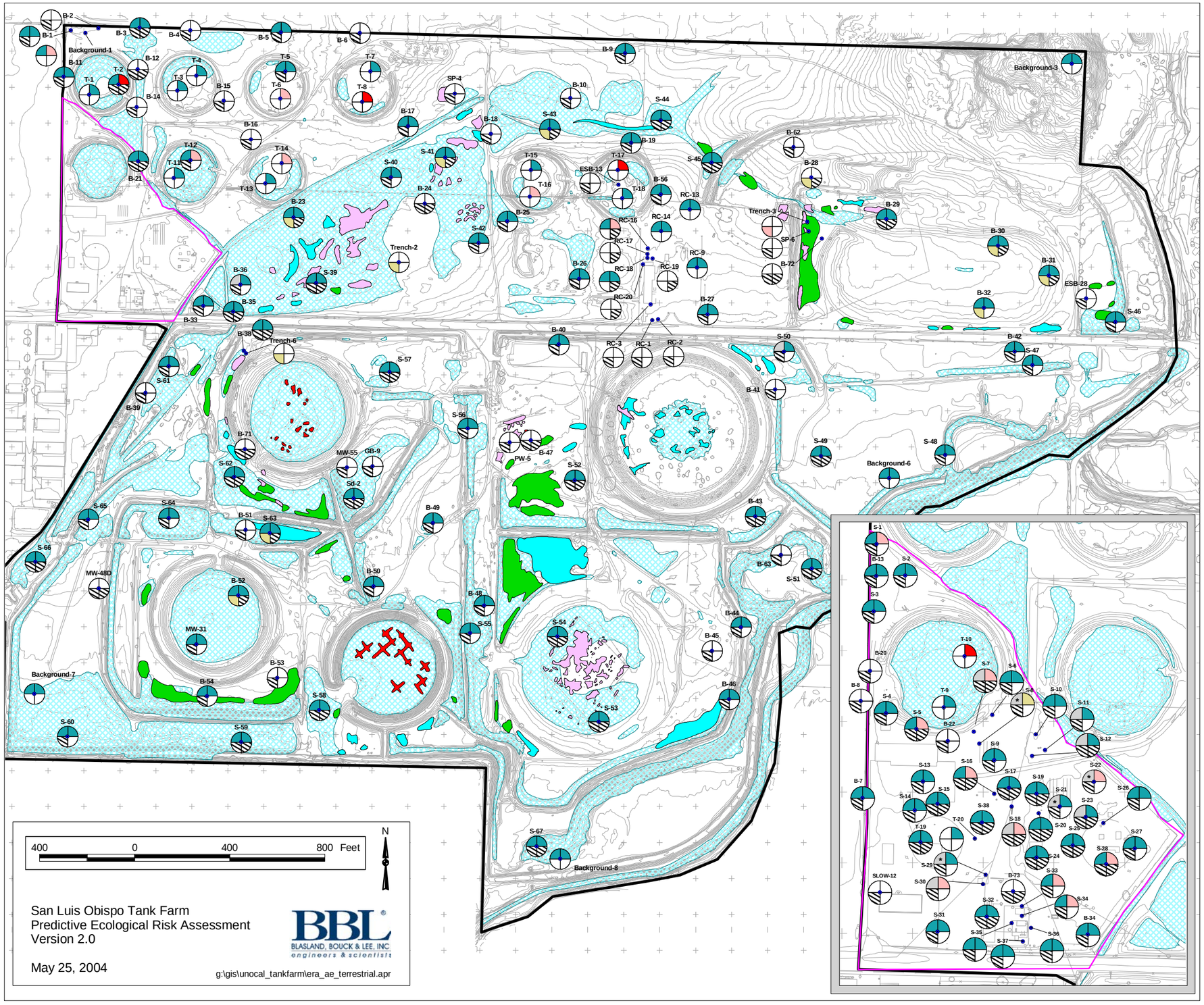


Figure 6-5a

Tier 2 Hazard Quotient Summary
for the Western Meadowlark (AE: T5)

Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Arsenic	Lead
Sum TPH	PAH (pyrene)

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

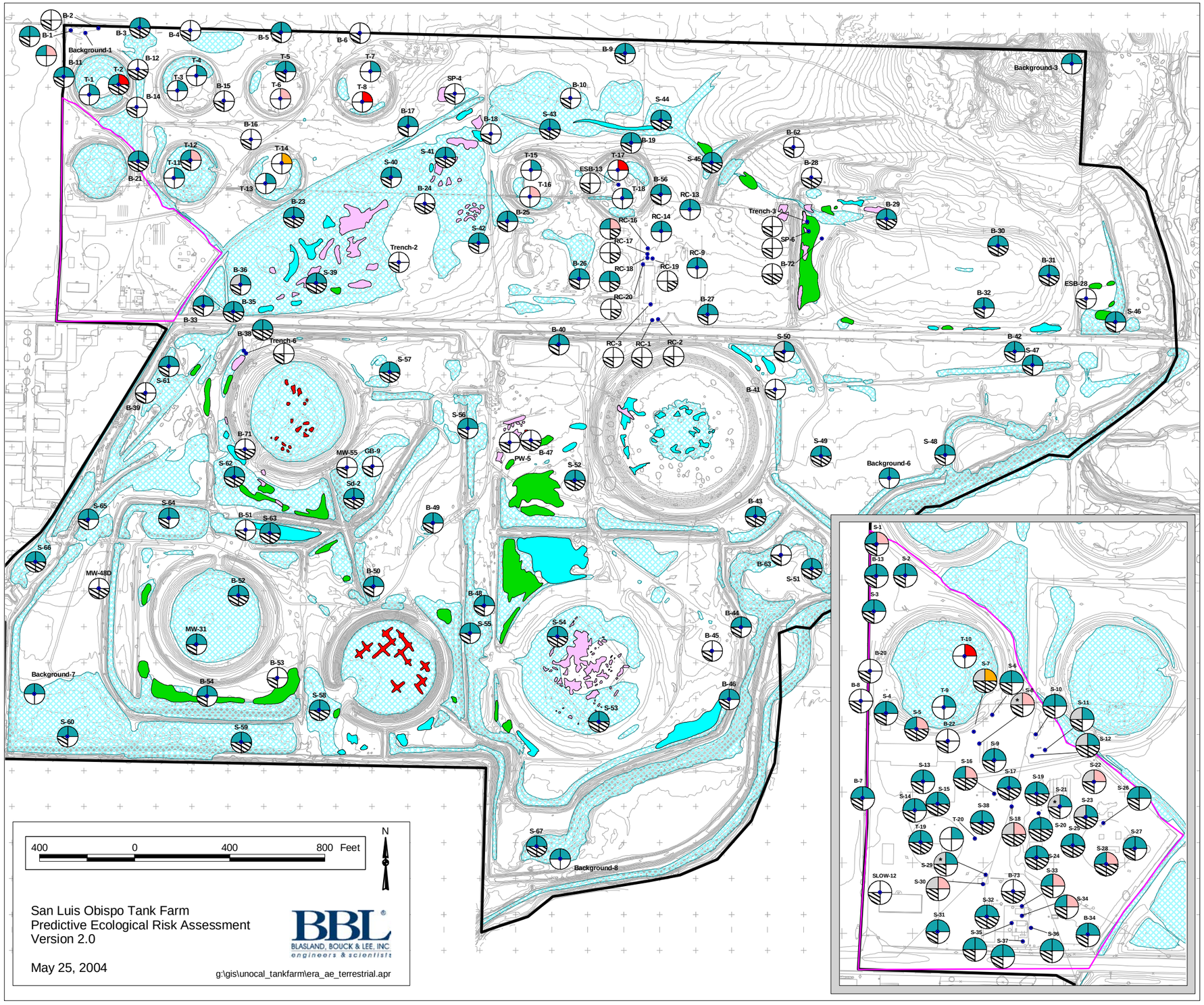


Figure 6-5b

Tier 2 Hazard Quotient Summary
for the Loggerhead Shrike (AE: T5)

Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Arsenic	Lead
Sum TPH	PAH (pyrene)

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

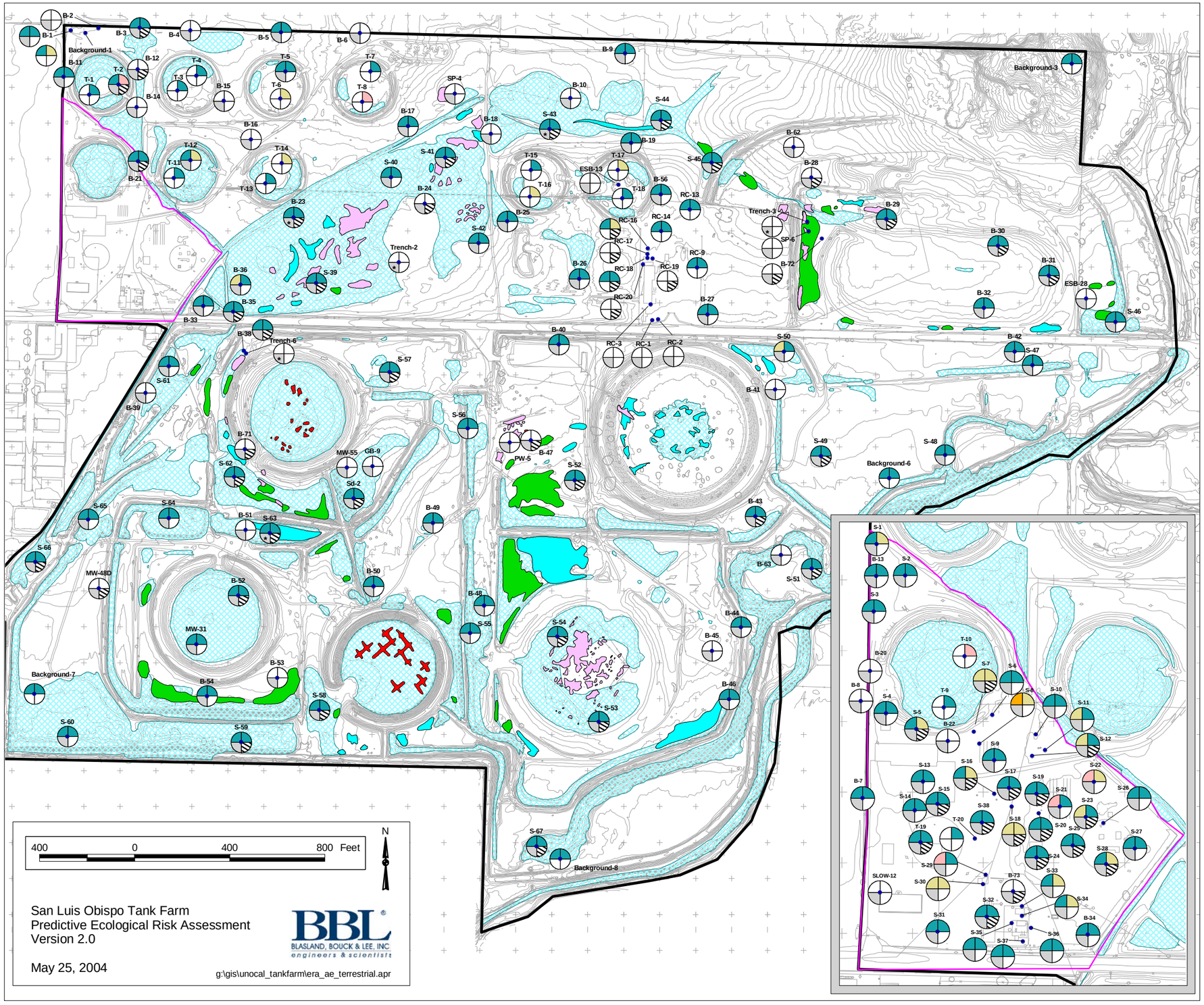


Figure 6-6

Tier 2 Hazard Quotient Summary
for the Ornate Shrew (AE: T6)

Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Arsenic	Lead
Sum TPH	PAH (pyrene)

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

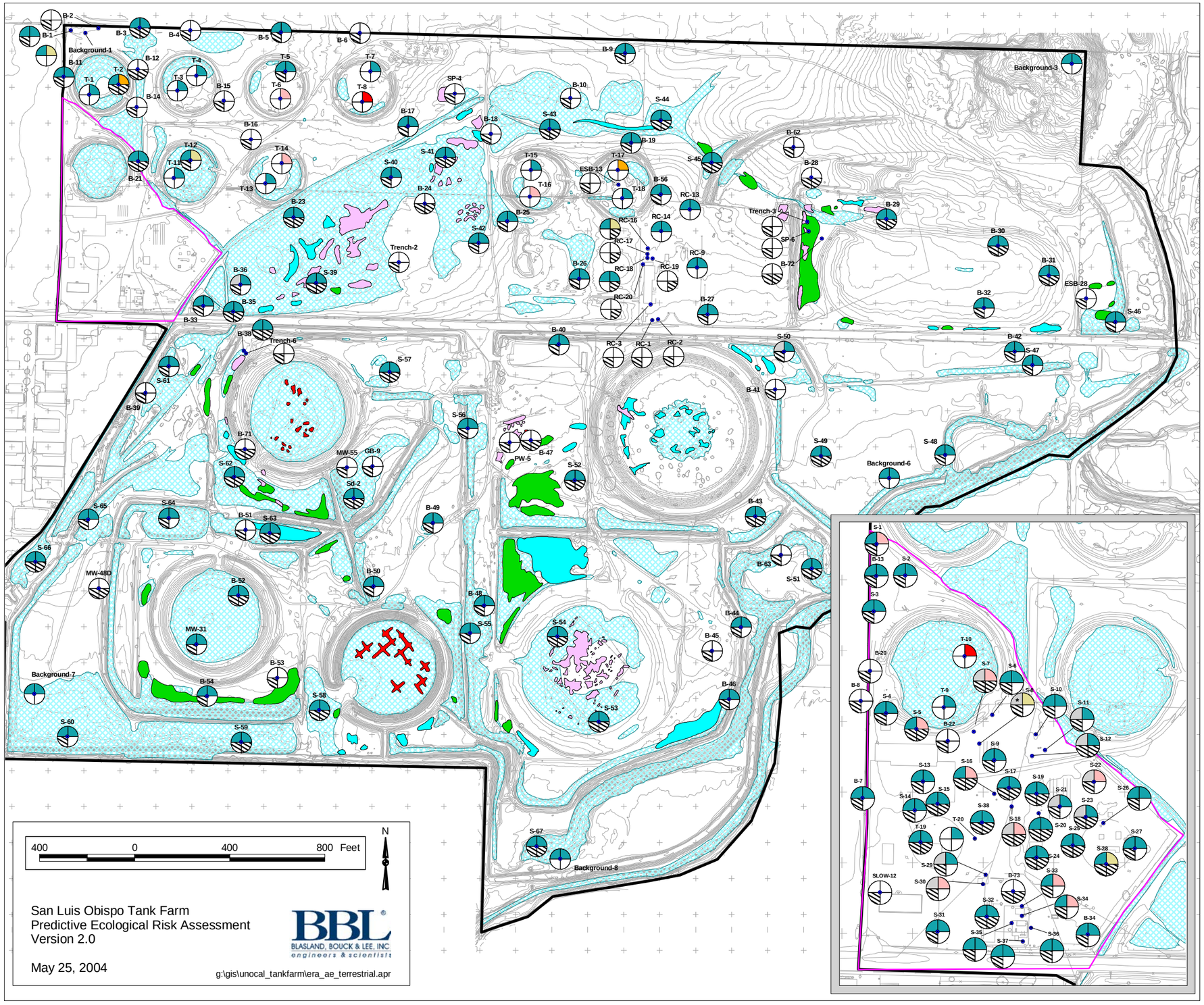


Figure 6-7a

Tier 2 Hazard Quotient Summary
for the American Kestrel (AE: T7)

Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Arsenic	Lead
Sum TPH	PAH (pyrene)

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

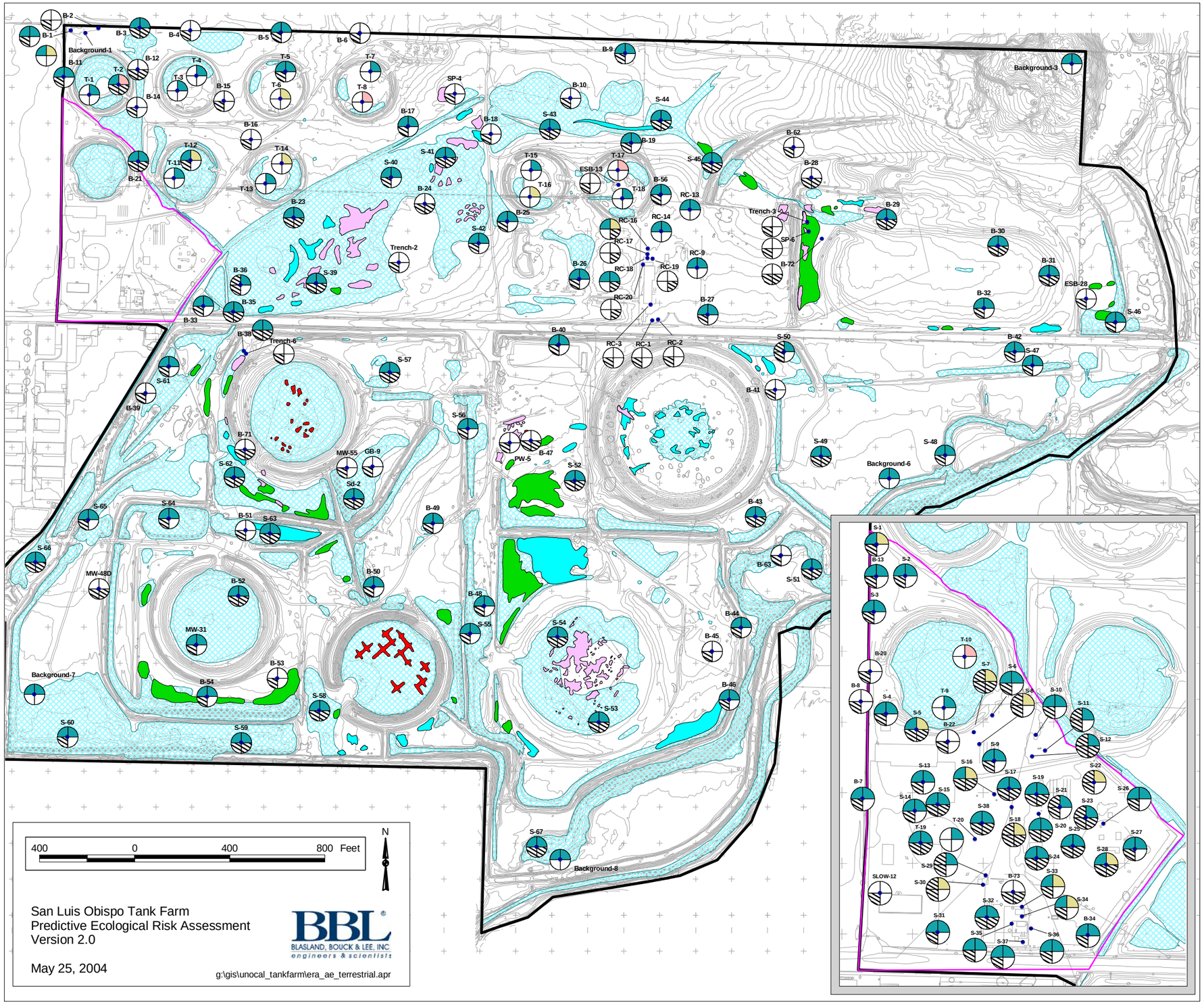


Figure 6-7b

Tier 2 Hazard Quotient Summary
for the Northern Harrier (AE: T7)

Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Arsenic	Lead
Sum TPH	PAH (pyrene)

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

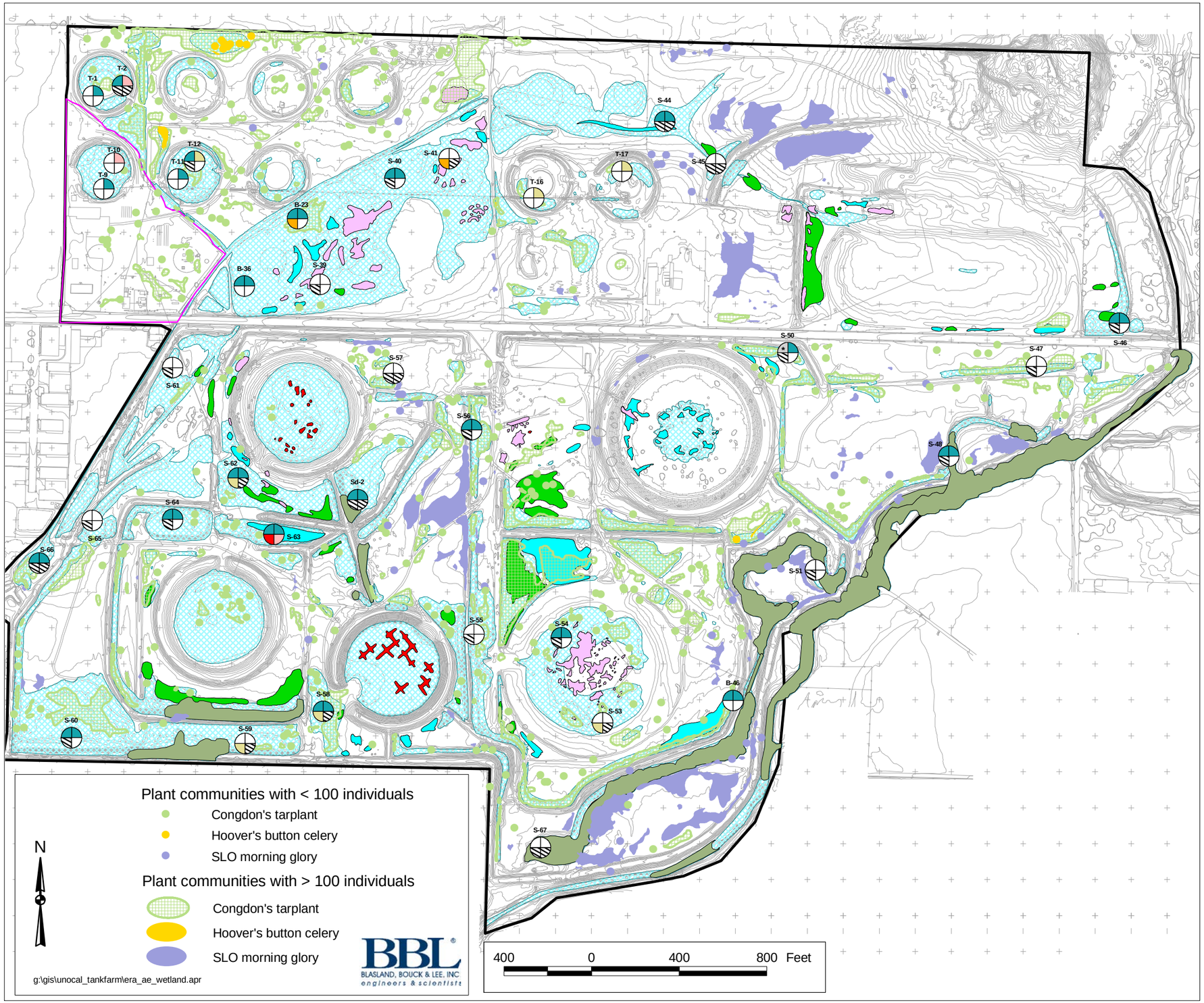


Figure 6-8

Tier 2 Hazard Quotient Summary
for Wetland Plants (AE: W1)

San Luis Obispo Tank Farm
Predictive Ecological Risk Assessment
Version 2.0

May 25, 2004

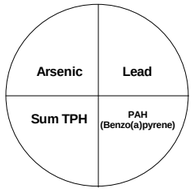
Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands
- Riparian areas

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed



Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

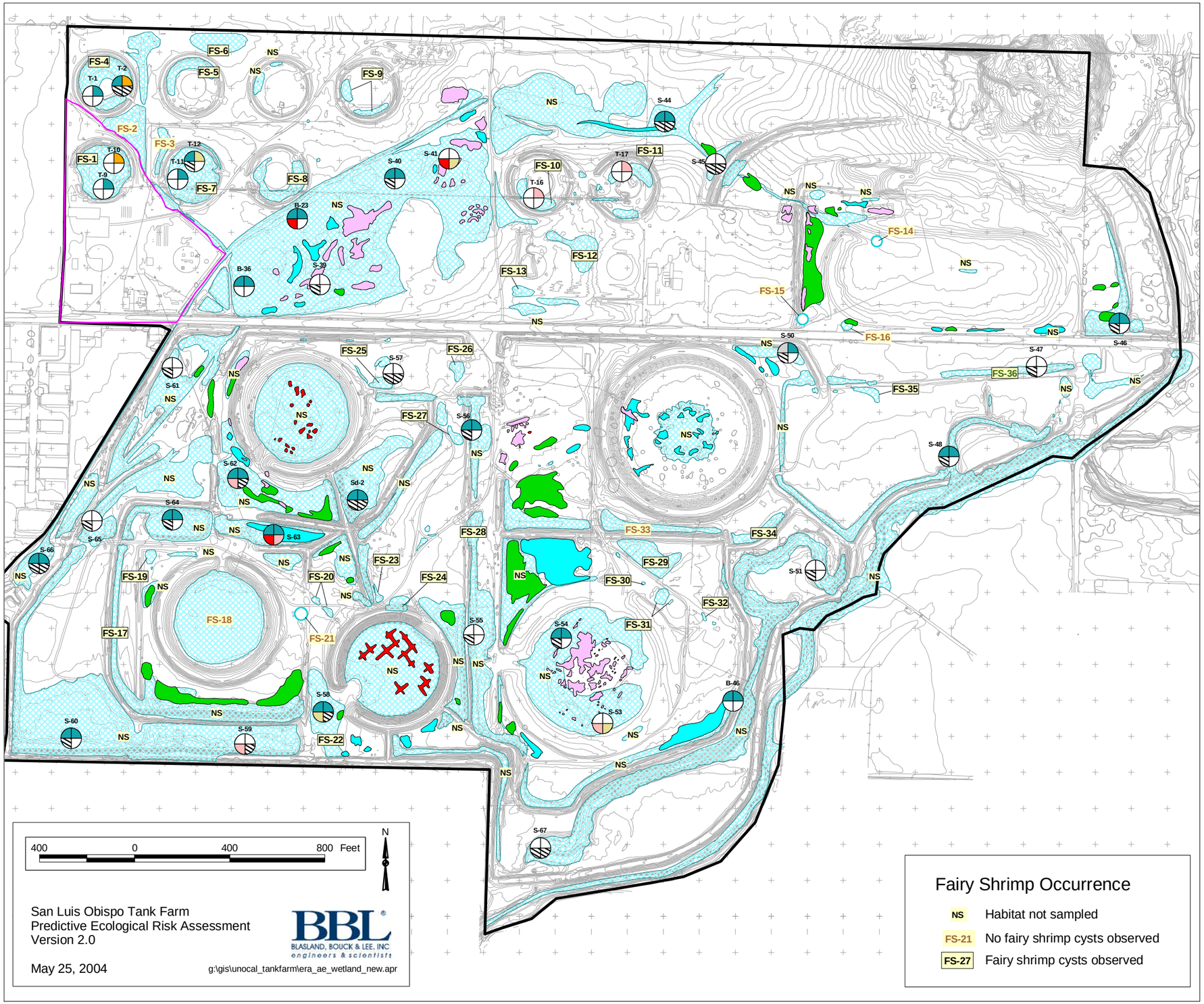


Figure 6-9

Tier 2 Hazard Quotient Summary
for Sediment Invertebrates Including
Vernal Pool Fairy Shrimp (AEs: W3 and W4)

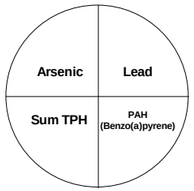
Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed



Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

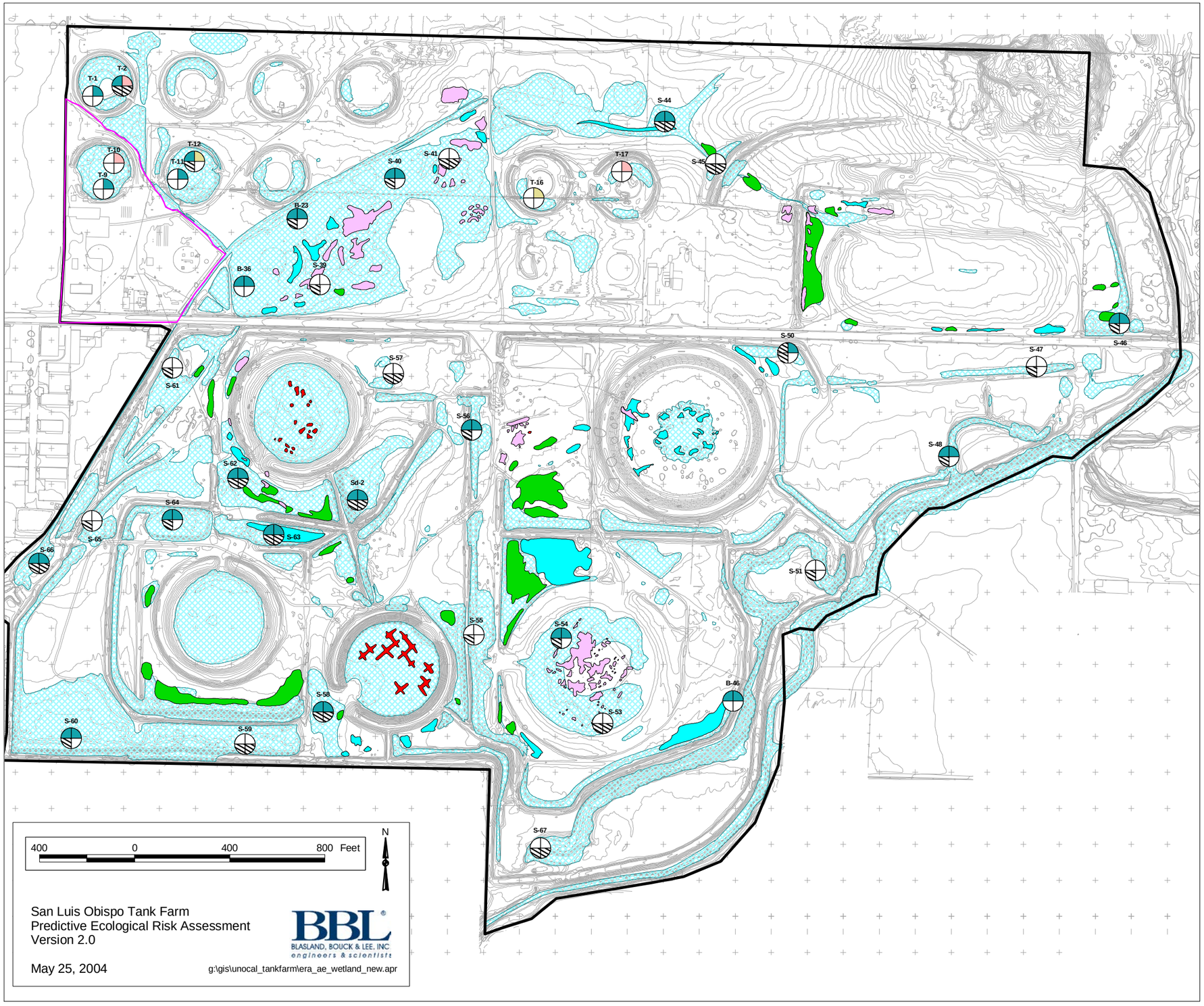


Figure 6-10

Tier 2 Hazard Quotient Summary for the Mallard (AE: W5) and the Great Blue Heron (AE: W7)

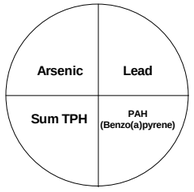
Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed



Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

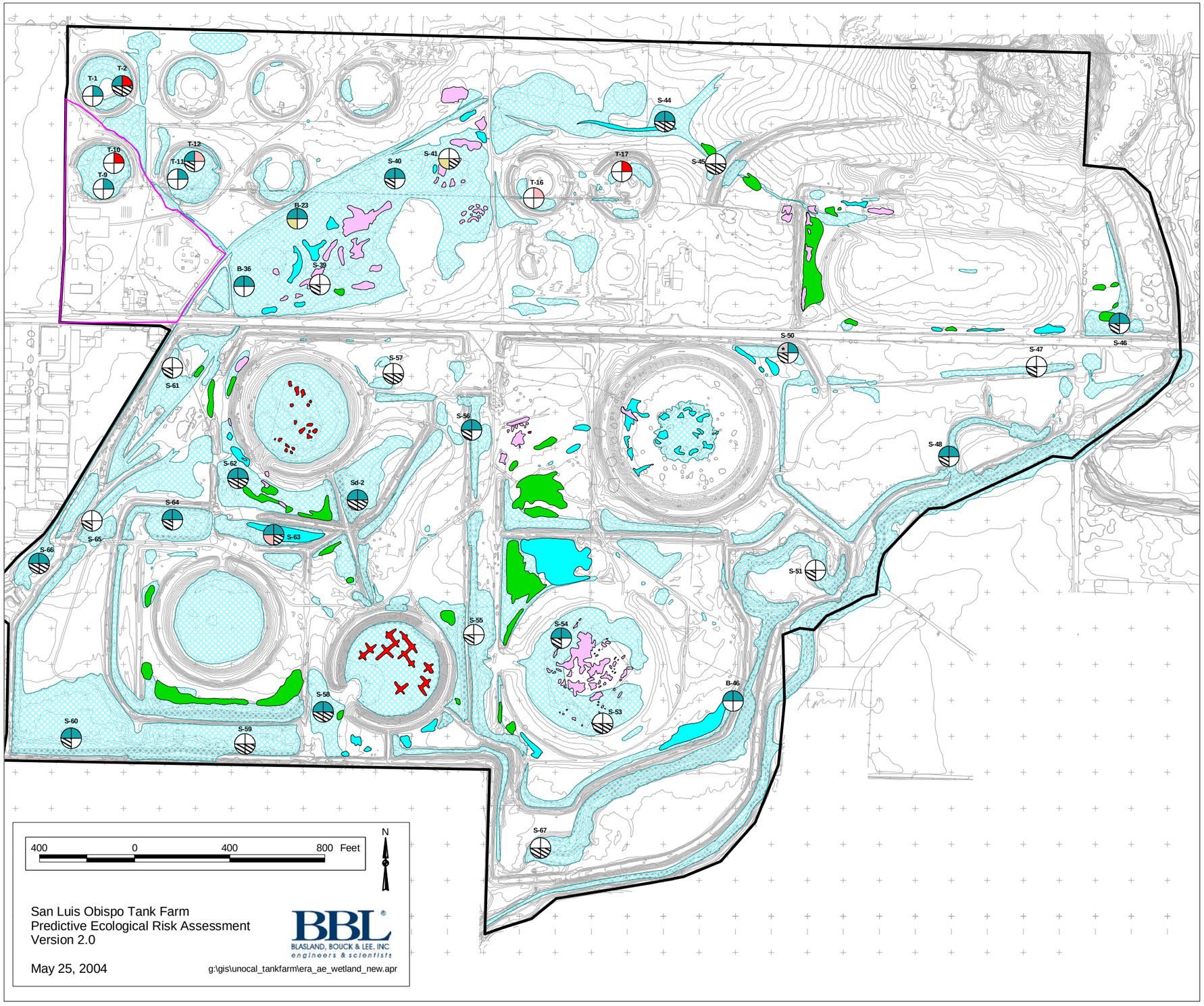


Figure 6-11

Tier 2 Hazard Quotient Summary
for the Western Sandpiper (AE: W6)

Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Arsenic	Lead
Sum TPH	PAH (Benzo(a)pyrene)

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

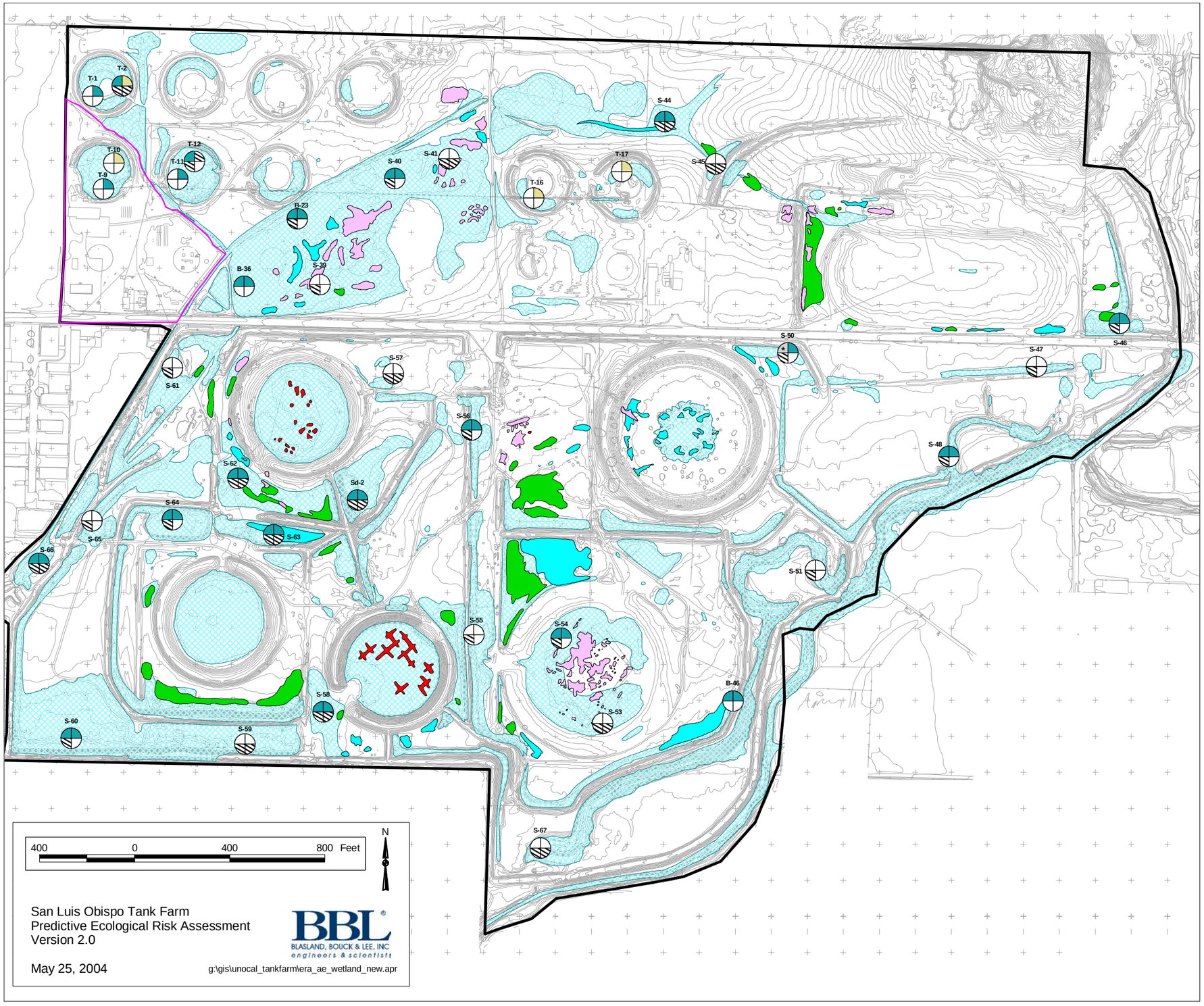


Figure 6-12

Tier 2 Hazard Quotient Summary
for the Raccoon (AE: W8)

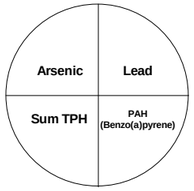
Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- Constituent not analysed
- Less than or equal to background
- 95% UCL low benchmark HQ less than or equal to 1 (* = Sample location low benchmark HQ > 1)
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed



Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

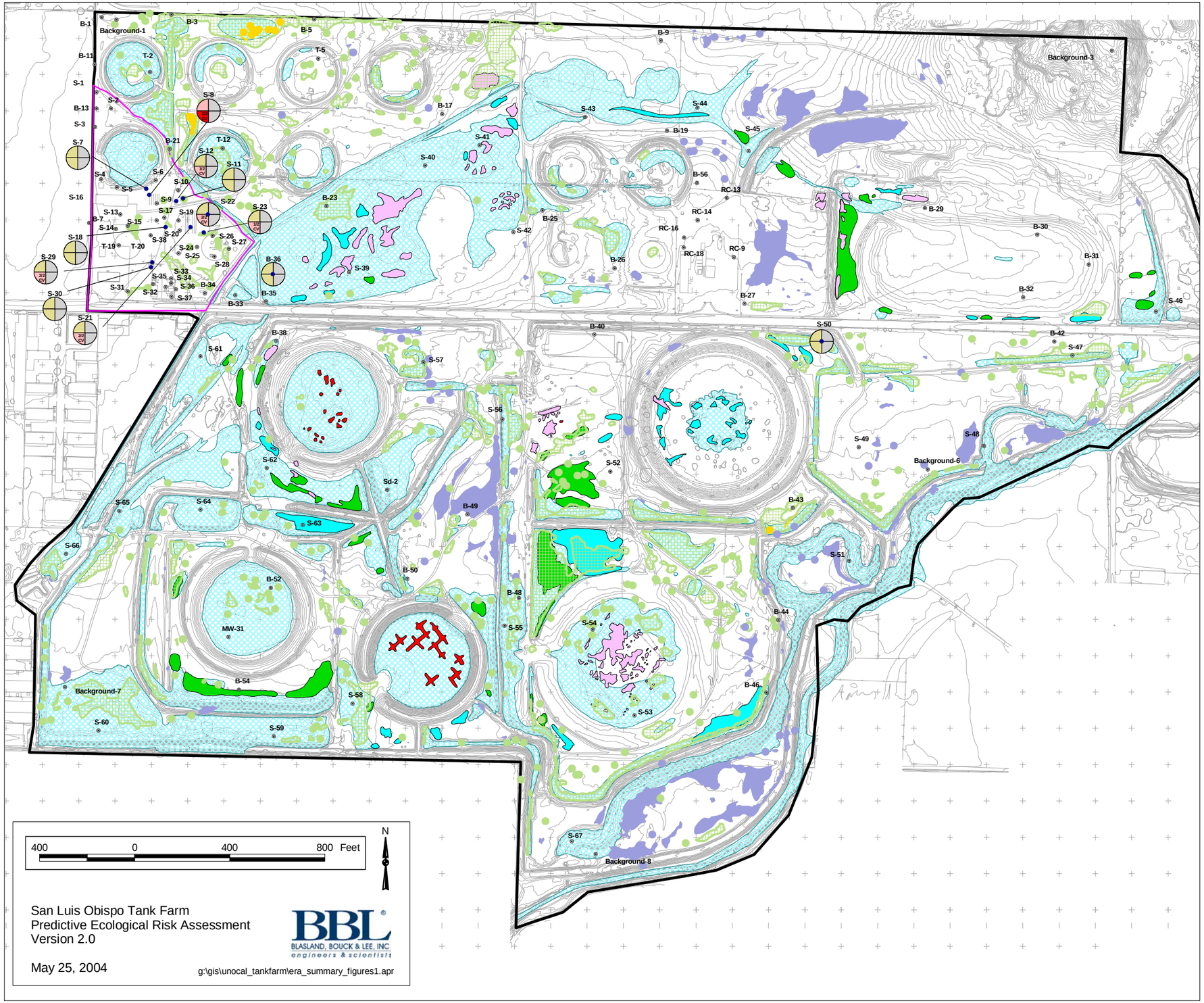


Figure 8-1

Arsenic Hazard Quotient Summary
for Terrestrial Receptors

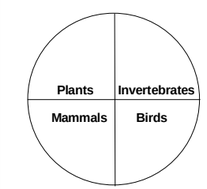
Legend

- Soil samples
- Concentration <= background
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- 95% UCL low benchmark HQ less than or equal to 1
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed



2/5 - number of species exceeding LOAEL out of number assessed

Species with highest HQ identified when LOAEL exceeeded
Birds: SS - Song Sparrow
WM - Western Meadowlark
LS - Loggerhead Shrike
AK - American Kestrel
NH - Northern Harrier
WS - Western Sandpiper

Mammals: CV - California Vole
OS - Ornate Shrew

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

Plant communities with < 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Plant communities with > 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

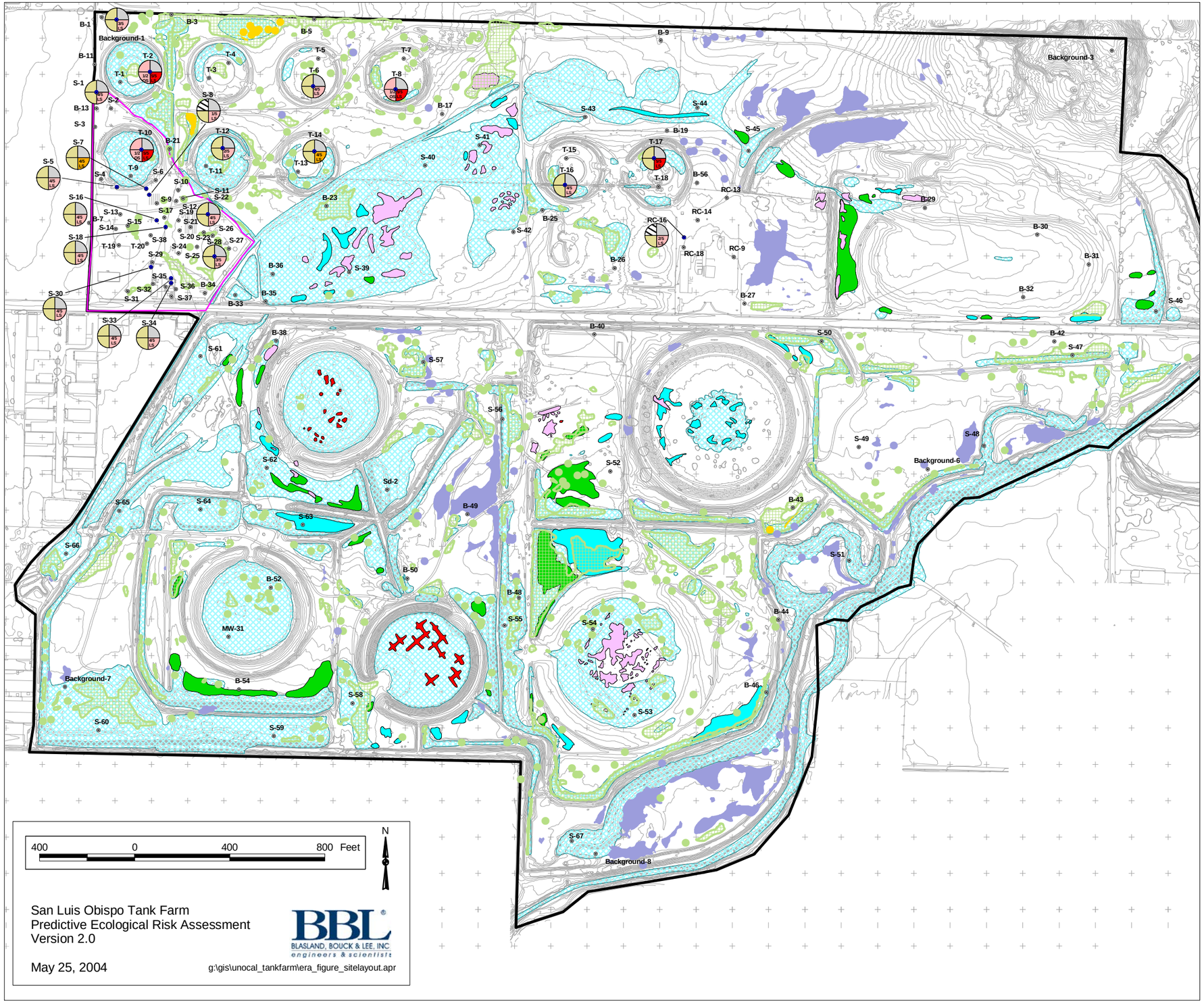


Figure 8-2

Lead Hazard Quotient Summary
for Terrestrial Receptors

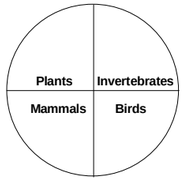
Legend

- Soil samples
- Concentration <= background
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- 95% UCL low benchmark HQ less than or equal to 1
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed



2/5 - number of species exceeding LOAEL out of number assessed

Species with highest HQ identified when LOAEL exceeeded
Birds: SS - Song Sparrow
WM - Western Meadowlark
LS - Loggerhead Shrike
AK - American Kestrel
NH - Northern Harrier
WS - Western Sandpiper

Mammals: CV - California Vole
OS - Ornate Shrew

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

Plant communities with < 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Plant communities with > 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

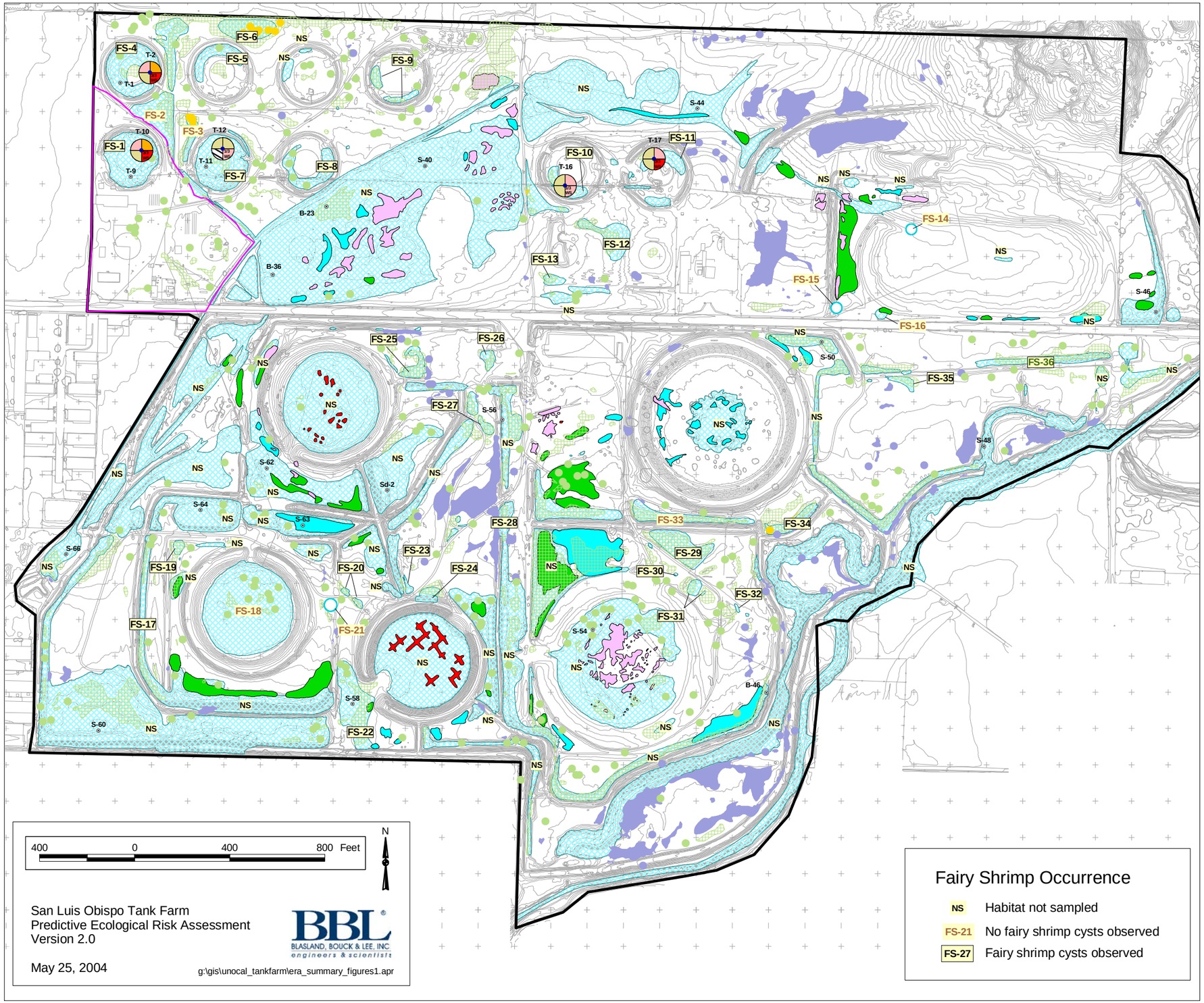


Figure 8-3

Lead Hazard Quotient Summary
for Wetland Receptors

San Luis Obispo Tank Farm

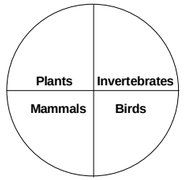
Legend

- Soil samples
- Concentration <= background
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- 95% UCL low benchmark HQ less than or equal to 1
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed



2/5 - number of species exceeding LOAEL out of number assessed

Species with highest HQ identified when LOAEL exceeeded
Birds: SS - Song Sparrow
WM - Western Meadowlark
LS - Loggerhead Shrike
AK - American Kestrel
NH - Northern Harrier
WS - Western Sandpiper

Mammals: CV - California Vole
OS - Ornate Shrew

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

Plant communities with < 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Plant communities with > 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

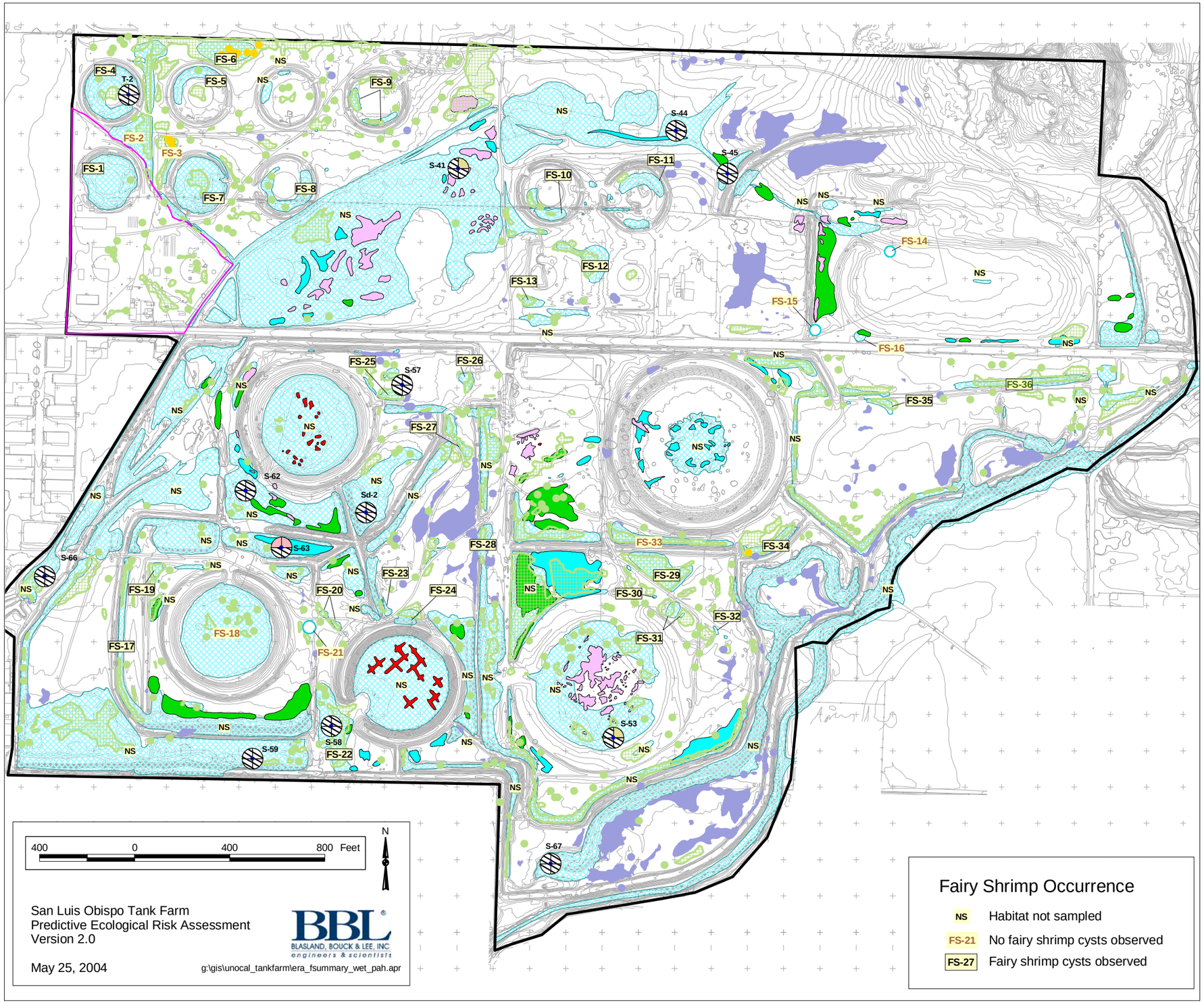


Figure 8-4

PAH Hazard Quotient Summary
for Wetland Receptors
(BaP used as surrogate for PAHs)

Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- 95% UCL low benchmark HQ less than or equal to 1
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Plants | Invertebrates
Mammals | Birds

2/5 - number of species exceeding LOAEL out of number assessed

Species with highest HQ identified when LOAEL exceeeded
Birds: SS - Song Sparrow
WM - Western Meadowlark
LS - Loggerhead Shrike
AK - American Kestrel
NH - Northern Harrier
WS - Western Sandpiper

Mammals: CV - California Vole
OS - Ornate Shrew

Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

Plant communities with < 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Plant communities with > 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

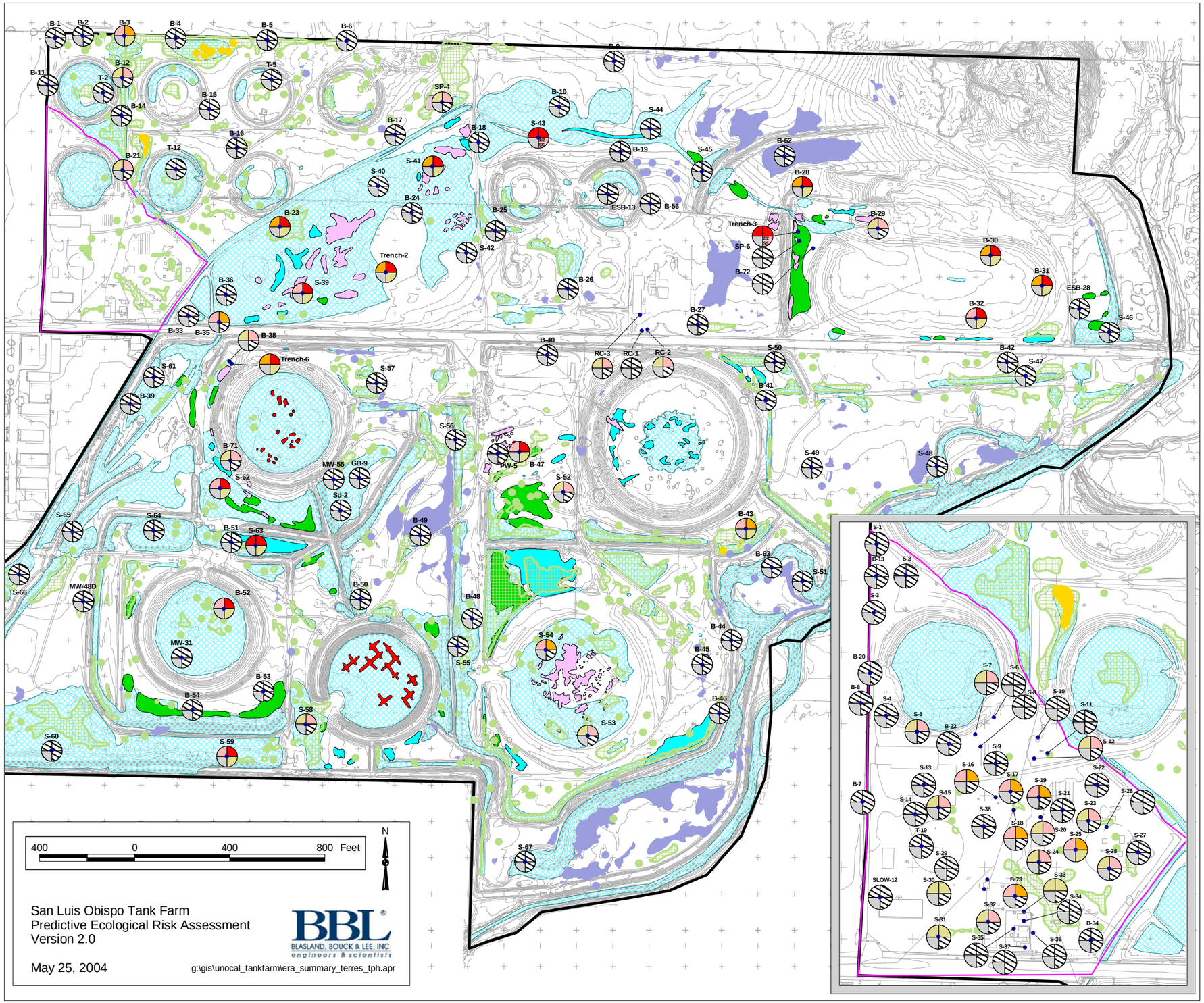


Figure 8-5

Sum TPH Hazard Quotient Summary
for Terrestrial Receptors

San Luis Obispo Tank Farm

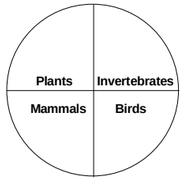
Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- 95% UCL low benchmark HQ less than or equal to 1
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed



2/5 - number of species exceeding LOAEL out of number assessed

Species with highest HQ identified when LOAEL exceeeded
Birds: SS - Song Sparrow
WM - Western Meadowlark
LS - Loggerhead Shrike
AK - American Kestrel
NH - Northern Harrier
WS - Western Sandpiper

Mammals: CV - California Vole
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Surface hydrocarbon expressions

- Solid, former crude oil.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Liquid crude oil. Capable of generating 'Free' droplets of oil.

Plant communities with < 100 individuals

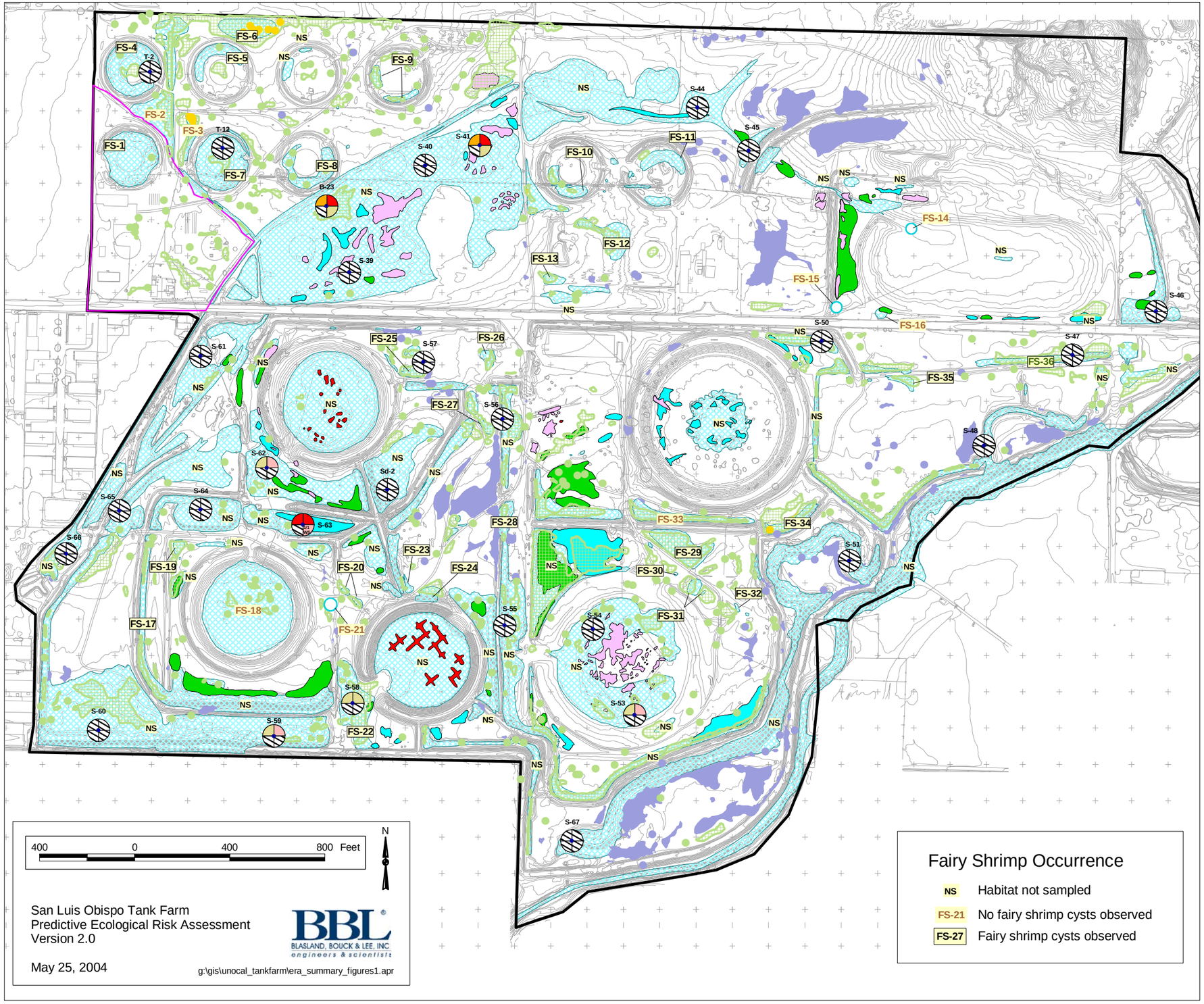
- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Plant communities with > 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Figure 8-6

Sum TPH Hazard Quotient Summary
for Wetland Receptors



Legend

- Soil samples
- Site boundary
- Operations Area
- Federal and State delineated wetlands

Assessment code

- 95% UCL low benchmark HQ less than or equal to 1
- *de minimus* risk (Low benchmark HQ <= 1)
- Level 1 risk (Low benchmark HQ > 1 > High benchmark HQ)
- Level 2 risk (1 < High benchmark HQ <= 5)
- Level 2 risk (5 < High benchmark HQ <= 10)
- Level 2 risk (High benchmark HQ > 10)

Constituents Assessed

Plants | Invertebrates
Mammals | Birds

2/5 - number of species exceeding LOAEL out of number assessed

Species with highest HQ identified when LOAEL exceeeded
Birds: SS - Song Sparrow
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Surface hydrocarbon expressions

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Plant communities with < 100 individuals

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- SLO morning glory

Plant communities with > 100 individuals

- Congdon's tarplant
- Hoover's button celery
- SLO morning glory

Appendix A
Ratified SERRT/ERWG Meeting Summaries

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Drafted by Strategic Initiatives based on the July 12, 2002 meeting of the SERRT. Reviewed, revised, and ratified at the SERRT meeting on October 4, 2002.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Draft Meeting Summary

Date: Friday July 12, 2002

Time: 9:30 AM – 2:00 PM

Location: Unocal Conference Room
276 Tank Farm Road
San Luis Obispo, CA

Participants:

Name	Organization	Name	Organization
Chuck Anders	Strategic Initiatives	Bill Owens	William L. Owens & Assoc.
Melissa Boggs-Blalack	CDFG	Harvey Packard	RWQCB
Bob Haddad	AGS	Steve Reiner	MIG
Neil Havlik	City of SLO	Mike Rendina	England Geosystem
Diane Kukol	RWQCB	Rick Rittenberg	Cannon Associates
John Ljung	Unocal	Karen Brooks	SLO APCD

Identifies Lead Person and Action Item

Indicates an "Action Item"

Introductions and Welcome

Chuck Anders welcomed the meeting participants and reviewed the meeting agenda. The meeting summary of the June 17, 2002 meeting was reviewed, revised and approved.

Mike Rendina will distribute PowerPoint Presentation

Surface and Groundwater Hydrology at the SLOTF

Mike Rendina reviewed the surface and groundwater hydrology at the SLOTF. The presentation included a brief overview of the site history and operations, the results of site assessment efforts particularly the nature and extent of soil impacts, and the results of water balance and hydrocarbon seepage studies performed at the site. Copies of the PowerPoint presentation will be distributed to all meeting participants.

The site is approximately 350 acres in size and is bisected by Tank Farm Road. There are 160 acres on the north side of the road and 190 acres to the south. The site is located in an unincorporated area of San Luis Obispo County and is within the City of San Luis Obispo's sphere of influence.
The tank farm was constructed in about 1910. Six large reservoirs (excavated concrete-lined containments with wooden roofs) stored between 0.75 - 1.3 million barrels of petroleum each. There were also 21 above ground 55,000 barrel steel

tanks located on the north side of Tank Farm Road. On April 7, 1926, 5.7 million barrels of crude oil and 0.6 million barrels of crude naptha (a petroleum fraction derived from crude oil by distillation) were in storage at the tank farm. Between April 7 and 13, 1926, a lightening caused fire destroyed all of the large reservoirs and 14 of the 19 (2 had been removed) above ground tanks resulting in the deposition of a substantial volume of oil on the ground surface in low spots surrounding the tanks and reservoirs. After the fire, four of the reservoirs and at least 10 of the steel above ground tanks were reconstructed. In addition to crude oil storage, the site also included a petroleum pumping station (pump house, boilers, and heat exchangers to heat the oil for pumping), maintenance support facilities for the tank farm and Unocal's northern pipeline division, and a fire training school. Large-scale crude oil storage was suspended in 1976. The pump station operated intermittently until the late 1980s. In the 1990s, all of the above ground oil storage tanks were removed and in 2001 the pipelines serving the tank farm were formally decommissioned.

The site has been subject to several environmental investigations since June 1998. These investigations have included the excavation and sampling of 133 exploratory borings and eight trenches; drilling, sampling, and completion of 83 borings as ground water monitoring wells (including several dual- and triple-nested wells), collection of shallow soil and/or tar samples from 119 locations, and the installation of eight, multi-level soil gas monitoring probes. Over 800 soil samples have been tested for a variety of potential contaminants including TPH, BTEX, other VOCs, PNAs, PCBs, herbicides/pesticides, and metals. In addition to characterization of the soil impacts, ground water monitoring has been routinely performed at the site since 1990, with up to 56 monitoring events available for some wells. Surface water monitoring has been routinely performed at the site since 1998.

The site is underlain by a variable thickness (0 to 190 feet) of unconsolidated alluvium overlying bedrock of the Franciscan Formation. The alluvium, which is thickest in the southwest and thinnest in the northeast, consists of laterally discontinuous interbeds of gravel, sand, silt, and clay. Fine-grained lithologies (silt and clay) predominate in the upper 100 feet, whereas coarse lithologies (sand and gravel) predominate at depth. Ground water occurs within the alluvium at depths ranging from less than one foot to almost 20 feet and fluctuates up to 15 feet in response to seasonal precipitation events. Ground water flow is toward the southwest. Twenty ground water monitoring wells contain free oil at thicknesses ranging from sheen (<0.01 feet) to about 13 feet. The free oil has viscosities hundreds to thousands of times greater than water and displays the physical and chemical characteristics of weathered crude oil. The lower density and higher viscosity renders the oil about a thousand times less mobile in the ground than water. With the exception of the fire school area, which apparently experienced fuel releases as a result of fire fighting exercises, BTEX is rarely detected in soil and/or free oil samples from the site. Low concentrations (<1 ppm) of BTEX have been detected in fewer than 6 percent of the hundreds of soil samples tested.

Ground water monitoring has been conducted at the site since 1990. None of the wells monitoring the crude oil impacted areas (i.e., everything but the fire school area) has ever exceeded 1 ppm TPH or contained detectable concentrations of BTEX. Four wells situated downgradient of the fire school area have contained TPH concentrations greater than 1 ppm and one of the wells historically contained BTEX. The results of 12+ years of ground water monitoring indicate that free- and/or

dissolved phase hydrocarbons are not migrating off tank farm property at concentrations in excess of commonly applied action levels.

Surface exposures of petroleum range from solid, asphalt-like material to viscous liquid petroleum. The surface exposures are significant because: 1) they locally contain elevated concentrations of PAHs; 2) they may develop a tacky surface during periods of warm weather creating a physical hazard to small animals; and 3) they may degrade water quality by contributing dissolved- or free-phase hydrocarbons to surface water. Two studies (trenching study and hydrocarbon seepage study) have been performed and/or are underway to understand the mechanisms responsible for producing/maintaining the surface exposures. These studies have shown that there are two types of surface exposure: 1) those without subsurface sources (i.e., basically shallow “puddles” of solid or plastic petroleum), and 2) surface exposures that exhibit evidence of receiving oil contributions from the subsurface. Of this later type, there appear to be two sub-types: those that receive subsurface contributions as a result of earth pressure (i.e., non-engineered fill is settling into the oil forcing the oil to the surface), and those that receive contributions as a result of ground water. The only areas that this later process has been identified are within reservoirs 5 and 7. Reservoirs 5 and 7 are located in topographically low areas of the site and are underlain by accumulations of free oil. Monitoring performed as part of the Hydrology Study and Hydrocarbon Seepage Study indicate that both the free oil and ground water potentiometric surfaces (as measured in monitoring wells) rise above the floors of reservoirs during winters of average and above average rainfall. The findings of the hydrocarbon seepage study suggest that rising ground water is the likely mechanism responsible for producing hydrocarbon sheen (i.e., vertical oil movement) in reservoirs 5 and 7.

A surface water monitoring program has been in-place at the site since 1998. Surface water samples are collected from ten locations – primarily along drainages that border or cross the property. To date there have been ten monitoring events and anywhere from four to ten samples have been collected from each sample point (depending upon whether water was present at the time of sampling). The samples are tested for TPH, BTEX, and PNAs. Low concentrations of high molecular weight TPH are detected in about half of the samples collected. All TPH is removed by silica gel and BTEX and PNAs have never been detected. Water samples collected from reservoirs 5 and 7 (closed catchments), where sheen occurs, had 3.3 and 6.6 mg/L TPH in November 1998. Based on the ten surface water monitoring events, there is no evidence that significant concentrations of dissolved hydrocarbons are entering drainages and flowing off site.

A hydrology study was completed in August 2001. The purpose of the study was to evaluate ground water/surface water interaction through water balance modeling. Secondary objectives included the compilation of a site-specific database of weather measurements for evaluation of future remediation and development alternatives and to correlate physical observations (i.e., wetland conditions) with precipitation values. The study involved weather measurements (direct measurement of precipitation and calculation of evapotranspiration), measurements of surface water run-on and run-off, and field measurements of surface water infiltration. The study, which provided an abundance of engineering data, did support a connection between ground water and surface water in localized areas of the site under certain rainfall conditions.

Neil Havik asked if there were any recommendations for remediation or land use as a result of the past studies. Mike said that remediation and land use were not part of the assessment.

Proposed Land-Use Alternatives

Neil Havlik presented a conceptual land use map prepared by a Unocal consultant. He discussed the areas identified for commercial/industrial development and open space. This information was incorporated into the Airport Specific Plan prepared by the City. Neil emphasized that the land use proposed in the specific plan is a function of biological and airport flight restrictions. Neil said that he believes that the area has a very high biological value.

Neil indicated that it is the City's position that if the constraint to development was due to contamination and the constraint could be remediated, the constraint could then be removed. The City has circulated the proposed plan and the EIR for comment. Comments have recently been received and are now being reviewed. Neil said that Unocal has expressed concern that the proposed uses would not provide adequate value to cover their development expenses and have asked for relief to develop certain areas to higher uses or reduction of infrastructure costs. The City is currently talking to Unocal regarding their concern. He emphasized the importance of all parties working together.

The City does not want to make changes that would result in the reissuence of the EIR. He anticipates action on the specific plan around the end of the year or early 2003. The City is relying on the RWQCB and other agencies to determine the level of remediation. Neil expressed concern that the remediation and/or mitigation requirements do not reduce the biological value of the site.

Steve Reiner and Bill Owens discussed how they will work with Unocal, the City and local stakeholders to identify opportunities for development. Steve said that they will be addressing site development/land-use alternatives, timing, economic feasibility, remediation implications, and environmental values. He indicated that the SLO Tank Farm Surface Evaluation, Restoration and Remediation Team (SERRT) could be most useful by providing information on the type, timing, and phasing of remediation alternatives in developable areas. Bill indicated that he will be dealing with the Brownfield elements of the project. They are currently, compiling a list of stakeholders and will be conducting stakeholder interviews. It was agreed that close coordination between the two activities was critical.

Melissa Boggs-Blalack asked if Unocal anticipated any significant changes in the areas designated as developable. Rick Rittenberg said that the he did not believe that Unocal anticipated any major changes from what was currently proposed. Participants agreed that the baseline assumptions would be based on the proposed land use designations presented in the Airport Specific Plan.

Proposed Mission Statement

Drafted by Strategic Initiatives based on the July 12, 2002 meeting of the SERRT. Reviewed, revised, and ratified at the SERRT meeting on October 4, 2002.

A draft mission statement drafted by Diane Kukol was distributed for discussion. The participants agreed that the collaborative activity would be called the "SLO Tank Farm Surface Evaluation, Remediation and Restoration Team (SERRT)." After significant discussion, the group agreed to the following mission statement.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Mission Statement

Given the current open space land use and various future land uses proposed for the SLO Tank Farm, the mission of the SLO Tank Farm Surface Evaluation, Remediation and Restoration Team (SERRT) is to cooperatively:

1. Evaluate potential impacts to human health, the environment, and water quality from existing on-site surface and near-surface petroleum related contamination related to tank farm operations,
2. Develop decision criteria and use these criteria to identify areas on the SLO Tank Farm that need surface remediation/restoration,
3. Evaluate appropriate surface remediation/restoration options where the impacts are determined to be unacceptable, and
4. Achieve multi-agency agreement on end points for surface remediation/restoration options.

<u>Future Work Tasks</u>

Define Baseline Information

Mike Rendina, Chuck Lambert & Bob Haddad will prepare presentations for the next meeting.

Identify all studies/documents that have been generated, including what agencies have reviewed or approved the documents. The following people will prepare a presentation for the next meeting. (They will also prepare a written report for documentation purposes.)

Mike Rendina - Surface contamination information

Chuck Lambert - Human health information

Bob Haddad - Ecological information

Mike Rendina & Rick Rittenberg will prepare an index of key information for project library.

Mike Rendina and Rick Rittenberg will compile an index of all key information for a project library.

Identify Data Gaps

Data gaps will be identified based on information presented at the next meeting. The data gaps and potential Data Quality Objectives would then be discussed at the 3rd meeting of the SERRT.

Diane Kukol will organize issues into Mission Statement

Organize Critical Issues in Context of Mission Statement

Diane Kukol agreed to organize the critical issues identified at the first meeting into the specific elements of the mission statement.

Future Meeting Schedule

It was agreed that future meetings of the SERRT will be scheduled on the first Wednesday of every month with the exception of the meeting for October which will be on Friday October 4th. Meetings will be from 9:30 AM to 2:30 PM. Diane will check on the availability of the RWQCB on August 7th and October 4th.

Steve Reiner asked when the group anticipated completing its work. The group estimated about one year based on the experience with the Avila Pier project.

Drafted by Strategic Initiatives based on the August 7, 2002 meeting of the SERRT. Reviewed and ratified at the SERRT meeting on October 4, 2002.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Draft Meeting Summary

Date: Tuesday August 7, 2002

Time: 9:30 AM – 2:30 PM

Location: Unocal Conference Room
276 Tank Farm Road
San Luis Obispo, CA

Participants:

Name	Organization	Name	Organization
Bill Almas	Unocal	Chuck Lambert	Lambert Daniels
Chuck Anders	Strategic Initiatives	John Ljung	Unocal
Melissa Boggs-Blalack	CDFG	Jeff Poel	Environmental Health
Bob Haddad	AGS	Steve Reiner	MIG
Neil Havlik	City of SLO	Mike Rendina	England Geosystem
Diane Kukol	RWQCB	Rick Rittenberg	Cannon Associates

Introductions and Review of Previous Meeting Summary

The meeting summary of July 12, 2002 meeting was reviewed and discussed. John Ljung raised the question about whether draft summaries of detailed technical presentations should be included in the meeting summaries. After discussion, it was agreed that summaries of technical presentations should be included in the meeting summaries. In order to make sure the meeting summaries accurately reflect the technical issues, the presenters will provide Chuck Anders with a brief summary of their presentations to be included in the meeting summary. Chuck will then integrate any pertinent comments or group discussion into the presentation summary. Presenters will also provide an electronic copy of their full presentation to all of the members of the SERRT.

Chuck Anders will distribute a draft of the meeting summary to the SERRT within approximately one week of the meeting. Comments and suggested revisions will be provided to Chuck within the following week. Chuck will then distribute the revised meeting summary to the SERRT at least one week prior to the next meeting at which time the meeting summary will be reviewed, revised, and approved.

Mike Rendina will provide Chuck Anders with a revised discussion of his technical presentation in the May 24, 2002 draft meeting summary. Chuck will then

redistribute the revised meeting summary for the May 24th meeting and it will be reviewed and approved at the next SERRT meeting on September 4, 2002.

Update on Status of Land Use Activities

Neil Havlik indicated that the City is committed to moving the Airport Area Specific Plan through the process. They anticipate City Council action on the plan in late spring of next year.

Steve Reiner said that MIG will begin interviewing stakeholders in September and should conclude by early October. Comments from stakeholders will provide insight into the range of issues and concerns.

Steve requested that the SERRT focus on those areas that are targeted for development in addition to other areas that contain the more severe contamination. This would be useful when MIG develops conceptual or prototype plans. Diane Kukol indicated that the SERRT has not ranked the areas that will be addressed. She wants to see these areas prioritized as early as practical. It was agreed that it is important to prioritize the areas that the SERRT will address, including the developable areas.

Review Critical Issues in Context of the Mission Statement

Diane Kukol distributed two documents that organized the critical issues within the objectives of the mission statement. She emphasized that it is important to maintain the list of issues to make sure they are all addressed. It was agreed to review the issues at least quarterly to be sure that all of the critical issues are being addressed.

Define Baseline Information/Data Gaps

Mike Rendina, Chuck Lambert and Bob Haddad reviewed selected studies and data that have been prepared for the SLO Tank Farm. They also distributed a brief summary of the information they consider pertinent.

Surface Contamination Information – Mike Rendina

Mike Rendina passed out a list of selected references for the San Luis Obispo tank farm. He indicated that the list reflects the principal studies that have been performed on or adjacent to the site. A few pertinent references, including England & Associates April 1999 Additional Site Characterization, the document from which most of today's shallow soil information was derived, were described.

Mike Rendina then presented the results of shallow soil characterization work performed at the San Luis Obispo tank farm. For context and continuity, the presentation included a brief overview of the site history and operations. It was pointed out to the group that topographic modifications associated with the site's former use have resulted in the creation of numerous closed depressions that accumulate water and about 70 acres have been delineated (federal) jurisdictional wetlands. The group was informed that the list of selected references included three documents pertaining specifically to wetland jurisdiction: the ACOE's 1994 delineation of the northern half of the tank farm, EDAW's 1999 delineation of the entire site, and Ted Winfield & Associates' 2001 redelineation based on recent court rulings.

Prior to 1997-1998, assessment work at the SLO tank farm focused on characterizing the nature and extent of petroleum in the subsurface (soil and ground water). Less attention was focused on shallow soil. As a result of conversations with Chuck Lambert, a scope of work was developed that focused specifically on shallow soil (upper 6-inches) and the surficial petroleum exposures. The scope of work included the collection and testing of 100 shallow soil and 24 surface petroleum samples from locations throughout the tank farm. Particular attention (i.e., a more dense sampling grid and more diverse suite of analytes) was paid to former operations areas in the vicinity of the current offices and the northwest parts of the site.

Approximately 80 shallow soil and 24 surface tar samples were tested for TPH/BTEX. Tables presenting statistical summaries of TPH and BTEX data for shallow soil and tar samples were presented. The results indicate that the shallow soil locally contains significantly elevated TPH concentrations, but BTEX is notably absent from both the shallow soil and surface tar. The TPH in the surface tar is comprised of higher molecular weight hydrocarbons than the TPH in shallow soil. Twenty-seven shallow soil and 18 surface tar samples were tested for polynuclear aromatic hydrocarbons (PAHs). Two tables presenting statistical summaries of six of the most commonly detected PAHs in shallow soil and surficial tar were presented. The results indicated that PAH concentrations were generally low in soil, but may be locally elevated in some of the surface tar exposures. Bob observed that the heavier molecular weight PAHs were the compounds detected, which tends to indicate more potential for human, rather than ecological, risk.

Eighty-five shallow soil and 18 surface tar samples were tested for the 17 CAM metals. Two tables presenting statistical summaries of six of the most commonly detected metals in shallow soil and surficial tar were presented. It was reported that chromium and nickel concentrations in the area are elevated relative to other parts of California as a likely result of the serpentinite bedrock. Arsenic and lead were detected in shallow soil at concentrations believed to be above background. The arsenic, which was primarily detected in former operations areas of the site, was attributed to possible former use of herbicides and/or pesticides. The lead, which was primarily detected surrounding the former ASTs, was attributed to lead-based paint. Tar samples have lower metals concentrations relative to the soils, which are derived from the geology of the area.

Twenty-three shallow soil samples were recently tested for herbicides and pesticides (Earth Systems Pacific, 2002). The samples were collected from biased (locations selected based on former operations) and unbiased (random) locations. Neither pesticides nor herbicides were detected in any of the samples.

Thirty-eight shallow soil samples collected from the former operations areas (including areas surrounding former electrical equipment) were tested for polychlorinated biphenyls (PCBs). Aroclor 1254, one of the PCB isomers, was detected in six samples at concentrations ranging from 0.03 to 0.09 mg/kg. Samples from the same 38 locations, but collected from depths of 2.5 feet (as opposed to 6-inches), were tested for volatile organic compounds (VOCs). Low concentrations (less than 0.1 mg/kg) of eight petroleum-related compounds were detected in seven soil samples.

Human Health Information – Chuck Lambert

Chuck Lambert reviewed the findings of three human health risk assessments (HHRAs) conducted for the San Luis Obispo Tank Farm from 1991 through 1999. The purpose of the three HHRA studies was to assess what health impacts the remaining hydrocarbon contamination may have on current and future onsite and offsite receptors. The risk assessments investigated the most likely human uses of the Site and the potential for exposure to contaminants under current and some potential future conditions.

The 1991 HHRA completed by Envirologic Data was a state-of-the-art assessment for its day. However, given the significant developments that occurred in the early to mid 90's in the field of risk assessment, as well as changes in the regulatory guidelines and detection limits, this assessment would not be acceptable today. It is also limited by the fact that it is not a forward risk assessment and does not calculate risk but instead works backwards from clean-up levels to determine if the site is safe. This HHRA looked at current on-and offsite users, as well as future onsite users. The overall conclusion was that onsite chemical concentrations are generally below Public Health Criteria for benzene and TPH (metals weren't addressed), except where free phase hydrocarbons are present at the soil surface. In addition, modeling suggested that migration of PAHs into groundwater was not likely.

The 1996 HHRA was completed by ERM-West under the guidance of a technical oversight committee that included the Cal/EPA DTSC, the CCRWQCB, and SLO County Environmental Health. The HHRA addressed current on- and offsite users. Although the oversight committee concluded that no unacceptable levels of risk for current uses were associated with the Site, a final version of the document was never completed or approved.

The 1999 HHRA completed by England & Associates followed a similar protocol to the 1996 ERM-West HHRA. The study used the same exposure parameters, but included additional sampling data and chemicals of potential concern (COPCs), as well as lower limits of detection for previously investigated COPCs. The study also concluded that no unacceptable levels of risk were associated with current uses of the Site.

The small difference in calculated risk between the 1996 ERM-West and 1999 England documents is mostly due to the increase in the number of COPCs in the 1999 HHRA. This had the effect of increasing the risk for the onsite workers and offsite child residents.

It is unlikely that the results obtained from the two previous HHRAs would be greatly different from studies addressing current conditions conducted today. Although, the methodology for calculating the risk from TPH has changed since the 1999 HHRA, it is not likely that these changes would significantly change the results of a current conditions scenario. However, in light of proposed land use changes, a HHRA may need to be conducted to accommodate different exposure scenarios and to determine if risks to the new receptors would exceed safe levels.

Depending on future site uses there may be a need for health protective and exposure scenario-specific TPH remediation goals.

Ecological Information – Bob Haddad

For internal planning purposes, Unocal conducted a preliminary ecological analysis in order to assess a limited subset of potential ecological issues at the San Luis Obispo Tank Farm. This analysis was not intended as a screening risk assessment, but rather used elements of a screening risk assessment to quickly evaluate potential ecological issues that might be associated with surface soils at the SLO Tank Farm.

Toward this end, the specific objective of this work was to provide some indication of potential ecological concerns associated with the surface soils at the Site. Surface soils (upper 0-0.5 ft below ground surface [bgs]) were selected as the focus of this evaluation because little was known about potential ecological risk associated with the surface soils, they represent the primary exposure media for most terrestrial organisms, they are relatively straight-forward to evaluate, and the surface soils at the Site have been characterized (England & Associates, 1999). The work used available Site data (collected during the past several years as part of the long-term ongoing assessment work for the RWQCB) and recently presented to the SERRT by Mike Rendina. No new or additional data were generated or available for this analysis. Thus, because sampling for ecological assessment has not previously been systematically performed at this Site, this analysis considered only ecological concerns arising from available surface soil samples collected from 0-0.5 ft below ground surface (bgs).

Potential ecological issues were not considered in this evaluation if:

- Sufficient site-specific data was not available to reasonably address a given issue (e.g., surface water, soils between 0.5 and 5 ft depth bgs);
- Standard “straight-forward” approaches could not be used to address a given issue (e.g., surface petroleum); or
- Toxicological criteria/benchmarks were not available to evaluate a given chemical (e.g., contact toxicity for PAHs).

To test the assumption that certain surface soils (with the exception of areas of petroleum surface expression) at the Site pose no unacceptable risk to plants and animals:

1. The existing Site surface soil data were reviewed and metals and polycyclic aromatic hydrocarbons (PAHs) were identified as compounds of potential ecological concern (COPECs);
2. Metals were subjected to a regional and local background screening process;
3. Standard screening-level ecological risk assessment approaches were then adapted and applied to evaluate potential contact exposure of plants and soil-dwelling animals (e.g., invertebrates); and

4. Potential food web exposure of higher trophic-level organisms (e.g., birds and mammals) was examined based on contaminants present in Site surface soils.

Two tiers of conservative food web screening levels were developed. Tier 1 screening values were developed using the most conservative contaminant uptake assumptions and toxicity reference values and Tier 2 screening levels were developed using less conservative uptake assumptions. However, both tiers are considered to be conservative and appropriate for use in a screening level assessment.

Maps illustrating the locations of surface petroleum expression, all surface soil sample locations evaluated (both the soils and the tar samples collected from the surface), and the locations of those surface soil samples that pose no unacceptable risk to plants or animals (as a function of exposure to (1) contact screening values for metals and (2) Tier 1 and Tier 2 food web screening values for metals and PAHs) were presented.

Based on this limited evaluation conducted, Unocal generally concluded:

1. Most of the surface soils at the Site (with the exception of areas of surface petroleum expression) pose no substantial risk to ecological receptors;
2. The areas where risk could not be ruled out and additional evaluation would be required to do so were primarily:
    - In the northwest portion of the Site, which is the historical operations area, where further evaluation will be required to evaluate arsenic, copper, and lead concentrations in terms of contact toxicity only;
    - The northwest marsh area where risk was ruled out for food web related risk from metal and PAHs will require further evaluation for metals contact toxicity only; and
    - Few isolated locations across the Site may require further evaluation to rule out ecological risk for PAH and metal concentrations.

However, as indicated above, this work was conducted for internal planning purposes and to obtain a quick look at where risk assessment will need to be focused. Unocal fully anticipates that a robust ecological risk assessment will be conducted as part of the facilitated process and is not suggesting that this analysis be substituted for any portion of such an assessment, merely used as a qualitative guide to understanding the conditions at the Site. Unocal assumes that in developing and following Data Quality Objectives for the proposed ERA, the ERA may cover the same ground as was covered in this planning evaluation, and more.

England & Associates. 1999. *Additional Site Characterization: Unocal San Luis Obispo Tank Farm*, Volume 1. Prepared for Unocal Corporation.

<u>Potential Data Gaps</u>

The meeting participants discussed what land use should be used as a basis for the risk assessments. It was suggested that the land uses proposed in the specific plan

document would be a good starting point. For open spaces, the City anticipates conservation as the primary land use as opposed to recreational uses such as a golf course or a park. The MIG stakeholder process, which should be concluded by early October, should identify any land use preferences that might be different from the specific plan.

Neil Havlik said that the airport land use restrictions preclude residential use on the property. The Airport has stated that the existing wetland/wildlife conditions are acceptable. They may be resistant to large scale wetlands outside of the site because of the attraction of birds into the aircraft flight paths. The City anticipates some on-site mitigation of wetlands on a one to one basis.

Neil Havlik sees the endpoint of the risk assessment as a map indicating where remediation is required or desired.

It was agreed that the baseline land use for designated open spaces would remain open spaces for the ecological risk assessment and unlimited recreational access for the human health risk assessment. Developable areas would be assessed based on a commercial/industrial use designation.

Melissa Boggs-Blalack requested that an eco-toxicologists be part of the SERRT. Bob Haddad and Melissa Boggs-Blalack will identify some candidate eco-toxicologists for the agencies to consider.

Bob Haddad will prepare draft data quality objectives (DQOs) for review at the next SERRT meeting. Diane Kukol will make arrangements to acquire toxicological review of existing and possible future HHRAs.

Unocal will explore obtaining a consultant to prepare a wetlands delineation following the State definition of a wetland (vs. USACOE).

Next Steps and Action Items

- Mike Rendina will provide Chuck Anders with a revised discussion of his technical presentation in the June 17, 2002 draft meeting summary.
- Bob Haddad will prepare draft data quality objectives for review at the next SERRT meeting.
- Melissa Boggs-Blalack and Bob Haddad will identify candidate eco-toxicologists for the agencies to consider.
- Jeff Poel and Chuck Lambert will identify toxicologists for agencies to consider regarding existing and possible future HHRAs.
- Rick Rittenberg will obtain a consultant to conduct a State a wetlands delineation.

Drafted by Strategic Initiatives based on the August 7, 2002 meeting of the SERRT. Reviewed and ratified at the SERRT meeting on October 4, 2002.

Upcoming Meetings

September 4, 2002	9:30 AM – 2:30 PM
October 4, 2002	9:30 AM – 2:30 PM
November 6, 2002	9:30 AM – 2:30 PM
December 4, 2002	9:30 AM – 2:30 PM

Drafted by Strategic Initiatives based on the September 4, 2002 meeting of the SERRT. Reviewed, revised, and ratified at the SERRT meeting on October 4, 2002.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Draft Meeting Summary

Date: Wednesday September 4, 2002

Time: 9:30 AM – 2:30 PM

Location: Regional Water Quality Control Board
San Luis Obispo, CA

Participants:

Name	Organization	Name	Organization
Bill Almas	Unocal	Bill Owens	William Owens & Associates
Chuck Anders	Strategic Initiatives	Harvey Packard	RWQCB
Melissa Boggs-Blalack	CDFG	Jeff Poel	Environmental Health
Bob Haddad	AGS	Steve Reiner	MIG
Neil Havlik	City of SLO	Mike Rendina	England Geosystem
Diane Kukol	RWQCB	Rick Rittenberg	Cannon Associates
Chuck Lambert	Lambert Daniels	Heather Tomley	APCD
John Ljung	Unocal		

Note: References to Action Items in the text are underlined and in italics

Introductions and Review of Previous Meeting Summary

The meeting summary for the 8/7/02 SERRT meeting was reviewed, revised and approved pending the review and approval at the next SERRT meeting of Bob Haddad's summary of his presentation on past ecological risk assessments.

The meeting summary for the 7/12/02 meeting will also be approved at the next SERRT meeting pending the review and approval of Mike Rendina's summary of his presentation on past surface and groundwater hydrology at the SLO Tank Farm.

Wetlands Discussion

Rick Rittenberg indicated that consultant Jenny Langford will prepare a scope of work for State wetlands delineation by Nov. 6, 2002. Members of the SERRT will review the scope. Actual delineation would likely be conducted during the first quarter of 2003.

Melissa Boggs-Blalack briefly explained the differences between the State and Federal wetlands designation. Under the federal definition, a wetland needs to have a specific soil type, hydrology, and specific vegetation and needs to meet all 3 criteria verses the state definition of a wetland where only one of those 3 criteria need to be met to be considered a

wetland. Therefore, the state defined wetlands are usually larger than the federally defined areas.

With respect to distinguishing between State and Federal wetlands designation, Bob Haddad said that text was written to define the wetlands determination process in a recent Guadalupe Oil Field document. Chuck Anders agreed to consult with Melody Kreimes regarding the availability of this text for distribution to the SERRT.

Neil Havlick recommended that maps be generated for all SERRT members that depicted State, Federal, and isolated wetlands. Rick Rittenberg agreed to provide Chuck Anders a copy of the Federal and isolated depictions from the Ted Winfield work by 9/4/02; the State depiction will be distributed after Jenny Langford's effort is completed. Chuck will distribute the maps to the SERRT.

Status of the Specific Plan and EIR Process

Unocal has requested suspension of the annexation process for 90 days to review technical issues. Unocal asked that any public hearings be postponed so that their concerns can be addressed prior to the public meetings. It is not likely that annexation will come before the City Council until after the first of the year.

MIG is on track with their process. They are poised to begin stakeholder interviews and are scoping alternative industrial/commercial uses. The delay will also allow MIG to implement their scoping process before the City takes action.

It was reaffirmed that the proposed site uses in the Airport Specific Plan will be the basis for the human health and eco risk assessment.

Human Health Risk Assessment and Potential Consultants

Jeff Poel and Chuck Lambert summarized the human health risk assessment, HHRA, process. The risk assessment would most likely focus on TPH and metals. They felt that it would be useful to take advantage of a similar approach being implemented at the Guadalupe Oil Field. *Chuck Lambert and Jeff Poel will prepare a draft human health risk assessment scope of services for review at the next SERRT meeting.* A Human Health Risk Assessment Working Group will be formed which includes Chuck Lambert, Jeff Poel, Gary Willey/Heather Tomley.

The RWQCB discussed the alternatives for obtaining DTSC and OEHHA toxicologist to review the HHRA. Diane Kukol called Steve DiZio with DTSC, who was involved with the review of the 1996 Health Risk Assessment by ERM-West, Inc, to see if he would be interested in participating in the HHRA review process. He said that he would be willing to participate. This would require an agreement between DTSC and Unocal. Jim Carlisle with OEHHA has been involved with the Guadalupe project and is familiar with that process.

Chuck Lambert recommended that the HHRA be current and up to date rather than being an update of previous studies. Diane agreed with Chuck's recommendation. She suggested that Chuck Lambert conduct the risk assessment and Jim Carlisle would possibly review it and present the results to the public during a public meeting. *Once the Human Health Risk Assessment Working Group prepares the draft scope of work, the RWQCB will talk with Jim Carlisle regarding his availability to review the HHRA.* If Jim is not available, the agencies will then consider either other OEHHA reviewers or a DTSC reviewer.

Bill Almas asked whether the risk assessment would consider buildings on areas where there was contaminated groundwater. Chuck Lambert said that it would be helpful to identify the types of buildings and the type of planned construction. Chuck explained that the RA would be much less

complex if a residential scenario is not included. Unocal said that there are no residencies planned near or adjacent to the tank farm.

Eco Risk Assessment and Potential Consultants

Melissa Boggs-Blalack and Bob Haddad distributed and reviewed the Statement of Qualifications, SOQs, received from Tetra Tech, BBL-Science and SOMA. They reviewed the potential firms based on a number of criteria and recommended selecting two firms to make presentations to the SERRT at the November meeting. References and other information will be checked and the two firms will be selected at the October SERRT meeting. *Melissa will check on experiences with the candidate firms within CDFG and Bob will check references and project experience.*

It was agreed that the Eco Working Group would prepare a draft scope of work for review at the next SERRT meeting with consultant presentations scheduled for the November meeting. The eco working group would consist of Melissa Boggs-Blalack, Bob Haddad, Neil Havlik and Regina Donahoe. It was agreed that the eco risk assessment will evaluate currently proposed land uses based on the Airport Area Specific Plan and proposed remedial alternatives. It should also identify safe soil concentrations.

Data Quality Objectives (DQOs)

Bob Haddad reviewed his August 28th memo discussing the DQO procedures. Bob identified three distinct processes; remediation, eco risk and human health risk. It is anticipated that development of DQOs would be the first step of the ecological and human health risk assessment so we don't find ourselves a year from now wondering why we didn't collect necessary data. It was also felt that the Corps of Engineers should be part of the DQO and project planning process to assure that identified remediation alternatives can be implemented. The SERRT will be the coordination and integration mechanism.

Unocal indicated that they anticipate conducting remediation activities at tank bottoms 5 and 7; therefore, it may not be necessary to conduct risk assessments of these areas in their present condition. It is anticipated that remediation criteria (pathways, concentrations, etc.) would be submitted to a remediation team and they would determine if a remediation strategy could be designed that would meet the criteria. After remediation, validation monitoring and sampling would be conducted.

A question was raised regarding whether there was adequate area on-site to mitigate wetland impacts caused by remediation of existing contamination. A previous wetlands feasibility study concluded that there was not enough area to mitigate the impacts of remediating existing contamination on-site assuming that no new wetlands would be created over contaminated areas. The study did not consider creating wetlands on lands once they were remediated.

Neil Havlik emphasized the importance of maintaining an area as a wetland after remediation, as opposed to remediation that results in an area no longer being a wetland. *Bill Almas suggested that Unocal request a pre-application meeting with the Corps of Engineers to discuss remediation of Tank bottoms 5 and 7.*

Project Library

It was agreed that it would be useful to have key documents available on-line in electronic format. *The SERRT members will identify documents that they would like to have available on-line before the next meeting. Chuck Anders will arrange for a project web site and work with Rick Rittenberg and Mike Rendina to upload requested documents to the web site by the October SERRT meeting.* A demonstration of the web site will be provided at the October meeting.

Drafted by Strategic Initiatives based on the September 4, 2002 meeting of the SERRT. Reviewed, revised, and ratified at the SERRT meeting on October 4, 2002.

Next Steps and Action Items

- Rick Rittenberg will provide Chuck Anders with an electronic version of the current federal and isolated wetlands delineation map by 9/4. Chuck will distribute the map to the SERRT.
- Chuck Lambert and Jeff Poel will prepare a draft human health risk assessment scope of services for review at the next SERRT meeting.
- The RWQCB will contact Jim Carlisle to determine his availability to review the HHRA based on the level of effort in the draft HHRA scope of work.
- The Eco Working Group will prepare a draft eco risk assessment scope of work for review at the next SERRT meeting.
- Melissa Boggs-Blalack will check on experiences with the candidate ERA firms within CDFG and Bob Haddad will check references and project experience.
- Bill Almas will request a pre-application meeting with the Corps of Engineers to discuss remediation of Tank bottoms 5 and 7. He will bring the proposal to the next SERRT meeting.
- The SERRT members will identify documents that they would like to have available on-line by 9/18.
- Chuck Anders will arrange for a project web site and work with Rick Rittenberg and Mike Rendina to upload requested documents to the web site by the October SERRT meeting.

Upcoming Meeting Dates and Agenda Items

- ***October 4, 2002 9:30 AM – 2:30 PM***
- ***November 6, 2002 9:30 AM – 2:30 PM***
- ***December 4, 2002 9:30 AM – 2:30 PM***

Drafted by Strategic Initiatives based on the January 8, 2003 meeting of the SERRT. Reviewed, revised, and ratified at the meeting on March 11, 2003.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Meeting Summary

Date: Wednesday January 8, 2003

Time: 9:30 AM – 2:30 PM

Location: Unocal San Luis Obispo Tank Farm Offices

Participants:

Name	Organization	Name	Organization
Bill Almas	Unocal	Jennifer Holder	BBL
Chuck Anders	Strategic Initiatives	Diane Kukol	RWQCB
Bonner Anthony	BBL	Chuck Lambert	Lambert Daniels
Melissa Boggs-Blalack	CDFG	John Ljung	Unocal
Rebecca Countway	BBL	Jeff Poel	Environmental Health
Regina Donohoe	CDFG	Mike Rendina	England Geosystem
Bob Haddad	AGS	Rick Rittenberg	Cannon Associates
Neil Havlik	City of SLO	Gary Willey	APCD

Introductions

The SERRT welcomed Jennifer Holder, Bonner Anthony and Rebecca Countway with BBL to the group. Chuck Anders briefly reviewed the SERRT mission statement and process for the new BBL participants.

Diane Kukol announced that there will be a permit workshop offered by the US Army COE on January 14th at the RWQCB offices. She encouraged anyone who was interested in participating to sign up soon.

Participants approved the November 12, 2002 meeting notes.

Status of the Specific Plan and EIR Process

Neil Havlik reviewed the history of the proposed annexation of the airport area and the Margarita area. The City has prepared separate specific plans for the airport area and the Margarita area and has combined the EIR for both areas. He anticipates the specific plans and draft EIR to be addressed during the first quarter of 2003. The City has been working with Unocal on the detail of the Airport area specific plan and is waiting on a response from Unocal. The City may separate the two areas into separate EIR's so that the Margarita area can move forward. The City views this as a cooperative process and intends to move forward in a cooperative vein with Unocal.

Bill Almas emphasized that this in an ongoing process and that as decisions are made with the City conditions might change regarding land characteristics, such as, the availability of

off-site water that could affect the wetlands; therefore, we may have to make adjustments. Unocal mentioned that the option of a golf course is a possibility. Regarding infrastructure negotiations between the City and Unocal, Unocal hopes to have a decision by the end of January.

In discussing a golf course and wetland creation, Melissa Boggs-Blalack emphasized that we can't create the type of wetlands that would attract birds because of the airport operational requirements. Diane Kukol expressed concern regarding the RWQCB's ability to approve a golf course land use. We discussed areas where there is free phase surface expression in the wetlands we are assuming those areas will be remediated.

Regina Donohoe emphasized the importance of involving the US Corps of Engineers (COE) in the ecological working group. She suggested that the COE be invited to a working group meeting, even if we have to hold the meeting in Ventura. Bob Haddad suggested having a COE permit specialist participate in the SERRT and interface with the COE periodically. Bill Almas suggested that it may be premature to include a permit specialist in the SERRT until the risk assessments are further developed.

Status of the Stakeholder Interviews and Community Planning Process

Bill Almas indicated that Unocal continues to meet with the City and Margarita land owners. MIG activities are on hold for the time being and there is no ongoing stakeholder process at this time. There is no need to include this agenda item in the future; however, continue to copy MIG on meeting activities.

Human Health Risk Assessment Workplan

Chuck Lambert reviewed the Draft Human Health Risk Assessment Workplan. Chuck indicated that he spoke with Jim Carlisle (OEHHA) and he is available to participate in the development of the risk assessment.

With respect to exposure routes, participants discussed separating tar observed on the surface into the following categories (per England Geosystem's characterization): Solid (asphalt-like), Pliable tar with no evidence of plastic flow, Pliable tar with evidence of plastic flow, and liquid crude oil.

With respect to the conceptual model, it was also agreed to include an additional pathway between surface soil and surface water. Surface tar will also be added as a medium. In addition, all agreed that Jim Carlisle will need to provide input regarding the inclusion of the offsite resident as a receptor.

It is important that the Human Health Working Group and the Ecological Risk Working Group discuss the methodology (carbon fraction or surrogate) to derive protective levels and determine if additional data are required. Mike Rendina indicated that limited subsurface fraction data were collected as part of the RTP data gap assessment and are available for reservoir seven that was collected as part of the RTP data gap assessment. It was also observed that there is no fraction data for surface tar.

The Human Health Risk Assessment Workplan will be ratified at the next SERRT meeting. Chuck Lambert will get comments from Jim Carlisle and Heather Tomley (APCD) and will prepare a revised draft for distribution prior to the next SERRT meeting.

Action Items:

Drafted by Strategic Initiatives based on the January 8, 2003 meeting of the SERRT. Reviewed, revised, and ratified at the meeting on March 11, 2003.

1. *The Human Health Working Group and the Ecological Risk Working Group will discuss the methodology to derive health-based protective TPH levels (and possibly those for other COPECs) and determine if additional data are required.*
2. Chuck Lambert will obtain comments from Jim Carlisle and Heather Tomley and prepare a revised draft of the Human Health Risk Assessment Workplan for distribution to the SERRT by February 3rd.

Species to be Surveyed during the Winter Months

Melissa Boggs-Blalack reviewed the list of species to be surveyed this winter. Melissa reviewed comments she received from Lisa Mangione from the Corps of Engineers (COE). She will also follow up with Steve Henry of the US Fish & Wildlife Service. Jennifer Holder asked whether a presence/absence or abundance survey should be conducted. Neil Havlik said that the City typically does a reconnaissance level survey that identifies the presence or the potential presence of species of concern. A detailed abundance survey would be useful for future permits that may be required.. It was agreed to conduct a presence/absence assessment this winter for the species listed in Melissa's 10/31/02 memo and Unocal can decide it they want to conduct more detailed abundance surveys.

Neil Havlik informed the group that the Morro Shoulderband Snail has been observed near and in SLO and suggested adding this species to the list. It was agreed to include Morro Shoulderband Snail and egg masses for red legged frog in the winter species survey.

Action Items:

1. *Melissa Boggs-Blalack will follow up with Steve Henry for comments on the list of species by 1/10/03*
2. *Bob Haddad will prepare a scope of work for the sensitive species surveys and circulate the draft to the ERWG for approval by 1/13/03.*
3. *Unocal will contract to conduct a presence/absence species survey this winter. They may choose to do a more detailed survey if it would be useful to the permitting process.*
4. *Melissa Boggs-Blalack and Neil Havlik will review the necessity for vegetation survey by April 2003.*

Ecological Risk Assessment

Jennifer Holder with BBL presented the overall objectives of the ecological risk assessment. She indicated that the schedule is controlled by the potential need to conduct wet season sampling in the last week of March. It is critical that the Ecological Risk Working Group and Chuck Lambert are available to prepare the DQOs during the first quarter of the year. The participants indicated their willingness to make time available to meet the schedule requirements.

Regina Donohoe indicated the importance of having large maps for the working group meetings. Mike Rendina indicated that all maps are included on the reports that are available online. It was agreed that Bob Haddad will prepare a list of maps that would be useful to have at the working group meetings. Mike Rendina will print the maps and provide them to Jennifer Holder, Bob Haddad, Chuck Lambert, Melissa Boggs-Blalack, Regina Donohoe, Diane Kukol, Neil Havlik and Rick Rittenberg.

Jennifer Holder indicated that BBL has agreed to use the web site included in their proposal as a project web site. The site can be accessed by inputting the email address as the user name and password. You will then be prompted to provide a different password. Jennifer briefly reviewed elements of the project web. She would like to include access to the

integrated data base on the web site. The site also has mapping capabilities, if desired. Jennifer, Chuck Anders and Mike Rendina will discuss integrating the database into the web site.

The ERWG and the HHWG agreed to meet on the following schedule:

1/28/03 – Meet at SLO Tank Farm from 9:30 AM – 5:00 PM to discuss DQOs (Contingent on availability of Jim Carlisle.)

2/10/03 - Meeting at SLO Tank Farm from 9:30 AM – 3:00 PM (Contingent on the availability of Jim Carlisle - SERRT meeting scheduled from 3:00 PM – 5:00 PM)

2/24/03 - Meeting at SLO Tank Farm at 9:30 AM – 5:00 PM.

Action Items:

1. *Jennifer Holder, Mike Rendina and Chuck Anders will discuss integrating the database into the project web site.*
2. *Bob Haddad will prepare a list of maps that would be useful to have at the working group meetings by 1/10/03.*
3. *Mike Rendina will print the maps (D size) and provide them to Jennifer Holder, Bob Haddad, Chuck Lambert, Melissa Boggs-Blalack, Regina Donohoe, Diane Kukol, Neil Havlik and Rick Rittenberg one day after receiving list.*
4. *Jennifer Holder and Chuck Lambert will include a comprehensive list of references on the project web site.*
5. *Jennifer Holder will provide strawman draft DQO document by 1/22/03*

Review List of Critical Issues

The SERRT conducted its quarterly review of the critical issues to be addressed during the SERRT process. Chuck Anders reviewed the list of critical issues. The participants agreed to include “the relationship of remediated open space on developed land use” as an additional issue of concern.

State Wetlands Delineation Statement of Work

Rick Rittenberg reviewed the proposal from Jennifer Langford to conduct a state wetlands delineation survey. The SERRT reviewed the proposal and recommended that Rick finalize the contract with Ms. Langford.

Action Item:

1. *Rick Rittenberg will contract with Jennifer Langford to conduct a state wetland delineation survey.*

Site Tour of the SLO Tank Farm

After the SERRT meeting was adjourned, the SERRT members participated in a site tour of the SLO Tank Farm. The tour was lead by John Ljung and Bob Haddad.

Upcoming Meeting Dates and Agenda Items

(Monthly SERRT meetings will be scheduled the second Wednesday of each month unless otherwise noted.)

- ***Tuesday January 28, 2003 - HHWG and ERWG Meeting from 9:30 AM – 5:00 PM at Unocal Tank Farm***
    - *Discuss DQOs*

- ***Monday February 10, 2003 - HHWG and ERWG Meeting from 9:30 AM – 3:00 PM at Unocal Tank Farm***

- ***Monday February 10, 2003 - SERRT Meeting from 3:00 PM – 5:00 PM at Unocal Tank Farm***
    - *Review and approve meeting summaries from January 8th SERRT meeting.*
    - *Finalize human health risk assessment workplan (Chuck Lambert will distribute a draft prior to the meeting.)*
    - *Review DQOs.*

- ***Monday February 24, 2003 - HHWG and ERWG Meeting from 9:30 AM – 5:00 PM at Unocal Tank Farm***

Drafted by BBL, Inc. based on the January 28, 2003 meeting of the Ecological Risk Working Group of the SERRT. To be ratified at the meeting on February 24, 2003

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team – Ecological Risk Working Group

Final Meeting Summary

Date: Tuesday January 28, 2003

Time: 9:30 AM – 5:00 PM

Location: UNOCAL San Luis Obispo Tank Farm Site

Participants:

Name	Organization	Name	Organization
Bill Almas	UNOCAL	Jennifer Holder	BBL, Inc.
Bonner Anthony	BBL, Inc.	Diane Kukol	RWQCB
Melissa Boggs-Blalack	CDFG	Chuck Lambert	McDaniel Lambert, Inc.
Regina Donohoe	CDFG	John Ljung	Unocal
Bob Haddad	AGS	Mike Rendina	England Geosystem
Neil Havlik	City of SLO	Rick Rittenberg	Cannon Associates

Meeting Summary:

The agenda for the meeting included the following topics:

1. Introduction
2. Project Update
3. Identification of habitats potentially at risk
4. Selection of constituents of potential ecological concern (COPECs)
5. Exposure pathway analysis and development of a conceptual site model (CSM)
6. Development of problem statement and risk questions
7. Identification of assessment endpoints (AEs)
8. Identification of measurement endpoints (MEs) and receptors of concern.

1. <u>Introduction</u>

Jennifer Holder started the meeting by reiterating that everyone needs to be comfortable with all the decisions that are made. While we do have a rigorous schedule, everyone should feel free to slow things down if they aren't comfortable that all decisions reached are acceptable.

Jennifer asked if the screening risk assessment conducted by UNOCAL and presented to the SERRT by Bob Haddad in August would be a useful planning tool. Bob Haddad briefly described the analysis. Since this analysis focused on terrestrial soils, it was agreed that a basic screen for water and sediment in addition to the soil screen conducted by UNOCAL would be useful in the data quality objective (DQO) process.

The group discussed whether the Predictive Ecological Risk Assessment (pERA) would be a screening level assessment or a baseline assessment. The general consensus was that the

assessment would include an initial screen and a more in-depth analysis, but that the final decision would be made during the DQO process.

Consensus Agreements:
The group agreed that we would review the UNOCAL screening risk assessment at the beginning of the next meeting to start the DQO process.

Action Items:
AI 1– Bob Haddad will provide a summary presentation for the next meeting to present the details of the UNOCAL screen to the group.
AI 2 - BBL will clarify with Mike Rendina re: the surface water samples available in the data base to ensure that all samples are included in any analysis conducted.
AI 3 – BBL will conduct a preliminary screen of surface water and sediment against conservative screening benchmarks (e.g., those identified for the Guadalupe Oil Field ERA) to supplement the UNOCAL soil screen.

2. Project Update

Jennifer Holder provided a brief project update with regard to the project website (including, database, GIS mapping and document uploads).

3. Identification of Habitats Potentially At Risk

All of the habitat types identified in the EDAW document and the ENTRIX Scoping Ecological Risk Assessment (SERA) were considered. The group discussed combining/condensing the listed habitat types into a general aquatic and terrestrial evaluation for simplification and because the available benchmarks don't support resolution beyond these general habitat types.

The actual area of the Site to be evaluated in the pERA was also discussed including which areas might be excluded based on planned remediation (i.e., Tanks 5 and 7 and surface oil expressions) or planned reuse (i.e., the Airport Plan), and which, if any, of the off site areas (the East Fork Creek, the Martinelli property, and the agricultural land to along the northwest side of the Site) would be included in the assessment. The potential risks from surface tar expressions were discussed and identified as toxicological and physical, including entrapment or expressions acting as a barrier.

Consensus Agreements:

- The whole site will be evaluated as terrestrial habitat and the subset of the area currently designated as wetland (or as revised based on the upcoming State wetland delineation) will be evaluated as aquatic (i.e., using sediment or surface water benchmarks).

- Tanks 5 and 7 will be remediated and will therefore not be evaluated in pERA. This assumption can be made with the caveat that the remedial options need to consider potential ecological risks.

- Surface tar expressions will be excluded from the direct toxicity screen because it was generally agreed that the hydrocarbon concentrations in the tar, while not necessarily available to ecological receptors, would likely exceed toxicity thresholds. Thus, this type of evaluation would not add resolution to the pERA. The surface tar expressions will be discussed for the potential physical hazards to ecological receptors. There was also a general concern about evaluating the potential for these areas to act as a source via leaching. It was agreed that this type of characterization would be done as a part of the remedial design to identify sources rather than as a part of the pERA.

- The pERA will be conducted with the assumption that all of the Site area could remain undeveloped (i.e., land reuses in the Airport Plan will not be considered). However, it is noted that a 2nd risk scenario might be included in the pERA that accounts for the potential for the specific land reuses outlined in the Airport Plan.

- The Martinelli Property: This property was not an operational part of the tank farm, is outside the site boundary and is not included in the Airport Plan. Petroleum has been identified in the sub-surface from an historical pipeline release but not in the surface (impacts identified below 5 feet). Potential risks to burrowing animals and vegetation root uptake were considered. Based on the soil type and the likely vegetation in this area (i.e., grasslands), plant roots and burrowing animals would not be expected to reach this depth. Therefore, the Martinelli property will not be included in the pERA. However, this property may need to be evaluated in the future based on specific redevelopment plans.

- The Forest Property: Based on site topography, and historical site operations, this area would not be expected to be impacted by Site activities. It has been sampled and there are no indications of elevated Site contaminants on the property. Therefore, this area will not be evaluated in the pERA.

Action Items:
AI 4 - East Fork Creek is offsite and there is no known connection between the creek and the Site (under non-flood stage conditions). However, the potential for site groundwater containing dissolved phase contamination to enter the creek needs to be assessed. Diane Kukol and Mike Rendina will look at East Fork Creek (on the west side of property) to see if it needs to be included in the pERA.

4. <u>Selection of COPECs</u>
A flow chart of a proposed COPEC screening process was presented and discussed.

An important component of that screen is inorganic background. Existing background samples for the Site currently include rock samples which may not be appropriate for screening purposes. Mike Rendina said that there are other shallow soil data that could be used as background.

The proposed COPEC screening process included an initial screen against conservative benchmarks for each media. The group thought this would be better included as a part of an initial screening Tier of the pERA. In addition, the need to evaluate adequacy of sample

coverage and detection limits prior to or as a first step in the COPEC screening process was identified.

A professional judgment step will be added to the COPEC screening process and will include evaluation of 1) compounds that are know laboratory contaminants, 2) nutrients, and 3)frequency of detect (i.e., compounds detected in less than 5% of samples will be evaluated for potential hot spots).

The group also discussed the general composition of total petroleum hydrocarbon (TPH) at the Site. Bob Haddad said that the carbon ranges at the site are predominantly higher end ranges. C-10 to 25 and C-25 to 40 were about even.

There was general discussion of fractions, TPH and indicator polynuclear aromatic hydrocarbons (PAHs) and their potential use in the pERA. This issue will be discussed further at the next DQO meeting.

Consensus Agreements:

- Due to the ephemeral nature of the wetlands, background for sediment will be the same as for soil and a background screen will not be conducted for water.
- The COPEC screening process will include frequency of detects and a background screen for inorganics. The process will also address adequacy of sample coverage, detection limits and will include a professional judgment step as described above. Comparison of site concentrations to benchmarks will be included as a part of the first tier of the risk assessment. See Attachment 1 for a revised COPEC screen flow chart.

Action Items:
AI 5 - Mike Rendina will prepare maps of sample locations and a data table of other potential background data for next meeting.

AI 6 - BBL will post the most recent EPA guidance on determining background to the project website.

AI 7 - Regina Donohoe and Melissa Boggs-Blalack will evaluate other COPECs that may need to be considered and will provide this information to the group prior to next meeting (2/5) (i.e., compounds that may result from combustion of hydrocarbons).

AI 8 - Chuck Lambert (HHRA) and BBL (ERA) will review benchmarks for determining adequacy of detection limits for PAHs (and other compounds) in water, soil and sediment. The adequacy of sample coverage in each media will also be evaluated and a memo will be prepared for the next meeting.

AI 9 – Bob Haddad will write a memo on the composition of TPH (carbon range distributions) of the samples at the Site after DQOs have been identified.

AI 10 – BBL will evaluate available TPH toxicity data for plant exposure to crude oil. This will help to decide whether a fraction-based evaluation for the pERA will be useful.

Drafted by BBL, Inc. based on the January 28, 2003 meeting of the Ecological Risk Working Group of the SERRT. To be ratified at the meeting on February 24, 2003

5. CSM – Exposure Pathway Analysis

In addition to specific habitat types to be evaluated in the pERA, the depth of each media that should be considered was also discussed. Root depth, characteristics of the Site soils and receptors at Tank Farm were all discussed. Using the CSM provided in the strawman memo as a starting point, the group worked through a revised CSM. The revised version is included here as Attachment 2.

Consensus Agreements

- Screen 3 habitat types – terrestrial (to 5'), wetland (to 6") and riparian (to 10'). The screen needs to be sure to consider places where we might not have surface data but may have high hits at depths.

6. Development of Risk Questions and AEs and MEs

A Problem Formulation Summary table was presented and is intended to be used to develop DQOs at the 2/10 meeting. Several proposed risk questions and assessment endpoints were proposed. Rather than work through the table at the meeting, the group requested that BBL fill in proposed Risk questions and AEs and MEs. The intent is to provide the table to the group by 1/31 and to get and incorporate their input prior to the next meeting. Regina stated that California Department of Fish and Game (CDFG) ARARs state no take on non-game bird species so protecting to a population may not be acceptable. The ERA may need to be protective of the individual. The group will review the results of the screens discussed above and discuss possible population level evaluations of receptors.

Action Items:
AI 11 - BBL will fill in food webs and the Problem Formulation table and distribute to group by 1/31. Group members are to provide input prior to the 2/10 meeting.

AI 12 – BBL will arrange for a call for Tuesday the 4th at 2:00 to discuss the food webs and problem formulation table.

AI 13 – BBL will distribute the meeting minutes by 2/5 and will include a revised COPEC screen and CSM with the minutes.

Upcoming Meeting Dates and Operational Business:

1) ERWG/HHRG Meeting on 2/10/03 – Develop Data Quality Objectives.

Based on the objectives of this meeting, the group will request that the previously scheduled SERRT meeting scheduled for the afternoon be postponed. The SERRT members would be welcome to join in with the ERWG/HHWG meeting at any time.

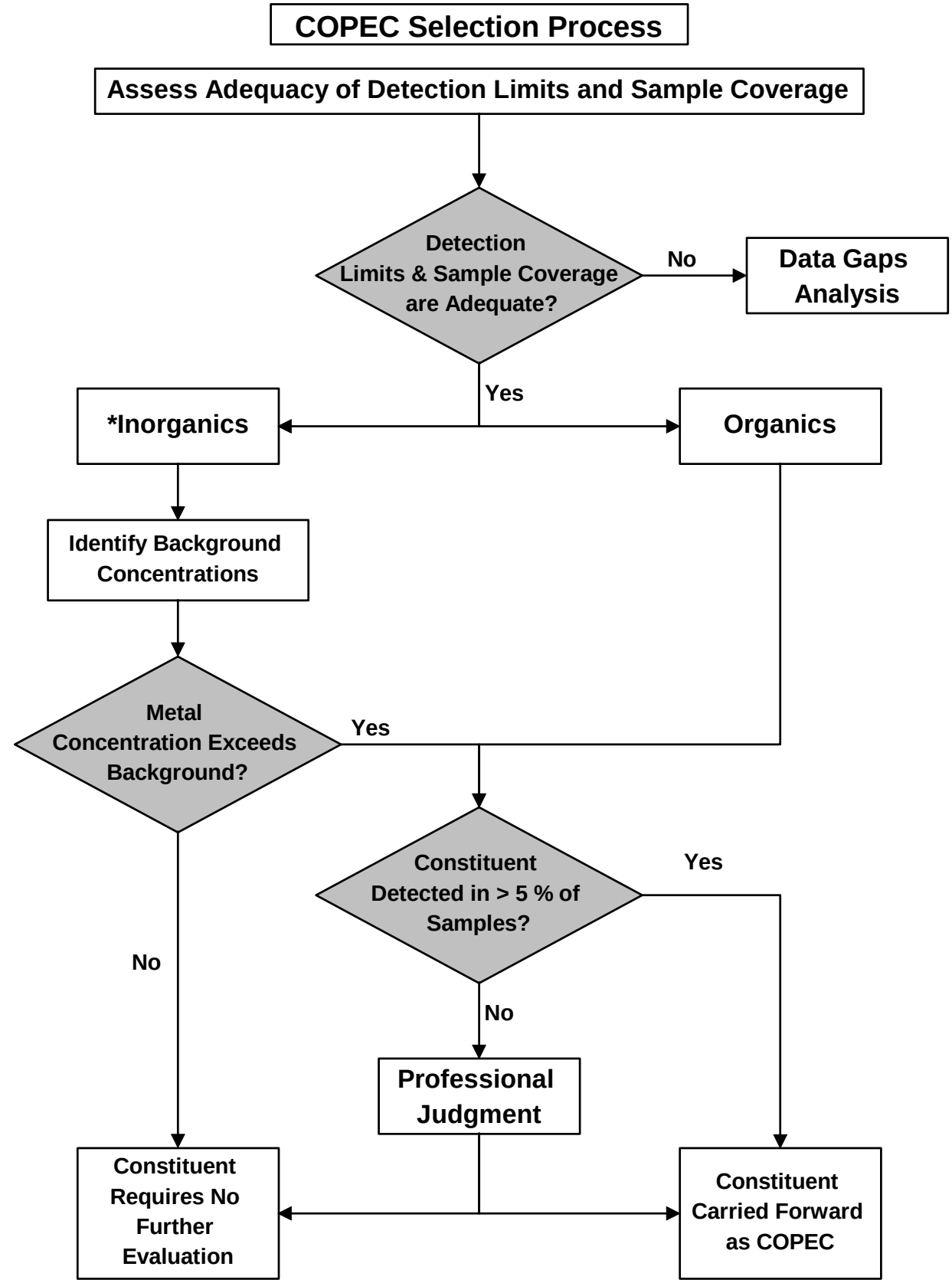
2) Conference Call to discuss the Problem Formulation Table scheduled for 2:00 pm on 2/4/03. Call in number will be distributed by BBL.

Drafted by BBL, Inc. based on the January 28, 2003 meeting of the Ecological Risk Working Group of the SERRT. To be ratified at the meeting on February 24, 2003

Action Item Summary:

Action Item Summary Table			
Action Item #	Assigned To	Description	Due Date
1	Bob Haddad – AGS	Provide a summary presentation for the next meeting to present details of the UNOCAL screen of Site soil.	2/10/03
2	BBL	Verify with Mike Rendina that all surface water samples are in the database.	2/10/03
3	BBL	Conduct a preliminary screen of surface water and sediment against benchmarks used at GOF.	2/10/03
4	Diane Kukol - /Mike Rendina - EGS	Review data and hydrology relevant to the East Fork Creek and make a determination as to whether the creek should be included in the pERA.	2/10/03
5	Mike Rendina-EGS	Prepare map and data table of available background soil data.	2/10/03
6	BBL	Post EPA Guidance for determining background to the web site.	1/31/03
7	Regina Donahoe and Melissa Boggs-Blalack - CDFG	Determine if any additional chemicals (i.e., compounds that might result from hydrocarbon combustion) need to be considered in the pERA.	2/5/03
8	Chuck Lambert McDaniel Lambert Inc. and BBL	Review detection limits for each compound in each media to determine if they are adequate for the HHRA and ERA respectively.	2/10/03
9	Bob Haddad - AGS	Prepare a memo on TPH composition at the Site.	TBD
10	BBL	Evaluate available TPH toxicity data for plant exposure to crude oil. This will help to decide whether a fraction-based evaluation for the pERA will be useful.	TBD
11	BBL	Fill in food webs and the Problem Formulation table and distribute to group.	1/31/03
12	BBL	Arrange for a call for Tuesday the 4th at 2:00 to discuss the food webs and problem formulation	1/31/03
13	BBL	Distribute the meeting minutes with a revised COPEC screen and CSM.	2/5/03

Attachment 1



*** Inorganic background screen includes soil and sediment only**

Drafted by BBL, Inc. based on the February 10, 2003 meeting of theEcological Risk Working Group of the SERRT. Ratified at the meeting on March 11, 2003.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team – Ecological Risk Working Group

Draft Meeting Summary – Revision 2

Date: Monday February 10, 2003

Time: 9:00 AM – 5:00 PM

Location: UNOCAL San Luis Obispo Tank Farm Site

Participants:

Name	Organization	Name	Organization
Jim Carlisle	OEHHA/Cal EPA	Jennifer Holder	BBL, Inc.
Bonner Anthony	BBL, Inc.	Diane Kukol	RWQCB
Melissa Boggs-Blalack	CDFG	Chuck Lambert	McDaniel Lambert, Inc.
Regina Donohoe	CDFG	Michael Sullivan	McDaniel Lambert, Inc.
Bob Haddad	AGS	Mike Rendina	England Geosystem
Jeff Poel	Environmental Health	Rick Rittenberg	Cannon Associates

Meeting Summary:

The agenda for the meeting included the following topics:

1) Review of 1/28/03 meeting minutes and action items
2) Overview of preliminary ecological risk screen conducted by UNOCAL
3) Discussion of preliminary ecological risk screen and path forward for predictive Ecological Risk Assessment (pERA)
4) Comments on Human Health Risk Assessment (HHRA) Work Plan
5) Identification of Data Needs for human health and ecological risk assessments
6) Development of Data Quality Objectives (DQOs)

1. Review of Previous Minutes and Action Items

The group reviewed the minutes from the 1/28/03 Ecological Risk Work Group (ERWG) meeting and provided comments for clarifications. The comments will be reflected in a revised draft and the minutes will be ratified at the next ERWG meeting on 2/24/03.

Action Items:
AI 1: ERWG will provide any additional comments on 1/28 minutes to BBL by 2/13/03.

AI 2: BBL will revise 1/28/03 minutes and distribute to group on 2/14/03.

2. Presentation of the UNOCAL Preliminary Risk Screen

Bob Haddad presented the results of the preliminary risk screen previously conducted by UNOCAL.

This screen was very preliminary in nature and was not intended to be a risk assessment. The screen was conducted for direct toxicity of metals to soil invertebrates and plants and for food chain effects. For PAHs, food chain effects were assessed. Metals exceeding background were evaluated (i.e., As, Cu and Pb). Available benchmarks for Guadalupe Oil Field (GOF) were used when possible. Soil concentration data from the top 6 inches of soil were utilized.

Bob included an additional risk analysis for soil data from 0-5' and 0-2.5' depth ranges. Both the direct toxicity screen and the food web screen indicated that the exceedances did not increase substantially at depth.

Bonner Anthony presented a preliminary wetland risk evaluation. This screen did not incorporate background and used sediment-based benchmarks for direct toxicity of metals and PAHs (GOF benchmarks when available). Food chain screening values used in the UNOCAL screen were used for the raccoon and the mallard and compared to the top 5 feet of sediments falling within areas designated as wetlands.

Action Items:
AI 3: BBL will post copy of the UNOCAL screen and the wetland screen presentations to website prior to the next meeting.

3. Discussion of Preliminary Ecological Risk Screen and path forward for pERA

It was discussed that the preliminary risk screens presented by Bob Haddad and Bonner Anthony might be useful in assisting with identification of data needs for the pERA. Topics that need to be discussed include: sample coverage, detection limits, and defining background concentrations for inorganics.

Coverage

Surface Water:
No inorganic data have been collected for surface water. For PAH analyses, only 3 samples have been analyzed using the SIM method (i.e., low detection limits), and PAHs were not detected in these samples. Two of these samples (the two of the highest TPH detects [2-3 ppm range]) were from reservoirs 5 and 7. The third was from the cow pond [0.33 ppm TPH].

Other surface water TPH samples collected at the site ranged from 110 ppb to 2700 ppb with no detectable PAHs (at detection limits ranging from 2 – 5 ppb). The ERWG and human health work group (HHWG) will determine if these data are adequately representative of all conditions within the wetland areas during the wet season. Mike Rendina confirmed that Earth Systems does the quarterly surface water sampling and that their primary objective is to see if anything is leaving the site. They have selected 10 basic locations. We may need to collect some basic TPH data to determine if the available data are representative of various temporal conditions. We would focus on areas that keep their water for longer periods as these wetlands would potentially provide greater exposure and would enable sampling to go forward regardless of rain fall.

Soil/Sediment:
In general, Regina Donohoe is interested in how homogeneous or heterogeneous the concentrations in soil are over various areas. ERWG group members will provide input to BBL on what types of maps they would like to see to aid in understanding the contaminant concentrations at the Site.

AI 4: BBL will either get the GIS tool on the web working or post maps to the web based on input from the ERWG.

The group will have to make final determination on coverage at a later date.

<u>Detection Limits</u>

Surface Water:
The group discussed the fact that the TPH data are only as useful as the benchmarks that are available for comparison. Without a benchmark, there would be no way to decide if the measured TPH concentrations are acceptable or not. Our freshest seep data (reservoirs 5 and 7) indicates ppm range TPH but undetectable PAHs at 0.1 ppb detection limits.

Chuck Lambert said metals in surface water are not an issue for Human Health exposures, but PAHs may be. The general SIM method detection limits of 0.1 ppb may not be adequate. Jim Carlisle and Chuck Lambert said that for HHRA, additional surface water would need to be collected.

Soil:
Pesticides and herbicides were all non-detect at the Site. The detection limits are generally adequate based on the range of available screening criteria for soil and sediment. A few compounds did have detection limits higher than low effect levels, but there is no reason to expect the site as a source for these compounds. The pERA will need to provide discussion of the adequacy of detection limits.

** Consensus Agreements:

- Detection Limits are adequate for pesticides and herbicides and no additional analysis for these compounds will be required.

- The adequacy of PAHs detection limits was discussed and the group agreed that there are sufficient soil SIM PAH data with adequate detection limits for both the HH and Ecological risk assessments.

Background

Mike Rendina explained available data and the background determination that was done for the UNOCAL preliminary risk screen discussed earlier. He presented a revised approach to determining background which included separate maps showing offsite and site data that might be considered background using only 0-5 feet samples. There were 200 on site and 68 offsite samples. Lead and arsenic are the only metals that appear to be site related, but they don't co-occur.

The group discussed looking at all on site and offsite data to determine a background population. An inflection point on a probabilistic regressions plot will be used to identify data points that are part of a different population.

The group discussed many ways to determining background for inorganics at the site.

1) Use non-parametric test like Wilcoxon Rank Sum test to compare distributions

2) Use range (i.e., tolerance limit) to determine if site data fall within the range.

3) Michael Sullivan pointed out that the specific complexity of the dataset should be considered when deciding on the appropriate methods.

** Consensus Agreement:

- For background determination, the entire soil dataset will be considered (all depths). Two lines will be included, one excluding the operations area and surface tar and one including all data. This evaluation would define where we exceed background by showing (or not showing) an inflection point. If no inflection point is observed, then site data are considered a part of the background population. If we do get an inflection point, the compound will be carried forward. Because we would plot both all the data and the data without the operations area – we will be able to ground truth what the inflection point analysis says.

Action Items:
AI 5: BBL will assemble available toxicity/bioassay data for TPH to provide context and understanding of what existing site TPH surface water data mean by the next meeting.

AI 6: Mike Rendina will provide an analysis of background using probabilistic regression plots and maps showing how concentrations map across the site (probably by quartiles) by 2/18/03.

4. Comments on HHRA Workplan

The RWQCB explained why they have concurred that the HHRA does not need to address groundwater.

The vapor/inhalation exposure need not be addressed because no volatile organic compounds (VOCs) are present. Methane is the only gas found in soil gas monitoring. Particulate inhalation will be addressed.

The HHRA will include the offsite resident scenario.

The HHRA will not evaluate an on-site resident because the airport plan won't allow for on site residents due to the flight path. Also there are no current residential land use zones on site. A deed restriction will be included as an assumption in the HHRA.

Jim Carlisle would like for the HHRA use professional judgment to evaluate frequency of detections (in the COPEC screen) rather than the specific percentage of 5%.

HHRA will develop human health protective concentration levels (HHPCLs) for compounds where there are no PRGs. Jim Carlisle recommended presenting a range of PCLs based on different cancer slope factors ($10^{-4,}$ 10^{-5} or 10^{-6}).

Action Items:
AI 7: Chuck Lambert will draft a final HHRA Workplan by next SERRT meeting.

5. Identification of Data Needs for HH and Eco RAs

Surface water:
The group discussed potential data needs for surface water. The existing data set does not contain any data for metals and does not include any water quality parameters. Basic water quality information (e.g., hardness, pH etc.) would be useful for application of metal toxicity benchmarks and, if warranted, for selection of aquatic bioassays. In addition, individual PAHs have only been analyzed in 3 samples with low detection limits (i.e., 0.1 ppb using SIM method).

** Consensus Agreement:

- Two additional surface water samples will be collected as a part of the next quarterly sampling event (Reservoir 3 and in the cow pond). All twelve samples will be analyzed for TPH and BTEX. A subset of the samples (excluding off site locations, SW5, SW6 and SW8) will be analyzed for CAM

metals, SIM PAH, and water quality parameters such as pH, DO, and hardness.

Other COPECs:
The possibility that dioxin might exist at the site from the fire was discussed. No specific reference to dioxin resulting from crude oil burning in a non-marine environment was found. The available studies do not allow for conclusive determination of whether or not dioxin would have been produced. The group discussed the concern that risk analysis of dioxin is very complicated as it is ubiquitous in the environment. Differentiating between site-related and ambient concentrations may be difficult and costly. In addition to assessing ambient levels, there is a question as to whether the dioxin remains a complete exposure pathway. There has been a lot of earth moving at the site and surface run off may have removed surface soil over the years. Thus what may have been deposited by the fire may not still be in place on site.

Fractions:
There are 4 types of surface tar expression defined at the site. The ones that might pose a risk in terms of significant exposure to humans are the plastic tars (the free product is only in areas we aren't evaluating). So, fraction data for these 2 media may need to collected for the HHRA because they may have different compositions. The detection limits in the surface tar (ST) samples are likely elevated due to the high concentrations present. The HHRA will have to develop an alternative exposure scenario for surface tar. However, the necessary detection limits may not be obtainable.

We will collect soil samples for fraction analysis so that we can then equate other site TPH data from the site. At a minimum, we can get the aliphatic and aromatic fractions. May or may not be able to get PAHs at adequate detection limits. Mike Rendina will assist Chuck Lambert in choosing 6 sample locations that represent a range of TPH in surface tar.

** Consensus Agreement:

- Surface tar would be the best representative of "worst case" scenario in terms of TPH fraction composition. Because of potential matrix interference with ST, 6 soil samples will be collected for TPH, fraction and PAH analysis.

Immediate Potential Data Needs:
Based on the screen presented today, the food chain may not be a risk driver. Whether we think we need to validate the existing models by collecting tissue remains a question. Regina Donohoe would like to carefully review the input parameters for the existing screen to determine if this is an adequate basis for moving forward.

Action Items:
AI 8: BBL will draft a bulleted surface water sampling plan as follows by Friday. Response will be due back from group by 2/18/03.

- CAM Metals
- PAH – SIM method (dl=0.01ppb)
- Water quality parameters

AI 9: Mike Rendina will make a formal Surface Water SAP from the approved bulleted sampling plan provided by BBL.

AI 10: BBL will provide a summary table of surface water data and map to group by 2/14.

AI 11: Mike Rendina will coordinate with John Ljung to arrange for the surface water sampling by Earth Systems.

AI 12: Mike Rendina will decide on sample locations for the 12 soil fraction samples to be collected. He will provide a bulleted sample plan by 21st.

AI 13: Bob Haddad and Michael Sullivan will investigate the dioxin issue further and will provide a brief write up (white paper) of whether dioxins are likely to be present on the Site. They will submit this paper for review by a person to be named.

AI 14: Bob Haddad will talk to Zymax to see if the appropriate HH detection limits are possible for surface tar samples.

AI 15: BBL will put the wetland screen and the UNOCAL screen on the web site by 2/14. A table of the benchmarks used will be included.

6. For Next Meeting – 2-24-03

- Finalize surface water sampling plan

- Distribute a list of objectives and an agenda a few days prior to meeting so we can be prepared to finalize DQOs then.

Action Item Summary*:

Action Item Summary Table			
Action Item #	Assigned To	Description	Due Date
1	ERWG	Provide any additional comments on 1/28/03 minutes to BBL.	2/13/03
2	BBL	Revise 1/28/03 minutes and distribute to group.	2/14/03
3	BBL	BBL will post maps to the web based on input from the ERWG.	2/24/03
4	BBL	Post copy of the UNOCAL screen and the wetland screen presentations to website.	2/20/03
5	BBL	Assemble available toxicity/bioassay data for TPH.	2/24/03
6	Mike Rendina	Provide an analysis of background using probabilistic regression plots and maps.	2/18/03
7	Chuck Lambert	Draft a final HHRA Workplan by next SERRT meeting	3/12/03
8	BBL	Draft a bulleted surface water sampling plan.	2/18/03
9	Mike Rendina	Make a formal Surface Water SAP from the approved bulleted sampling plan provided by BBL.	TBD
10	BBL	Provide a summary table of surface water data and map to group.	2/14/03
11	Mike Rendina	Coordinate with John Ljung to arrange for the surface water sampling by Earth Systems.	TBD
12	Mike Rendina	Decide on sample locations for the 12 soil fraction samples to be collected for the HHRA.	TBD
13	Bob Haddad and Michael Sullivan	Investigate the dioxin issue further and provide a brief write up (white paper) of whether dioxins are likely to be present on the Site.	TBD
14	Bob Haddad	Determine from Zymax if appropriate HH DLs are possible for surface tar samples.	TBD
15	BBL	Put the wetland screen and the UNOCAL screen on the web site.	2/14/03

* Action Item List Reflects only action items from 2/10/03 meeting. For a comprehensive list of action items, see Action Items on the SLO Tank Farm Web Site.

Drafted by BBL, Inc. based on the February 24, 2003 meeting of the Ecological Risk Working Group of the SERRT. Ratified at the June 30, 2003 ERWG meeting..

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team – Ecological Risk Working Group

Final Meeting Summary – Version 1.1

Date: Monday, February 24, 2003

Time: 9:30 AM – 4:30 PM

Location: Unocal Offices, 276 Tank Farm Road, San Luis Obispo
Front Conference Room

Participants:

Name	Organization	Name	Organization
Bonner Anthony	BBL, Inc.	Diane Kukol	RWQCB
Melissa Boggs-Blalack	CDFG	Chuck Lambert	McDaniel Lambert Associates
Regina Donohoe	CDFG	John Ljung	UNOCAL
Bob Haddad	AGS	Mike Rendina	England Geosystem
Neil Havlik	City of SLO	Rick Rittenberg	Cannon Associates
Jennifer Holder	BBL, Inc.		

Meeting Summary:
Agenda items for the 2-24-03 meeting included:

1) Final review and ratification of meeting minutes from 1/28/03
2) Review of 2/10/03 meeting minutes
3) Finalize Problem Formulation Tables
4) Finalize surface water data quality objectives (DQOs) and discuss the sampling and analysis plan (SAP)
5) Review petroleum fraction sampling workplan
6) Presentation of background analysis
7) Discussion of Unocal screen as a planning tool for DQOs
   - Review of primary inputs to screen
   - Review concentration maps
   - Need for bioassays?
   - Need for tissue data?

Drafted by BBL, Inc. based on the February 24, 2003 meeting of the Ecological Risk Working Group of the SERRT. Ratified at the June 30, 2003 ERWG meeting..

1. Final review and ratification of meeting minutes from 1/28/03

The meeting began with final review of the 1/28/03 meeting minutes.

Action Items:
AI 1: BBL will make final revisions to the 1/28 meeting minutes based on comments provided at the meeting. The minutes are considered ratified and will be posted to the web site.

2. Review of 2/10/03 meeting minutes

The group reviewed the 2/10 minutes and comments were provided by Bob Haddad and Chuck Lambert. Other group members would like additional time to review the minutes and provide comments. The group reviewed the action item list. Jennifer talked specifically about # 5 (surface water DQOs). See discussion under agenda item #4 below.

Action Items:
AI 2: The group will provide comments to BBL (Bonner) by COB 2/26/03. Bonner will incorporate in red line mode and redistribute to group by 3/3/03.

3. Finalize Problem Formulation Tables

The group agreed to wait to finalize the Problem Formulation tables until we make final determinations of receptors. We anticipate making receptor determinations after completion of the DQOs (in approximately 1 month).

Action Items:
AI 3: The ecological risk work group (ERWG) will select representative receptors and finalize Problem Formulation tables at a time to be determined (TBD).

4. Finalize surface water DQOs and sampling plan

Fraction analysis for the human health risk assessment (HHRA) was discussed. Petroleum fractions will be analyzed in surface water if TPH $\geq$ 1 ppm (based on a water board standard).

All samples will be analyzed for BTEX, C4 - C10 and C10 – C40. An electronic deliverable data package will be requested from Earth Systems. England Geosystems (EGS) will validate the data and distribute the data to BBL and McDaniel Lambert, Inc. (MLI).

Discussion of what the TPH in SW means at the site:

Jennifer Holder reported on the literature search/review of TPH freshwater toxicity values. In her preliminary review she found no freshwater studies with crude oil. There are a few studies in freshwater systems using refined products and numerous studies with crude oils in marine systems. Jennifer also discussed screening values developed by the San Francisco Regional Water Quality Control Board. These numbers were developed to be protective of groundwater entering surface water. These screening values are: TPH Gas - 500 ppb and TPH diesel - 640 ppb.

Regina Donohoe mentioned paper by D. French specific to aromatics that showed that marine and freshwater species were similar in terms of sensitivity and that inverts were

not necessarily more sensitive than fish. The group discussed whether fresh product can be considered more acutely toxic than weathered product. While this is generally accepted as true for acute exposures, it is not necessarily true for chronic exposures. In general, there are so many variables associated with conducting petroleum bioassays that finding a general number to use as a screen for TPH is very complicated and has associated uncertainties.

**Consensus agreement:

- The difficulties of developing a general surface water screening value for TPH were recognized by the group and it was agreed that no further investigation of TPH screening values may be conducted at a later date.

Discussion of Bioassay:

The lack of applicable TPH screening values for surface water led to discussion of possibly conducting surface water bioassays at the Site. There are basically three key factors that might influence the decision to conduct bioassays:

1) Water quality parameters.

The water quality parameters currently included in the surface water sampling plan will be reviewed and considered prior to making a decision about conducting bioassays to determine if a bioassay would be likely to be confounded by non-contaminant issues.

2) Are Threatened or Endangered (T&E) species present?

Regina Donohoe noted that if fairy shrimp or other T&E species are present at the site, they may require a higher level of protection than might be provided by a TPH screening level with a great deal of associated uncertainty. Thus, bioassays may be warranted to mitigate the uncertainty of available screening values and/or to verify the protectiveness of any screening value we might determine.

3) How much of the carbon in TPH is petroleum-related versus biogenic?

The group discussed the possibility that the silica gel clean up step used in some TPH analyses may remove some potentially toxic petroleum fraction (e.g. the polar fraction). Likewise, the precipitation processes for determining humic and fulvic acids may precipitate some petroleum compounds as well. Assessing the percent humic and fulvic acid organic carbon content in the context of the overall dissolved organic carbon (DOC) concentrations may allow for determination of how much of the carbon is biogenic and how much is petrogenic. The group also discussed making field observations of the color/odor etc of the water samples to help explain some of the humic/fulvic information. A separate sample could be collected for each location for color observations.

Based on this discussion, it was noted that the group might not be able to make bioassay decisions in time to conduct wet season bioassays. This is due to the time required to conduct lab analyses of surface water samples. Thus, there is a possibility that the end product of the wetland portion of the predictive ecological risk assessment (pERA) might have to be a recommendation for path forward rather than a final risk conclusion for these areas.

Action Items:
AI 4: Mike Rendina will produce a memo regarding the finalization of the database (exclusive of biological data that may be collected in the future) – TBD.

AI 5: BBL and MLI will coordinate on development of exposure point concentrations (EPCs). We will come up with a consensus on how to handle data issues such as multiple depths at one sample location and duplicate samples - TBD.

AI 6: BBL will provide revised DQOs (Version 1.2) to Mike Rendina by 2/25/03.

AI 7: Mike Rendina will distribute a full SAP by 2/28/03.

AI 8: ERWG will provide comments to Mike Rendina on the SAP by 3/5.

AI 9: ERWG will have a conf. call on 3/7 - 8:30 am to resolve any potential conflicting comments on the SAP and to discuss the schedule.

5. Review petroleum fraction sampling workplan

Chuck Lambert presented slides regarding the fraction methodology and rationale. He will use the same methodology used at Guadalupe Oil Field for the human health risk assessment (HHRA).

Chuck and Mike Rendina decided that the sample size will be increased to 12 soil and 12 surface tar samples (rather than 6 and 6 as previously stated). In choosing sample locations, they will try to capture a range of contamination but will primarily focus on three areas to be determined at a later date.

Action Items:
AI 10: Mike Rendina and Chuck Lambert will develop a workplan for the fraction data sampling and distribute to the SERRT by 3/5/03. The SERRT will discuss this at the 3/11 meeting and will ratify the workplan.

AI 11: Chuck Lambert will let Chuck Anders know that we would like to reschedule the SERRT meeting from 3/12/03 to 3/11/03. He will also coordinate with Jim Carlisle about the issues to be discussed and will provide agenda items to Chuck Anders.

AI 12: BBL will provide any eco-related agenda items for the SERRT meeting to Chuck Anders by 3/5/03.

6. Presentation of inorganic background analysis

Mike Rendina presented the background analysis conducted by EGS. Two probability plots were looked at for each metal, one for “all samples” (approximately 255 samples) and one for “background samples” (approximately 65 samples). The “all samples” set included all available samples. The background data set included sample locations at less than or equal to 5 ft. depth, without detected TPH, excluding bedrock samples, and outside the operations area.

Several ERWG group members would like more time to look over the background report and would like to be sure that Jim Carlisle has carefully reviewed it as well.

Action Items:
AI 13: The group should carefully review the background analysis conducted by EGS and call Mike Rendina with any questions or concerns. Everyone should come to the 3/11/03 meeting prepared to discuss the background analysis.

7. Discussion of Unocal screen as a planning tool for DQOs

Review of primary inputs to screen – R. Donohoe

Regina Donohoe provided an overview of the inputs to the preliminary UNOCAL screen.

She noted that TPH was not evaluated, PAH contact toxicity was not evaluated, and the assessment did not include comparison to a LOAEL food web value for birds. Biota Soil Accumulation Factors (BSAFs) from Oakridge National Laboratory (ORNL) were used to model uptake of contaminants by terrestrial invertebrates. She felt these values were adequately conservative for the type of analysis conducted. However, the model used to estimate contaminant uptake by plants (i.e., Travis and Arms) was not conservative enough based on review of other plant PAH uptake factors.

Based on this review, it is possible that we may need to collect plant and/or invertebrate tissue to understand the bioavailability of identified contaminants of potential ecological concern (COPECs). The group discussed our current understanding of what types of benthic communities might be present at the Site.

**Consensus agreements:

- It is not necessary to collect plant tissue for the wetland herbivore because these receptors (i.e. mallard) feed on aquatic plants that are exposed to water and not sediment. Since it is believed that the major petroleum contaminant source is sediment rather than water, the collection of wetland plant tissue is not considered a high priority.
- The critical wetland receptors that will need to be evaluated are benthic or epi-benthic feeders (e.g., sandpiper/killdeer).
- A reconnaissance-level benthic survey will need to be conducted to determine if the site supports benthic invertebrate communities. This will need to be determined prior to deciding if we need to collect invertebrate tissue or conduct sediment bioassays.

Action Items:
AI 14: Bob Haddad and BBL will discuss possible surveys of benthos and aquatic invertebrates. This may be coordinated with the biologist scheduled to conduct the T&E species surveys.

Drafted by BBL, Inc. based on the February 24, 2003 meeting of theEcological Risk Working Group of the SERRT. To be reviewed and ratified at the meeting on April 23, 2003.

Action Item Summary Table*			
Action Item #	Assigned To	Description	Due Date
1	Bonner Anthony	Finalize 1/28/03 meeting minutes and post to the web.	2/26/03
2	ERWG/Bonner Anthony – BBL	ERWG will provide comments to BBL on 2/10/03 meeting minutes. BBL will distribute revised minutes to the ERWG/HHWG.	3/3/03
3	ERWG	Finalize Problem Formulation Tables (decide on receptors of concern)	TBD
4	Mike Rendina – EGS	Produce a memo documenting the final database validation.	TBD
5	Jennifer Holder - BBL/ Chuck Lambert - MLI	Coordinate development of exposure point concentrations.	TBD
6	Jennifer Holder – BBL	Revise surface water DQOs and provide to Mike Rendina.	2/25/03
7	Mike Rendina – EGS	Produce the Sampling and Analysis Plan for the surface water sampling and distribute to the team.	2/28/03
8	ERWG/HHWG	Provide comments to EGS on the surface water SAP	3/5/03
9	ERWG/HHWG	Conference call to discuss surface water SAP	3/7/03
10	Mike Rendina - EGS	Provide a surface soil and surface tar petroleum fraction workplan to the SERRT for discussion at the 3/11/03 meeting.	3/5/03
11	Chuck Lambert	Reschedule SERRT meeting for 3/11/03 with Chuck Anders. Coordinate with Jim Carlisle and provide agenda items.	3/3/03
12	BBL	Provide Eco-related agenda items for SERRT meeting to Chuck Anders.	3/4/03
13	ERWG/HHWG	Review the background document provided by EGS and come to the 3/11/03 meeting prepared to discuss.	3/11/03
14	BBL/Bob Haddad - AGS	Discuss reconnaissance level benthos and aquatic invertebrate surveys.	2/28/03

* Action item list reflects only action items from 2/24/03 meeting. For a comprehensive list of active action items, see SLO Tank Farm Web Site.

Drafted by BBL, Inc. based on the March 11, 2003 meeting of the Ecological Risk Working Group of the SERRT. Ratified at the June 30, 2003 ERWG meeting..

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team – Ecological Risk Working Group

Final Meeting Summary

Date: Tuesday, March 11, 2003

Time: 9:30 AM – 12:30 PM ERWG
1:00 PM – 3:30 PM SERRT

Location: Regional Water Quality Control Board Offices, 895 Aerovista Place, Suite 100, San Luis Obispo

Participants:

Name	Organization	Name	Organization
Bill Almas	UNOCAL	Jim Carlisle (by phone)	OEHHA
Bonner Anthony	BBL, Inc.	Diane Kukol	RWQCB
Melissa Boggs-Blalack	CDFG	Chuck Lambert	McDaniel Lambert, Inc.
Regina Donohoe	CDFG	John Ljung	UNOCAL
Bob Haddad	AGS	Mike Rendina	England Geosystem
Neil Havlik	City of SLO	Rick Rittenberg	Cannon Associates
Jennifer Holder	BBL, Inc.		

Ecological Risk Work Group (ERWG) Meeting Summary:
Agenda items for the 3-11-03 meeting included:

1) Final review and ratification of meeting minutes from 2/10/03
2) Review of 2/24/03 meeting minutes
3) Discussion of Background
4) Miscellaneous Technical Issues

1. Final review and ratification of meeting minutes from 2/10/03

2/10/03 minutes were reviewed and ratified. It was agreed that this and all future meeting summaries will be posted to web in pdf format.

2. Review of 2/24/03 meeting minutes

The group reviewed 2/24/03 minutes and provided comments. Any additional comments should be provided to BBL by Friday 3/14/03.

Action Items:
AI 1: Final ratified 2/10/03 minutes will be posted to the website.
AI 2: BBL will revise 2/24/03 minutes and redistribute on 3/17/03.

3. Discussion of Background

Jim Carlisle had provided written comments to Diane Kukol prior to the meeting and she distributed these to the group in hard copy. The group discussed the inflection points determined by England Geosystems (EGS) in the Background Metals Evaluation Letter Report. While Jim Carlisle pointed out how the selection might vary by interpretation, it was generally agreed that the inflection points selected by EGS are acceptable.

A separate discussion ensued regarding the range of background concentrations identified for those compounds that did not have inflection points (Be, Cr, Cu, and Ni). Regina Donohoe expressed concern about the relationship between soil type and concentrations of metals. Specifically she had concerns that the background concentrations determined for coarse soil types and bedrock might not capture anomalous concentrations in other finer grained soil types. To address this issue, it was decided that any additional data collected for these compounds would be compared to the highest on-site soil (non-bedrock) soil concentration to evaluate whether the new data fall within the identified background population.

** Consensus Agreements:

- The inflection points described and selected in the EGS letter report are acceptable.
- No inflection point was identified for beryllium, chromium, copper, and nickel. Future concentrations that exceed the highest, non-bedrock (i.e., soil) concentration present in the on-site data set (Be – 0.7, Cr – 720, Cu – 92 and Ni – 1100) should be re-evaluated in light of background.

Action Items:
AI 3: Mike Rendina will revise the background document to reflect the changes discussed above. He will send out revised text and tables to the ERWG. Figures will not be revised.
AI 4: A conference call will be scheduled to finalize COPEC selection based on background – either the 18th at 1:00 pm or the 20th at 9:30 am – depending on Jim Carlisle's schedule.

4. Miscellaneous Technical Issues

Bioassays and Schedule

The need for and the timing of bioassays was discussed. Regina Donohoe explained the possible difficulties associated with bioassays and the importance of water quality parameters in selecting and designing useful bioassays. In addition, it was discussed

that the threatened and endangered (T&E) species surveys may influence selection of sample locations. Bill Almas clarified that UNOCAL does not recommend proceeding with bioassays unless we determine that they will be useful technically.

** Consensus Agreement:

- The group understands that if bioassays are determined to be necessary, we may miss wet season sampling period. However, it was agreed that it would not be advisable to move forward without the surface water and biological survey results.

5. Other Business

The group discussed a number of SERRT-related issues at the morning meeting to accommodate Bill Almas' schedule. Issues discussed are summarized below.

Golf Course

Neil Havlik expressed concerns with some information he had heard regarding the potential golf course scenario being considered by UNOCAL. Discussion ensued between Neil and Bill Almas and it was ultimately determined that this was not an issue for the SERRT. Bob Haddad clarified that the golf course is a potential remedial scenario but that it doesn't affect the findings of the predictive Ecological Risk Assessment (pERA). Consistent with the underlying assumption decided upon at the 1/28/03 ERWG meeting, the pERA will assess risk under the assumption that the entire site will remain ecological habitat, without a specific land use in mind.

Operations Area

Bill Almas presented a proposal to the ERWG regarding the Operations Area. He discussed possibly excluding the operations area and/or the greater northwest operations area from the pERA based on planned remediation.

The ERWG noted that some type of risk evaluation of these areas will be necessary at some stage in the process to determine appropriate clean up levels. Removing either the operations area or the greater northwest operations area from the pERA will simply mean that the evaluation happens later in the process. It was noted that this could be particularly useful in terms of explaining risk to the public. To aid in understanding of the impacts these exclusions might have on the pERA, BBL will calculate 95% upper confidence limits (UCLs) for the three different site areas. The issue of potentially excluding the operations area and/or the greater northwest operations area will be discussed further on the 3/18/03 afternoon conference call.

Overview of website activities

Jennifer Holder presented the GIS mapping capabilities on the project website. A few questions regarding the underlying data arose including whether data are wet or dry weight, what makes up the sum PAH and what are units. It was specified that most of the original soil and sediment data were reported as wet weight. To convert these values to dry weight for risk assessment purposes, it was assumed that the samples

contained 21% moisture based on a subset of samples for which moisture data were reported. The final pERA should document the process of the wet weight/dry weight conversions. In addition, it should be confirmed whether the data on the website have been converted to dry weight.

Action Items:
AI 5: BBL will email ERWG to clarify that data in database on the website are dry weight and that sum PAH encompasses the 16 indicator compounds. Also a footnote specifying units and dry weight will be added to the website.
AI 6: BBL will calculate exposure point concentrations (i.e., 95% UCLs) for several metals using 3 different scenarios: 1) Whole Site; 2) Site excluding the operations area; 3) Site excluding operations area and the northwest operations area by Friday 3/14/03.

SERRT Meeting: 1:00 to 4:30 - see meeting note provided by Strategic Initiatives (Chuck Anders). Action Items from SERRT and ERWG meetings will be added to the website.

Action Item Summary Table*			
Action Item #	Assigned To	Description	Due Date
1	BBL	Post final ratified 2/10/03 minutes to the website.	3/14/03
2	BBL	Revise 2/24/03 minutes and redistribute.	3/17/03
3	Mike Rendina - EGS	Revise the background document to reflect the changes discussed in the meeting and distribute revised text and tables to the ERWG.	TBD
4	BBL /Strategic Initiatives	Schedule a conference call for 3/18/03 to discuss metal COPEC selection and the operations area	3/14/03
5	Bonner Anthony - BBL	Email ERWG to clarify that data in database on the website are dry weight and that sum PAH encompasses the 16 indicator compounds.	3/14/03
6	Bonner Anthony – BBL	Calculate 95% UCLs for metals using 3 different scenarios: 1) Whole Site; 2) Site excluding the operations area; 3) Site excluding operations area and the northwest operations area.	3/14/03

* Action item list reflects only action items from 3/11/03 meeting. For a comprehensive list of active action items, see SLO Tank Farm Web Site.

Drafted by Strategic Initiatives based on the March 11, 2003 meeting of the SERRT. Ratified at the August 6, 2003 SERRT meeting.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Draft Meeting Summary

Date: March 11, 2003

Time: 1:00 PM – 3:30 PM

Location: RWQCB Offices, San Luis Obispo

Participants:

Name	Organization	Name	Organization
Chuck Anders	Strategic Initiatives	Diane Kukol	RWQCB
Bonner Anthony	BBL	Chuck Lambert	Lambert Daniels
Melissa Boggs-Blalack	CDFG	John Ljung	Unocal
Regina Donohoe	CDFG	Jeff Poel	Environmental Health
Bob Haddad	AGS	Mike Rendina	England Geosystem
Neil Havlik	City of SLO	Rick Rittenberg	Cannon Associates
Jennifer Holder	BBL	Gary Willey	APCD

General Announcements/Review Previous Meeting Summaries and Tasking Memo

The SERRT members reviewed and ratified the January 8, 2003 meeting summary. The participants also reviewed and updated the near-term action items in the tasking memo

The concept of excluding the operational area from the ecological risk assessment (ERA) and the human health risk assessment (HHRA) was discussed. Removal of this area would be based on the assumption that the operational area poses both ecological and human health risk. Since the operational area would have to be remediated prior to development, a risk assessment of the current situation would be unnecessary. It was emphasized that the possible exclusion of the operational area from the risk assessments does not suggest or imply any particular type of remediation.

Action Item:

Unocal and the Ecological and Human Health Working Groups will discuss this concept further and accept or reject it on the 3/18/03 afternoon conference call.

Status of the Specific Plan and EIR Process

Neil Havlik explained that the Airport Specific Plan is moving forward again. The process had been put on hold at Unocal's request while Unocal assessed whether they should proceed with development at the site. Unocal has requested that the south side of the property (south of Tank Farm Road) be excluded from annexation. Neil explained that the City has made some changes to the plan and he anticipates that it will be completed and adopted around the end of the year or early 2004.

Neil indicated that the costs to complete the specific plan have exceeded budget and an additional $80,000 will be necessary to complete the plan. Unocal has agreed to contribute a portion of the additional funds as a prepayment of development fees since the delay was due in part to Unocal's request.

Overall SERRT Process and Schedule

The overall SERRT process is moving forward as planned. No additional site planning issues have been identified other than Unocal's request to exclude the south portion of the site from City annexation and the possible development of a golf course south of Tank Farm Road.

Jennifer Holder indicated that the ERA is slightly behind schedule. She briefly reviewed the schedule for the various ERA tasks. She had hoped to have the data quality objectives (DQOs) complete for all of the activities and feels that they will be completed soon. She anticipates completion of the ERA this fall as long as all of the data for the wetlands task can be collected this year.

Chuck Lambert anticipates completion of the HHRA in August or September of this year.

Approval of the Human Health Risk Assessment Statement of Work

Chuck Lambert reviewed minor changes to the previous draft of the HHRA workplan. He indicated that an off-site residence receptor will be evaluated; however, no on-site residence receptor will be included since no on-site residence is anticipated at the site. As a result, Unocal may be required to include a deed restriction prohibiting any future on-site residence.

After brief discussion, the March 3, 2003, HHRA Workplan Version 2.0 was unanimously ratified.

Status of Winter Species Survey

Bob Haddad reviewed selected species protocols for various species to be surveyed at the site. He observed that some species require absence to be observed for two consecutive years in order to conclude that the species is not present, thus the survey could not be completed this year. There was extensive discussion regarding the type of survey that was necessary. Neil Havlik indicated that he would like some qualitative assessment of abundance. Jennifer Holder suggested obtaining soil cores in selective areas for benthic organisms. Bob Haddad raised questions regarding the DQO for the species survey.

It was agreed that it is important to understand how the data will be used and how it would support the DQO document and decision criteria. Since there is very little time available to conduct the survey before the rainy season ends this year, the SERRT agreed that a subgroup of Bob Haddad, Jennifer Holder, Melissa Boggs-Blalack and Neil Havlik will prepare draft DQOs for the species survey and the Eco Working Group and Unocal will make a final decision on the DQO decision criteria, species to be surveyed, and the scope of work to conduct the surveys.

Action Items

1. ***Bob Haddad, Jennifer Holder, Melissa Boggs-Blalack, and Neil Havlik will recommend the type of species surveys that they would like to see conducted by March 14th. Bob will prepare a draft scope of work and Jennifer will prepare draft DQOs for the subgroup to review.***

Drafted by Strategic Initiatives based on the March 11, 2003 meeting of the SERRT. Ratified at the August 6, 2003 SERRT meeting.

2. ***The Eco Working Group plus John Ljung will discuss the recommendations of the subgroup by conference call on Tuesday March 18th at 9:30 and agree on the species to be surveyed and the scope of work.***
3. ***Unocal will make its best effort to complete a contract by March 21st to conduct the species surveys.***
4. ***Melissa Boggs-Blalack will check the listing status for the California Tiger Salamander and the Southwestern Pond Turtle by March 14th.***

Surface Water Sampling Workplan – Mike Rendina

Mike Rendina briefly reviewed the Surface Water Sampling Workplan that the Eco Risk Working Group had previously approved. The SERRT unanimously approved the Sampling and Analysis Plan, Supplemental Evaluation of Surface Water dated March 3, 2003. Sampling will begin on Thursday March 13th.

Other COPEC's (e.g. dioxins)

Bob Haddad briefly discussed the status of the data gap report which is in progress and Bob expect's a draft to be out next week (third week in March).

Upcoming Meeting Dates and Agenda Items

March 18th 9:30 AM – 11:00 AM - ERWG Conference Call - Finalize species survey scope of work.

March 18th 1:00 PM – 3:00 PM - ERWG Conference Call – Background Metals

March 20th 9:30 AM - 11:30 AM - ERWG Conference Call – Background Metals (Alternate date if Jim Carlisle is not available on March 18th.)

April 23, 2003 - 9:30 AM – 2:30 PM	***Joint SERRT and Working Group Meeting***
May 14, 2003 - 9:30 AM – 2:30 PM	***Monthly SERRT Meeting***
June 11, 2003 - 9:30 AM – 2:30 PM	***Monthly SERRT Meeting***

Drafted by BBL. Ratified at June 30, 2003 ERWG meeting.

SLO Tank Farm – Ecological Risk Working Group
Draft Summary of Consensus Agreements from 3/18/03 Conference Calls

Date: Tuesday, March 18, 2003

Time: 9:30 AM – 11:45 AM – Data Quality Objectives for Biological Surveys

Participants:

Name	Organization	Name	Organization
Bonner Anthony	BBL, Inc.	Jennifer Holder	BBL, Inc.
Melissa Boggs-Blalack	CDFG	Diane Kukol	RWQCB
Regina Donohoe	CDFG	John Ljung	UNOCAL
Bob Haddad	AGS	Rick Rittenberg	Cannon Associates
Neil Havlik	City of SLO		

The primary objective of the call was to review the Data Quality Objectives (DQOs) for the biological surveys to be conducted at the Site. This includes DQOs for an aquatic invertebrate survey, a benthic invertebrate survey and protocol-level surveys for identified threatened and endangered (T&E) species.

**Consensus Agreements:

- In general, it was decided that all of the identified T&E species and Species of Special Concern at the site would be assumed to be there for the purposes of the predictive ecological risk assessment (pERA). However, if a species is not observed on site in the first year of a protocol survey, the group, may decide based on input from the identified biologist (e.g., presence of critical habitat) to exclude that species from further evaluation in the pERA.
- Protocol surveys will be initiated for any T & E species and Species of Special Concern for which the time specified for initiation has not passed.
- For the T&E species and Species of Special Concern whose timelines for wet season protocol surveys have passed, it was decided that while the biologists are conducting the aquatic and benthic invertebrate surveys, they will also conduct reconnaissance level surveys this winter for these listed species.
- A subgroup of the ERWG will schedule a meeting with the biologist (to be identified by UNOCAL) to discuss the T&E surveys as well as the aquatic and benthic invertebrate surveys. This meeting will be used to discuss the information needs of the pERA relative to the surveys, the level of effort required and sample size, methods, locations, and timeline.
- The DQOs for the T&E surveys will not be finalized at this time. The group will revise the DQOs as necessary based on the meeting and proposal from the identified biologist.
- The winter bird surveys will be initiated this year if the identified biologist verifies the timing is appropriate. If the winter bird survey is not done this year it will be done next year.

Drafted by BBL. Ratified at June 30, 2003 ERWG meeting.

Time: 1:00 – 3:00 PM – Inorganic Background and Site Area Discussion
Participants:

Name	Organization	Name	Organization
Bonner Anthony	BBL, Inc.	Jennifer Holder	BBL, Inc.
Melissa Boggs-Blalack	CDFG	Diane Kukol	RWQCB
Jim Carlisle	OEHHA	Chuck Lambert	McDaniel Lambert, Inc.
Regina Donohoe	CDFG	Rick Rittenberg	Cannon Associates
Bob Haddad	AGS		

The primary objectives of this call were to: 1) make decisions regarding the inclusion or exclusion of the operations area and/or northwest operations area in the pERA; 2) finalize consensus on the inorganic background memo produced by England Geosystems (EGS) to determine which metals should be carried forward for analysis in the pERA.

**Consensus Agreements:

- The pERA will include two scenarios. The first scenario will include both the operations area and the northwest operations area. The second will be a "post-remediation" scenario and will exclude the operations area (as designated on the map provided by EGS). The second scenario would assume that the operations area would be cleaned up to specified remedial goals that would be developed based on the future land use identified for the area.
- Specific metals to be carried forward for the pERA will be determined through the COPEC screening process. BBL will conduct the COPEC screening process for both of the scenarios identified above and will distribute to the group by 3/28/03.
- BBL will provide a summary of the path forward for the pERA and a proposed schedule to the ERWG by 3/28/03.

Drafted by Strategic Initiatives based on the April 23, 2003 meeting of the ERWG. Ratified at the ERWG meeting on June 30, 2003.

SERRT
Environmental Risk Working Group

Final Meeting Summary

Date: April 23, 2003

Time: 9:30 AM – 3:00 PM

Location: Unocal Offices, San Luis Obispo

Participants:

Name	Organization	Name	Organization
Chuck Anders	Strategic Initiatives	Jennifer Holder	BBL
Bonner Anthony	BBL	Diane Kukol	RWQCB
Melissa Boggs-Blalack	CDFG	Chuck Lambert	Lambert Daniels
Regina Donohoe	CDFG	Rick Rittenberg	Cannon Associates
Bob Haddad	AGS	David Wolff*	Rincon Consultants
Neil Havlik	City of SLO		

*Biological Resource Study Agenda Item Only

Draft Biological Resource Study Workplan

David Wolff with Rincon Consultants briefly summarized the draft biological resource study work plan that was previously distributed to all ERWG members. The participants reviewed/revised each section of the draft workplan and approved the workplan as amended. David Wolff will provide the revised work plan and schedule to Chuck Anders who will distribute to the ERWG members. Survey data will be collected real-time and will be provided to the ERWG immediately after it is collected. Rincon will provide the written survey report by August 31, 2003. Any species of concern will be noted.

The ERWG deleted the Phase II - Special-Status Species Surveys from the approved work plan. Unocal intends to proceed with the Phase II study and will keep the ERWG informed.

Action Item:

AI-1: David Wolff will revise and distribute the ratified *Biological Resource Study Workplan.*

Overview of Dioxin Assessment

Discussion of the dioxin assessment was deferred to the next ERWG meeting.

Drafted by Strategic Initiatives based on the April 23, 2003 meeting of the ERWG. Ratified at the ERWG meeting on June 30, 2003.

Surface Water Data and COPEC Screen

Jennifer Holder reviewed the COPEC screen and path forward memorandum and Attachment A that were distributed prior to the ERWG meeting. Jennifer provided the participants with a copy of her presentation.

***** Consensus Agreement:***

- The participants agreed that a specific COPEC could be excluded based on "professional judgment" that is thoroughly discussed and well documented in the report.

Bob Haddad reviewed his in-depth assessment of petroleum constituents in surface water. Bob will provide a written discussion of his findings to the ERWG before the next ERWG meeting.

Action Item:

AI-2: Bob Haddad will provide a written discussion the assessment of petroleum constituents by the next ERWG meeting.

Soil and Sediment

Lead bioavailability*:* Path forward is to look further into the bioavailability test that is recommended by HERD. While the assay was developed for Human Health evaluations, it has been recommended by HERD for use in ecological risk assessment. However, there are a number of uncertainties with the application of this assay to ecological receptors. A subgroup (Chuck, Jennifer and Regina) will reconvene on the subject on a conference call on May 5th at 2:00.

Plant bioassays*:* Available plant benchmarks for TPH and PAHs were discussed. Regina pointed out that because endangered plant species are known to occur on the Site, terrestrial plant bioassays may be necessary to mitigate the uncertainties that are likely to be associated with any benchmark that is developed. Jennifer expressed concerns about the general uncertainties that are typically associated with plant bioassays (i.e.: the plant species available for standard tests may not be relevant to site) and that even if we did conduct plant bioassays, a significant amount of uncertainty could remain. The group was unable to reach consensus regarding plant bioassays and it was decided that BBL will put together a pro con analysis of bioassays (Bob, Regina, Bonner and Jen) for everyone's review prior to the next meeting. Everyone should think about this issue and what information they might need to make risk management decisions so that a decision can be made at the next meeting on June 9.

Surface expressions: A question was posed as to how surface expressions will be addressed in the ERA. The plastic expressions may be bioavailable; however, observations of plants growing through these expressions indicate that the surface tar is a physical hazard rather than a toxicological one.

***** Consensus Agreement:***

- No additional data are required to address surface expressions.

Sediment data: It was generally agreed that the path forward for sediment would be determined based on the results of the benthic surveys being conducted by Dave Wolff. However, as with plants, the T & E species that may be present may require additional evaluation (i.e., the cyst stage of the fairy shrimp). Regina Donohoe will investigate the life cycle of the fairy shrimp to determine if the sediment evaluation will need to include this as a receptor.

Surface water

Metals in surface water were generally found at concentrations below available screening criteria. Barium was detected above its screening criteria, but upon further evaluation and considering the background levels that are present in site soils as the predominant source, it will not require further evaluation. TPH was detected in all surface water samples using the standard TPH analysis. However, when the silica gel TPH analysis was conducted, no TPH was detected. Bob Haddad presented an analysis of the composition of the detected TPH to identify whether the components eliminated using the silica gel analysis could be petroleum related. His analysis indicated that the TPH found in SW-1 was the only location that could be petroleum related.

*****Consensus Agreement:***

- No additional data (i.e., bioassays) will be required for surface water. The uncertainties associated with SW-1 will be discussed in the ERA

Benchmarks and input parameters used in COPEC memo

A subgroup (Regina, Bonner and Jennifer) will meet to further discuss benchmarks and food chain inputs. BBL will provide Regina with additional detail on the benchmarks and parameters used in the COPEC memo. In addition BBL will develop and provide supporting rationale for TPH and/or PAH benchmarks for terrestrial plants and invertebrates. A call or meeting of the subgroup will be scheduled as necessary to work through any outstanding issues.

Action Items:

AI 3: Regina Donohoe will ask the regulator from the Golden Gate Bridge site for information about the use of the lead bioavailability assay for ecological purposes at that site.

AI 4: Chuck Lambert will look into the California mining site where the lead bioavailability assay was used in an ecological risk assessment.

AI 5: Jennifer Holder will review documents from the recent lead bioavailability conference to clarify the utility to better understand the uncertainties of the assay for use in ecological risk assessment.

AI 6: The subgroup (Jennifer, Regina and Chuck) will have a conference call on May 5, 2003 at 2:00 to discuss the use of the lead bioavailability assay.

AI 7: BBL will work with Bob Haddad and Regina Donohoe to develop a pro/con analysis of plant bioassays prior to the June 9 meeting.

AI 8: Regina Donohoe will review the life cycle of fairy shrimp to determine if sediment exposures need to be considered for this receptor if it is identified on the site.

AI 9: Bob Haddad will provide a summary memo regarding the TPH composition analysis he conducted for surface water.

ERWG Business

1. The group decided that the next meeting would be for the ERWG only (no SERRT meeting) and is scheduled for June 9, 2003 at 9:30 am.
2. The Background Evaluation Memo (by EGS) was ratified.
3. The group did not have time to address the 2/24/03 meeting minutes, 3/11/03 meeting minutes, and the consensus agreements from 3/18/03 conference calls in detail. Thus, it was agreed that everyone would review the three documents and send comments or approval to BBL. If comments are minimal, Bonner will make the revisions and the minutes will be considered ratified. If significant comments are received, another draft will be circulated for final approval.

Action Item:

AI 10: ERWG members should take a copy of the most recent minutes (provided at meeting) and email any comments (or approval) to Bonner by 4/30/03.

Upcoming Meeting Dates and Agenda Items

ERWG Meeting: June 11, 2003 from 9:30 AM – 4:30 PM

Drafted by BBL. Ratified at the ERWG meeting of the SERRT on June 30, 2003.

SLO Tank Farm – Ecological Risk Working Group

Final Summary of Consensus Agreements from 6/9/03 Conference Call

Date: Monday, June 9, 2003

Time: 9:00 AM – 11:00 AM

Participants:

Name	Organization	Name	Organization
Bonner Anthony	BBL, Inc.	Jennifer Holder	BBL, Inc.
Melissa Boggs-Blalack	CDFG	Diane Kukol	RWQCB
Jim Carlisle	OEHHA	Chuck Lambert	McDaniel Lambert
Becky Countway	BBL, Inc.	John Ljung	UNOCAL
Regina Donohoe	CDFG	Michael Sullivan	McDaniel Lambert
Bob Haddad	AGS	Dave Wolff	Rincon Consultants
Neil Havlik	City of SLO		

The primary objective of the call was to provide an update on pERA activities and to get resolution of the COPEC selection. Agenda items included:

1. **Update/Report on biological surveys** – Dave Wolff provided an overview of the results of the field surveys. Water column invertebrates and epibenthic invertebrates (mostly larval stages of water column inverts) were observed and a minimal benthic community was found in the bottom sediments. Dave noted that these findings were not surprising because most of the ponds have only a small layer of oxic sediments below which is anoxic clay.

   There were no observations of the California tiger salamander or the California red legged frog. The field biologist noted that these species would not be expected based on the site observations, the observed presence of a population of bull frogs and their know***n*** distribution in the general area of the central coast.

   While no fairy shrimp were observed during the surveys, the biological surveys could not conclusively address the presence or absence of fairy shrimp due to the timing of the surveys. Melissa Boggs-Blalack and Regina Donohoe will make a final determination of the potential exposure of fairy shrimp and the evaluation that will be required in the pERA prior to the 6/30/03 meeting.

   No California black rail were observed in the areas of the site where the most suitable habitat was present (i.e., the north marsh and the southwest marsh).

2. **Update from lead bioavailability bioassay conference call** – Jennifer Holder summarized the results of the ERWG/HHWG subgroup's conference call regarding lead

and arsenic bioavailability bioassays. Based on the information that is provided by this type of assay and the associated uncertainty of applying it to ecological receptors, it was generally agreed that conducting this type of assay would not be highly useful for the pERA. It was also decided that it would not be necessary for the HHRA.

3. **Discuss COPEC selection and Jim Carlisle's concerns** – Jim Carlisle provided written comments regarding the determination of inorganic background COPECs to the group prior to the call. Mike Rendina provided clarifications regarding the assessment of the metals in question (copper, cobalt, vanadium and zinc). Based on this discussion it was agreed that these metals fall within the background population and will not be assessed in the pERA or the HHRA. The high anomalous concentration of molybdenum at B-31 (within Reservoir 4) was discussed. It was generally agreed that this was likely from reinforcement in the concrete bottom of Reservoir 4, and because other samples in the general area showed no anomalous concentrations, no additional sampling will be required.

4. **Update on benchmark selection** – Bonner Anthony provided a draft memo to Regina Donohoe. BBL and Regina will be working together to finalize the memo which will be circulated to the group prior to the 6/30/03 meeting. Bonner extended an open invitation to anyone else in the ERWG to participate in the benchmark development process.

5. **Review outstanding action items** – Bonner Anthony reviewed the outstanding action items (as found on the active action item list on the project web site). Outstanding issues not previously addressed on the call included: 1) development of a data validation/data usability; 2) finalization of the dioxin memo; 3) development of surface water TPH composition memo; 4) development of surface tar and surface soil TPH composition memo; 5) evaluation of the life stage sensitivity of the fairy shrimp; and 6) finalization of the problem formulation tables. The status and path forward for these issues are summarized in the action items below.

6. **Discuss path forward for pERA** – Jennifer Holder summarized the path forward for the pERA. See action items below.

Consensus Agreements:

- Based on the findings of the biological surveys, the pERA will not evaluate the California red legged frog and the tiger salamander as assessment endpoints. The pERA will include a general amphibian assessment endpoint.
- Lead bioavailability bioassays will not be conducted for the pERA or for the HHRA.
- COPEC Selection:
    - No additional sampling for molybdenum will be required.
    - Inorganic COPECs to be evaluated in the pERA and the HHRA are arsenic (scenario 1 only) and lead (both scenario 1 and 2).

Action Items/Path Forward:

- Dave Wolff will provide a preliminary report of the findings for the biological surveys in each wetland by 6/20.
- Melissa Boggs-Blalack and Regina Donohoe will make a final determination of the potential exposure of fairy shrimp and the evaluation that will be required in the pERA prior to the 6/30/03 meeting.

Drafted by BBL. Ratified at the ERWG meeting of the SERRT on June 30, 2003.

- EGS will provide the revised (state) wetland delineation map to the group and will provide BBL with a GIS version of the map by 6/10/03.
- Melissa Boggs-Blalack and Neil Havlik will review the revised wetland map and let BBL know if this is the final map that should be used to identify samples that are evaluated as sediment in the pERA. A call will be scheduled for 6/12 or 6/13 to discuss the finalization of the map.
- BBL will provide a brief assessment of the wetland areas based on the new wetland delineation and on the findings of the biological surveys prior to the 6/30/03 meeting so that a final determination regarding bioassays can be made at the meeting.
- Based on the field reports, the information provided regarding fairy shrimp, and the preliminary wetland assessment, BBL will provide updated problem formulation tables (including proposed assessment and measurement endpoints and receptors of concern) to the ERWG.
- BBL and EGS will draft a data validation and data usability memo for circulation to the ERWG by 6/20/03.
- BBL will work with Regina Donohoe to finalize the benchmark selection memo and will circulate the memo to the group prior to the 6/30/03 meeting.
- Rick Rittenberg will coordinate the dioxin paper and distribute a draft to the group prior to the 6/30/03 meeting (this action item is to be approved by Rick when he returns from vacation).
- Bob Haddad will provide a surface water TPH composition memo to the ERWG by 6/25/03.
- Bob Haddad will provide a TPH composition memo for surface tar and surface soil (pending receipt of data from lab).
- BBL will send out a draft agenda for the 6/30/03 meeting by 6/14/03 so that the group can prioritize their review of the technical memos.

Drafted by Strategic Initiatives based on the June 30, 2003 meeting of the ERWG. Reviewed, revised, and ratified at the ERWG meeting on August 6, 2003.

SERRT
Environmental Risk Working Group

Meeting Summary

Date: June 30, 2003

Time: 9:30 AM – 4:30 PM

Location: Unocal Offices, San Luis Obispo

Participants:

Name	Organization	Name	Organization
Chuck Anders	Strategic Initiatives	Diane Kukol	RWQCB
Bill Almas	Unocal	Chuck Lambert	McDaniel Lambert
Bonner Anthony	BBL	John Ljung	Unocal
Melissa Boggs-Blalack	CDFG	Mike Rendina	England Geosystems
Regina Donohoe	CDFG	Rick Rittenberg	Cannon Associates
Neil Havlik	City of SLO	David Wolff*	Rincon Consultants
Jennifer Holder	BBL		

*Biological Resource Study Agenda Item Only

Review of Previous Meeting Minutes and Action Items

Meeting minutes from 2/24/03, 3/11/03, and two conference calls on 3/18/03 that had been previously distributed for comments were ratified as amended. Meeting minutes from the 4/23/03 ERWG meeting were ratified as amended pending Bob Haddad's review and approval. Consensus agreements from the 6/9/03 conference call were ratified as written, pending Bob Haddad's review and approval.

Action items from the 6/9/03 conference call were reviewed. All action items were complete with the exception of the preparation of two TPH composition memos by Bob Haddad.

The State Wetlands Delineation Report that was distributed on May 29, 2003 was briefly discussed. The report will be ratified by the full SERRT at the next SERRT meeting.

Preliminary Results of the Site Biological Survey

Dave Wolff briefly reviewed the preliminary results of the biological survey that was previously distributed. He indicated that dry season fairy shrimp sampling would be conducted in the near future. Because the presence or absence of the fairy shrimp cannot be definitively determined at this time, it will be assumed to be present in sediment and surface water for the purposes of the pERA.

A question was raised regarding how the results from small area known as SW-1 would affect the overall site. David Wolff indicated that the only species found in SW-1 were aquatic

invertebrates (i.e., no fish or amphibians). Jennifer Holder indicated that the results from SW-1 will be interpreted in light of the receptors present and in terms of its limited spatial area.

Melissa Boggs-Blalack clarified that the presence of Congdon's tar plant does not necessarily require designation of an area as a wetland unless it is a dominate species in the area. Neil Havlik indicated that they have observed the Congdon's tar plant in areas that are clearly not wetlands. Rincon will map the Congdon's tar plant on site in subsequent surveys.

Dave Wolff confirmed that the black rail was not found on site and that it would not be expected given the limited suitable habitat. Melissa Boggs-Blalack clarified that a winter bird survey is still necessary. We also discussed that burrowing owls may be present on site.

** Consensus Agreements:

- Fairy shrimp will be an assessment endpoint in the pERA and will be evaluated in both sediment and surface water in the areas designated as "seasonally wet meadows" in Jenny Langford's revised wetland delineation map.
- The Congdon's tar plant will be evaluated in both the wetland and terrestrial environments.
- The black rail will not be identified as a site receptor for the pERA.

ERA Process Update and Presentation of pERA Outline

Jennifer Holder distributed and reviewed the Ecological Risk Assessment Process Flow Chart. The terminology used to describe the risk assessment was discussed. The term "predictive" ecological risk assessment is a naming convention developed by Califorina's Department of Toxic Substances Control (DTSC) and is generally consistent the USEPA's definition of a screening level risk assessment. The group agreed that the term pERA was appropriate for the risk assessment but that the document should be very clear about what types of assessment the risk assessment includes. BBL believes the most appropriate course of action for the pERA is to complete the assessment with the existing data for the September deliverable, recognizing that the output will generally be consistent with a screening level assessment. A decision regarding the need for a more in depth baseline assessment (i.e., Validation Study) will be made based on the results of the pERA and the needs of the risk managers. Alternative remediation options could also be integrated into this decision process.

John Ljung asked whether temporal considerations would be included in addition to spatial and magnitude factors. Jennifer Holder indicated that temporal factors would be used for mammals and birds that would only be exposed for a portion of the year when water was present; however, temporal factors would not be used for aquatic organisms whose complete life cycle is in water.

** Consensus Agreements

- The term pERA will be appropriate for the process defined, but the document should be clear about what the risk assessment covers.
- The ERWG agreed that the pERA should proceed according to the process presented in the flow chart.
- The output of the pERA will be comparison of site media concentrations to the agreed upon benchmarks and a spatial analysis of these comparisons.
- The pERA will be distributed as one document rather than piecemeal as chapters.

Drafted by Strategic Initiatives based on the June 30, 2003 meeting of the ERWG. Reviewed, revised, and ratified at the ERWG meeting on August 6, 2003.

Overview Presentation of Data Validation/Data Usability Memo

Bonner Anthony and Michael Rendina reviewed the process used to prepare the primary database. Mike Rendina indicated that England Geosystems always relied on the primary data source from the laboratory to check data. It was agreed to call the area currently known as the "operations area" the "former operations area."

The participants provided and discussed comments regarding the draft data usability memo. A revised memo addressing the comments will be prepared and distributed for review by July 9th. Bonner Anthony will obtain comments from Bob Haddad. The working group participants will immediately provide any additional comments on the revised memo to BBL so that it can be ratified at the next ERWG meeting.

Overview Presentation and Discussion of Benchmark Memo

Bonner Anthony provided an overview of the benchmark memo. The working group discussed the appropriateness of using the more conservative lower benchmark values from the CCME studies (782 ppm for plants and 842 ppm for soil invertebrates). Regina Donohoe indicated that the more conservative approach to developing benchmarks (i.e., use of the 10th percentile of 20% effect data) was generally accepted in California. Questions were raised regarding the potential for the more conservative lower benchmark to trigger plant or invertebrate bioassay studies. Jennifer Holder explained that a bioassay would use actual contaminated soil at the SLO Tank Farm and clean reference soil from the site. It was agreed to defer the decision regarding the TPH soil low-benchmark levels until the high-benchmark level values were developed. Any concerns regarding benchmark information should be provided to BBL by July 3rd.

Outstanding issues regarding benchmark development include:

- Verification of frequently detected PAHs using recent PAH data.
- Identification of plant benchmarks and TRVs for frequently detected PAHs.
- Development of TPH sediment benchmark, if possible.
- Identification of TPH mammalian TRV.
- Review of USEPA's model for PAH BAFs and identification of empirical data sources for developing PAH BAFs.
- Development of high benchmarks as necessary.
- Agreement on Low benchmarks.

Finalization of Problem Formulation

BBl distributed the following three tables:

- Table 1 - Wetland Problem Formulation Summary for Screening Level and Baseline Ecological Risk Assessment at the San Luis Obispo Tank Farm
- Table 2 – Terrestrial Problem Formulation Summary for Screening Level and Baseline Ecological Risk Assessment at San Luis Obispo Tank Farm
- Table 3 – Rationale for Selection of ROCs for Wetland Foodweb.

Drafted by Strategic Initiatives based on the June 30, 2003 meeting of the ERWG. Reviewed, revised, and ratified at the ERWG meeting on August 6, 2003.

The Working Group discussed and revised Tables 1 and 2 Wetland and Terrestrial Problem Formulation Summary Table. BBL will distribute revised tables to the Working Group the week of July 7th.

The Working Group discussed the necessity of evaluating amphibians as a separate assessment endpoint. Specifically, the possibility of developing amphibian-specific benchmarks was discussed. Since there are few detected COPEC concentrations in surface water and no exceedances of water quality criteria (all TPH/PAH's were ND after silica gel "cleanup" except for SW-1), it was agreed that development of amphibian-specific benchmarks is not warranted. It was agreed that the assessment endpoint would be revised as "Protection of aquatic invertebrates and vertebrates" (e.g., aquatic invertebrates, fish and amphibians) and that the comparison of surface water concentrations to water quality criteria would be sufficient to address the potential risk to these aquatic receptors.

** Consensus Agreements:
The risk assessment will include 1 assessment endpoint for both aquatic invertebrates and vertebrates. - Agreed to evaluate wetland plants and terrestrial plants separately and Congdon's tar plant locations will be overlayed on areas of contamination.

- Development of amphibian-specific benchmarks is not warranted.

Action Items

AI 1 - Arrange for conference call to review the dioxin memo – Chuck Lambert

AI 2 - Provide surface water TPH composition memo to the ERWG - Bob Haddad

AI 3 - Provide a TPH composition memo for surface tar and surface soil to the ERWG – Bob Haddad

AI 4 – Prepare T/E Species Survey Workplan – is this for fairy shrimp?

AI 5 - Provide Concerns regarding benchmark issues by 7/3/03 - ERWG

AI 6 - Mapping of Congdon's Tarplant and Cambria Morning Glory will be provided to BBL for use in the pERA by mid August - Dave Wolff/John Ljung

AI 7 - BBL will prepare revised data usability memo by July 9th – ERWG will provide comments by July 16th.

AI 8 - BBL will distribute revised problem formulation tables by 7/7/03.

AI 9 - BBL will distribute recommendations for receptors of concern prior to next meeting.

AI 10 - BBL will distribute a revised benchmark memo to the group prior to the 7/30 conference call (schedule for revised draft to be provided by 7/4/03).

Upcoming Meeting Schedule

July 14 (9:30 AM – 11:30 AM) - Dioxin Conference Call (Chuck Lambert will check with Bob Haddad and others regarding availability before sending out the conference call announcement)

Drafted by Strategic Initiatives based on the June 30, 2003 meeting of the ERWG. Reviewed, revised, and ratified at the ERWG meeting on August 6, 2003.

July 30 (9:30 AM – 11:30 AM) - Benchmark Conference Call

August 6 (9:30 AM – 2:00 PM) - ERWG Meeting

August 6 (2:00 PM – 4:00 PM) - Full SERRT Meeting

Drafted by Strategic Initiatives based on the August 6, 2003 meeting of the ERWG. Reviewed, revised, and ratified at the ERWG conference call on September 3, 2003.

SERRT
Environmental Risk Working Group

Meeting Summary

Date: August 6, 2003

Time: 10:30 AM – 1:30 PM

Location: Unocal Offices, San Luis Obispo

Participants:

Name	Organization	Name	Organization
Chuck Anders	Strategic Initiatives	Diane Kukol	RWQCB
Bonner Anthony	BBL	Chuck Lambert	McDaniel Lambert
Melissa Boggs-Blalack	CDFG	John Ljung	Unocal
Michael Clark	City of SLO	Mike Rendina	England Geosystems
Regina Donohoe	CDFG	Rick Rittenberg	Cannon Associates
Bob Haddad	AGS	David Wolff*	Rincon Consultants
Jennifer Holder	BBL		

*Biological Resource Study Agenda Item Only

Review and Ratify the Phase II Biological Studies Workplan

David Wolff reviewed the Phase II Biological Studies Workplan. David confirmed that Rincon Consultants will conduct the survey for all suitable habitats. They will reference appropriate protocols and also identify the laboratory that will evaluate the samples. The surveys will be conducted on August 12 - 14.

The ERWG approved the draft workplan with the following revisions:

- Surveys will be conducted at ALL suitable habitats
- The appropriate survey protocols will be referenced
- The laboratory where the samples will be analyzed will be identified

David also reviewed the results of the recent plant survey. He distributed pictures and location maps of the Cambria morning glory and Congdon's tar plant. David indicated that Rincon will provide a composite map of the distributions of the plants of concern and sample locations by next week. The final report will be provided by August 30th.

A question was raised regarding whether the cattle created a confounding aspect of the plant survey. John Ljung explained that the cattle were currently used for fire suppression. Unocal would entertain any other ideas for fire suppression.

Drafted by Strategic Initiatives based on the August 6, 2003 meeting of the ERWG. Reviewed, revised, and ratified at the ERWG conference call on September 3, 2003.

Action Items:

1. Rincon will prepare a composite map of the distributions of the two plants of concern and sample locations by August 15.
2. Rincon will revise and finalize Phase II Biological Studies Workplan.
3. Rincon will distribute the final field survey reports by August 30.Rincon will include discussions regarding distribution of Congdon's tar plant and Cambria morning glory in the field survey report.

Review of Previous Meeting Minutes and Action Items

The ERWG ratified the June 30, 2003 ERWG meeting summary with revisions. The August 4, 2003 draft ERWG conference call summary was distributed for review, discussed and revised. Chuck Anders will distribute the revised summary and solicit comments from Neil Havlik regarding references to his concerns about providing information to the public. Diane Kukol will also provide Neil and Chuck with her recommended language regarding the need for clarity when communicating with the public.

The ERWG also reviewed the action items from the June 30, 2003 ERWG meeting summary. All action items have been completed with the exception of the preparation of the surface water TPH composition memo by Bob Haddad. Bob indicated that the memo was close to completion and he would distribute the memo soon.

Action Items:

1. Chuck Anders will distribute 8/4/03 ERWG conference call summary to the ERWG and specifically solicit comments from Neil Havlik.
2. Diane Kukol will draft recommended language regarding the need for clarity when communicating with the public.
3. Bob Haddad will complete and distribute the surface water TPH composition memo.

Draft Screening Benchmark and Bioaccumulation Factor Technical Memorandum

BBL was not able to address the development of a mammalian TPH benchmark for crude oil (as was requested on the 8/4/06 conference call). Recognizing that that specific issue would remain outstanding, the Benchmark and Bioaccumulation factor (BAF) memo was discussed. Regina Donohoe would like the following technical points addressed prior to finalizing the memo:

1. develop a mammalian TPH benchmark specifically for crude oil (specific literature provided by Regina Donohoe),
2. develop BAFs for PAHs in sediment (rather than defaulting to soil values),
3. provide the octonol/water partitioning factors (Kows) used to calculate the plant BAF modeled values,
4. expand Table 4 (i.e., BAF summary table) to include all PAHs,

5. include the underlying data used in the development of the soil invertebrate BAFs,
6. clarify the discussion in the TPH direct toxicity benchmark section on the studies conducted by Salanitro et al (1998) and Dorn et al (2001 and).

It is critical to BBL to finalize the screening levels so that the risk assessment can be conducted. These issues will be addressed by BBL working with Regina Donohoe over the next two weeks and a revised memo will be circulated to the ERWG by 8/22/03. Bob Haddad emphasized that it is important to convey, particularly to the risk managers, that while there is a broad range of recognized screening values, we have chosen highly conservative levels.

Action Items:

1. BBL will review references provided by Regina Donohoe and prepare a recommendation for the mammalian TPH TRV and PAH sediment BAFs by August 15.

2. Regina Donohoe will provide key technical references to Diane Kukol and Melissa Boggs-Blalack.

3. Bob Haddad will provide language to be included in the benchmark memorandum to address his uncertainty concerns.

4. BBL will provide a redline version of the technical memorandum by August 22.

Review of TPH Memorandum

Bob Haddad presented his findings regarding the distribution of carbon ranges for the TPH concentrations at the site. Hydrocarbons appear to be weathered and dominated by heavy molecular weight components (C25-C40 range). He characterized the hydrocarbons in soils and tars in terms of broad organic families and reviewed the TPH – PAH correlations. He observed that the concentrations of both the aliphatic and aromatic fraction increase with increasing carbon range for both soils and tars. Bob will provide BBL with the information presented at the meeting and complete a draft of the TPH memorandum for review by August 20.

Action Item:

1. Field photos will be obtained for samples to determine if samples are plastic.
2. Bob Haddad will provide BBL with the TPH information presented at meeting.
3. Bob Haddad will distribute a draft TPH memorandum for review by August 20.
4. Bonner Anthony will verify that the sum-PAH numbers are calculated in a consistent manner.

Receptors of Concern Technical Memorandum

BBL distributed a draft SLO Tank Farm Selection of Receptors of Concern Technical Memorandum and provided an overview presentation of the contents of the memo. Jennifer

Holder explained that the ecological risk protocol requires that they identify a specific species to represent each feeding guild of birds or mammals identified as assessment endpoints for the Site. The technical memorandum discusses the species that were observed on site and BBL's recommendations for receptors of concern for each guild.

Action Items:

1. Melissa Boggs-Blalack will check to see if the California Gull is designated as a species of special concern.
2. Jennifer Holder will send Neil Havlik a copy of the draft technical memorandum.
3. The ERWG will provide comments to Jennifer and Bonner by August 13.
4. BBL will provide a revised draft of the Receptors of Concern Technical Memorandum, including a summary table of exposure parameters for each receptor, by August 22.

Upcoming Meeting Schedule

- ***ERWG Conference Call – September 3, 2003 (10:00 AM – Noon)***

    1. Review and approve the August 6, 2003 ERWG meeting summary.
    2. Ratify the Data Validation and Data Usability Memo
    3. Review the revised draft Screening Benchmark and Bioaccumulation Factor Technical Memorandum.
    4. Review the revised Receptors of Concern Technical Memorandum.

Drafted by Strategic Initiatives based on the August 6, 2003 meeting of the SERRT. Reviewed, revised, and ratified at the meeting on October 29, 2003.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Ratified Meeting Summary

Date: August 6, 2003

Time: 2:00 PM – 4:00 PM

Location: Unocal Offices, San Luis Obispo

Participants:

Name	Organization	Name	Organization
Chuck Anders	Strategic Initiatives	Diane Kukol	RWQCB
Bonner Anthony	BBL	Chuck Lambert	McDaniel Lambert
Melissa Boggs-Blalack	CDFG	John Ljung	Unocal
Regina Donohoe	CDFG	Mike Rendina	England Geosystem
Bob Haddad	AGS	Rick Rittenberg	Unocal
Jennifer Holder	BBL	Heather Tomley	APCD

General Announcements/Review Previous Meeting Summaries and Tasking Memo

It was announced that Jeff Poel will not be able to continue to participate in the SERRT due to workload limitations. Jeff will ask Curt Batson whether the County Department of Health will assign another staff member to participate in SERRT activities.

The SERRT members reviewed and ratified the March 11, 2003 meeting summary as revised. The participants also reviewed and updated the near-term action items in the tasking memo

Status of the Specific Plan and EIR Process

Chuck Anders distributed a schedule provided by Neil Havlik outlining the City's schedule for the San Luis Obispo Airport Area and Margarita Area Specific Plans. It is the City's intention to approve the combined EIR and the Margarita Area Specific Plan by the end of 2003. It is anticipated that the San Luis Obispo Airport Area Specific Plan will be approved in the spring of 2004.

Chuck Anders indicated that Neil Havlik expressed a desire for the SERRT to view a map that showed the location and concentrations of surface expressions of petroleum products. Neil is concerned that the participants have a good understanding of the spatial extent of the areas that the SERRT is discussing rather than simply refer to the area in square feet or acres. Mike Rendina will contact Neil to review the available data and discuss what maps are currently available.

Drafted by Strategic Initiatives based on the August 6, 2003 meeting of the SERRT. Reviewed, revised, and ratified at the meeting on October 29, 2003.

Action Item:

1. Mike Rendina will contact Neil Havlik to review site data and discuss available maps that would illustrate the extent of surface expressions of petroleum.

Dioxin White Paper

Chuck Lambert provided a brief overview of the paper entitled Dioxin Compounds in Soil at the Unocal San Luis Obispo Tank Farm dated July 30, 2003. The SERRT ratified the paper as written.

Human Health Risk Assessment Update and Path Forward

Chuck Lambert presented the status of the Human Health Risk Assessment (HHRA). Chuck has completed the site conceptual model and developed the exposure parameters. He has also compiled and reviewed all available site data. Remaining tasks include conducting the HHRA, determining health-based protective levels for the site, and preparing a draft and final report. Chuck anticipates completing the draft report in 4-8 weeks.

Ecological Risk Assessment and Path Forward

Jennifer Holder distributed and reviewed the ecological risk assessment (pERA) process flow chart. She indicated that it would be very difficult to complete the draft report by the end of September especially since the biological resources report would not be complete until the end of August. It was the consensus of the SERRT that the schedule for completion of both risk assessments be extended 2-3 weeks to assure that all data are thoroughly considered. It was suggested that BBL and McDaniel Lambert make their initial presentation of results and distribute their draft reports at the next SERRT meeting on October 29, 2003. Rick Rittenberg will discuss the time extension with Bill Almas.

Action Item:

1. Rick Rittenberg will discuss extending the completion date of the pERA and HHRA to October 29, 2003.

State Wetland Delineation Report

John Ljung indicated that the state wetland delineation report should be completed by the end on August. The revised report will reflect the comments provided by Melissa Boggs-Blalack and Diane Kukol. It was agreed that the revised report would not require SERRT ratification. Melissa will follow-up to obtain an approval letter from the California Department of Fish and Game (CDFG).

Action Items:

1. John Ljung will work with Jennifer Langford with JENESIS to finalize the State Wetland Delineation report by the end of August.
2. Melissa Boggs-Blalack will obtain a letter of approval from the CDFG.

Drafted by Strategic Initiatives based on the August 6, 2003 meeting of the SERRT. Reviewed, revised, and ratified at the meeting on October 29, 2003.

Upcoming Meeting Dates and Agenda Items

October 29, 2003 (9:30 AM – 2:30 PM)

1. Review/Approve August 6, 2003 Meeting Summary.
2. Presentation of Results of HHRA.
3. Presentation of Results of pERA.
4. Next Steps/Action Items

Drafted by Strategic Initiatives based on the September 3, 2003 ERWG conference call. Reviewed and ratified at the ERWG conference call on September 25, 2003.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Ecological Risk Assessment Working Group

Conference Call Summary

Date: **September 3, 2003**

Time: **10:00 AM – 11:00 AM**

Participants:

Name	Organization	Name	Organization
Chuck Anders	Strategic Initiatives	Jennifer Holder	BBL
Rebecca Countway	BBL	Diane Kukol	RWQCB
Regina Donohoe	CDFG	Rick Rittenberg	Unocal
Neil Havlik	City of SLO		

ERWG Business

The ERWG reviewed and ratified the August 4 ERWG conference call summary. The ERWG also reviewed and ratified the August 6, 2003 ERWG meeting summary.

Data Validation and Data Usability Memo

The ERWG briefly discussed and ratified the Draft Data Verification and Analysis Technical Memorandum (version 1.1) dated July 9, 2003. It was agreed that the memorandum would be included as an attachment to the risk assessment and any subsequent changes would be called out and discussed in a "variant" section of the pERA.

Draft Screening Benchmark and Bioaccumulation Factor Technical Memorandum

The ERWG discussed the Draft Screening Benchmark and Bioaccumulation Factor Technical Memorandum (version 1.4) dated August 22, 2003. Regina Donohoe will provide minor editorial comments to BBL. Diane Kukol indicated that she had no comments. Melissa Boggs-Blalack had previously submitted an email indicating that she had no comments on this draft. Ratification of the draft memorandum was placed on the agenda of the next ERWG conference call so that Bob Haddad will have the opportunity to offer his comments, if any.

Action Items:

1. Chuck Anders will check with Bob Haddad to determine if he has any comments on version 1.4 of the Draft Screening Benchmark and Bioaccumulation Factor Technical Memorandum.
2. Ratify draft memorandum at the next ERWG conference call.

Drafted by Strategic Initiatives based on the September 3, 2003 ERWG conference call. Reviewed and ratified at the ERWG conference call on September 25, 2003.

Revised Receptors of Concern Technical Memorandum

The ERWG discussed the Revised Receptors of Concern Technical Memorandum (version 1.1) dated September 3, 2003. Regina Donohoe provided comments regarding the correlation of the type of habitat at the tank farm site with the home range habitat for the mallard, harrier and coyote. BBL intends to use home range information qualitatively and will include additional language to clarify how it should be considered. Regina also pointed out a calculation error in the spreadsheet for soil ingestion rates for the western sandpiper, heron, raccoon and California vole. BBL will check all similar calculations. Regina is not comfortable with the 3% soil ingestion rate for the shrew because there is so little data available. Regina will send BBL the reference for the rates that were used at Guadalupe. Regina observed that the memorandum was very clear and thoroughly described how values were derived. BBL will distribute a revised draft early in the week of September 8th and will begin to use the information to prepare the pERA. The revised draft will be ratified at a future ERWG conference call.

Action Items:

1. Regina Donohoe will send BBL the reference for the rates that were used for the shrew at Guadalupe.
2. BBL will distribute the revised memorandum early in the week of September 8th.
3. The Revised Receptors of Concern Technical Memorandum will be ratified during a future ERWG conference call.

Follow-up from the August 6, 2003 ERWG Meeting

Action items from the August 6, 2003 ERWG meeting were reviewed. Chuck Anders will check the status of the following items:

1. Preparation of a composite map showing the distributions of the Cambria morning glory and Congdon's tar plant at the site. (Rincon and England Geosystems)
2. The final biological studies field survey reports, which were to be distributed by August 30th. (Rincon)
3. Additional language from Bob Haddad to be included in the Draft Screening Benchmark and Bioaccumulation Factor Technical Memorandum.
4. Compilation of field photos to determine if samples collected at the site are plastic. (England Geosystems)
5. Bob Haddad's comments, if any, on the Revised Receptors of Concern Technical Memorandum.

Upcoming Meetings and Conference Calls

<u>ERWG Conference Call – Tuesday September 9, 2003 from 3:00 PM – 4:00 PM</u>

(Contingent upon Bob Haddad's availability)

1. Review and approve September 3, 2003 ERWG conference call summary.
2. Ratify Draft Screening Benchmark and Bioaccumulation Factor Technical Memorandum (version 1.4) dated August 22, 2003

Drafted by Strategic Initiatives based on the September 3, 2003 ERWG conference call. Reviewed and ratified at the ERWG conference call on September 25, 2003.

3. Review Bob Haddad's memorandum on TPH characterization of SLO Tank Farm surface waters dated August 25, 2003. (Distributed via email on 8/25/03)
4. Discuss Bob Haddad's memorandum on TPH characterization in SLO Tank Farm surface soils, sediments, and tars dated August 25, 2003 (Distributed via email on 8/29/03)

<u>ERWG Conference Call – Monday September 15, 2003 from 10:00 AM – 11:00 AM</u>

(Backup time if Bob Haddad is not available on 8/9/03)

Drafted by Strategic Initiatives based on the September 25, 2003 ERWG conference call. Reviewed, revised, and ratified at the ERWG Conference Call on November 6, 2003.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Ecological Risk Assessment Working Group

Conference Call Summary

Date: **September 25, 2003**

Time: **3:00 PM – 4:00 PM**

Participants:

Name	Organization	Name	Organization
Chuck Anders	Strategic Initiatives	Jennifer Holder	BBL
Bonner Anthony	BBL	Diane Kukol	RWQCB
Rebecca Countway	BBL	Chuck Lambert	McDaniel Lambert
Jim Carlisle	OEHHA	John Ljung	Unocal
Regina Donohoe	CDFG	Rick Rittenberg	Unocal
Bob Haddad	AGS	David Wolff*	Rincon Consultants
Neil Havlik	City of SLO		

*Discussion of preliminary fairy shrimp survey results only.

Discussion of Preliminary Fairy Shrimp Survey Results

David Wolff summarized the results of the fairy shrimp dry season survey. Rincon collected a total of 36 soil samples from all sites that were deemed suitable wetland habitat locations; 27 samples had cysts of the genus *Branchinecta,* which were all cultured to *B. lynchii* (known by common name as the vernal pool fairy shrimp, which is federally listed as a threatened species). The more common unlisted fairy shrimp *Linderiella occidentalis* (known by common name linderiella) was found co-occurring with *B. lynchi* at 11 of the sample locations. The final report and map will be issued the week of October 6th.

Regina Donahoe indicated that Melissa Boggs-Blalack will keep Steve Henry with the US Fish and Wildlife Service informed of the findings.

Action Items:

1. *David Wolff will distribute the fairy shrimp final report and map the week of October 6th.*

ERWG Business

The ERWG reviewed and ratified the September 3, 2003 ERWG conference call summary as written.

Drafted by Strategic Initiatives based on the September 25, 2003 ERWG conference call. Reviewed, revised, and ratified at the ERWG Conference Call on November 6, 2003.

Draft Screening Benchmark and Bioaccumulation Factor Technical Memorandum

The ERWG discussed and ratified (as written) the Draft Screening Benchmark and Bioaccumulation Factor Technical Memorandum (version 1.5) distributed by Bonner Anthony on September 22, 2003.

Action Items:

1. *Bonner Anthony will distribute the ratified Screening Benchmark and Bioaccumulation Factor Technical Memorandum to the ERWG for their files.*

Draft Selection of Receptors of Concern Technical Memorandum

The ERWG discussed the revised the Receptors of Concern Technical Memorandum (version 1.2) dated September 24, 2003. Neil Havlik suggested that a listing of the chosen receptors of concern to be used for the ecological risk assessment be included in the document summary and that the summary reference the appropriate tables. The ERWG ratified version 1.2 of the Receptors of Concern Technical Memorandum dated September 24, 2003 including Neil's suggested revision.

It was agreed that technical memorandums and meeting summaries will be attached to the risk assessment documents and stand-alone reports will be referenced.

Action Items:

1. *Bonner Anthony will distribute a PDF of the ratified Receptors of Concern Technical Memorandum (including tables) to the ERWG by September 29, 2003.*

Surface Water TPH Technical Memorandum

The ERWG briefly discussed and ratified the Surface Water TPH Technical Memorandum version 1.2 dated September 17, 2003. It was agreed that it was acceptable to apply the findings in the memorandum differently in the human health risk assessment and the ecological risk assessment since there is less availability of toxicity benchmarks for the ecological risk assessment. Once the risk assessments are drafted, the language will be reviewed to assure that the two documents are coordinated.

Soils, Sediments, and Surface Tars TPH/PAH Technical Memorandum

The ERWG discussed the Soils, Sediments and Surface Tars TPH/PAH Technical Memorandum version 1.1 dated September 17, 2003. Jim Carlisle questioned why Dibenzo(a,h)anthracene was not taken into consideration to estimate the PAH concentrations. He also suggested the inclusion of upper and lower confidence limits on the slope of the regression analysis. Bob Haddad will review how Dibenzo(a,h)anthracene was handled and will also include the upper and lower confidence limits. Bob will redistribute a revised draft highlighting the revised language and pointing out the changes in the transmittal letter. The revised draft will be ratified by email.

The use of the data in the technical memorandum was discussed. Both Chuck Lambert and Jennifer Holder indicated that they believe that the measured data adequately characterizes the site and that they intend to use measured rather than modeled PAH

values. Regina Donohoe and Jim Carlisle agreed that empirical data are preferred as long as they adequately characterize the site.

Action Items:

1. *Bob Haddad will review* how Dibenzo(a,h)anthracene was handled and will also include the upper and lower confidence limits in the revised draft. He will distribute a revised draft by October 3, 2003.
2. *Chuck Anders will coordinate the ratification of the revised draft via email.*

Risk Assessment Schedule and Review Process

Both Jennifer Holder and Chuck Lambert indicated that they are on schedule to distribute the draft risk assessments on October 29th. There was a discussion regarding the appropriate distribution of the draft documents and the review process. It was agreed that Chuck Anders will poll the SERRT members to determine which risk assessments they want to review and whether they require a hard copy or electronic version. The review procedure will be established after the draft documents are distributed and the extent of revisions is better understood. Participants expressed a desire to submit written comments rather then conduct a line-by-line review.

Action Items:

1. *Chuck Anders will poll the SERRT members to determine which draft risk assessment documents they want to review and whether they need a hard copy or an electronic version.*

Upcoming Meetings and Conference Calls

<u>SERRT Meeting – Wednesday October 29, 2003 from 9:30 AM – 2:30 PM</u>

1. Review Draft Human Health Risk Assessment
   - Presentation of Findings (Chuck Lambert)
   - Discussion
2. Review Draft Ecological Risk Assessment
   - Presentation of Findings (Jennifer Holder/Bonner Anthony)
   - Discussion
3. Discuss and Agree on the Review and Approval Process (Chuck Anders)

Drafted by Strategic Initiatives based on the October 29, 2003 meeting of the SERRT. Ratified, as written, at the meeting on January 21, 2004.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Meeting Summary

Date: October 29, 2003

Time: 9:30 AM – 2:30 PM

Location: RWQCB Offices, San Luis Obispo

Participants:

Name	Organization	Name	Organization
Bill Almas	Unocal	Diane Kukol	RWQCB
Chuck Anders	Strategic Initiatives	Michael LeBrun	RWQCB
Bonner Anthony	BBL	Chuck Lambert	McDaniel Lambert
Regina Donohoe	CDFG	John Ljung	Unocal
Bob Haddad	AGS	Mike Rendina	England Geosystem
Neil Havlik	City of SLO	Rick Rittenberg	Unocal
Jennifer Holder	BBL		

General Announcements/Review Previous Meeting Summaries and Action Items

Bill Almas briefed the SERRT on the status of the recent Holdgrapher trial. The case involved a historic leak that had taken place from a Unocal pipeline along Tank Farm Road. Bill explained that Unocal has been working with land owners along Tank Farm Road for the past twelve years to resolve issues associated with the pipeline leak. They have reached agreement with a number of landowners; however, one case recently went to trial. The jury returned a judgment of $2.5 million plus $10 million punitive damages. While the issues associated with the pipeline leak and the tank farm are completely separate, it is likely that the public will not differentiate between the pipeline and the tank farm so the jury verdict could have an impact on the SERRT activities.

The SERRT members reviewed and ratified the August 6, 2003 SERRT meeting summary as revised. The participants also reviewed and updated the near-term action items in the meeting summary. All action items have been completed except obtaining a letter of approval of the State Wetland Delineation Report from the CDFG. Diane Kukol indicated that she would obtain a similar letter of approval from the RWQCB.

Action Items:

1. *Melissa Boggs-Blalack will obtain a letter of approval of the State Wetland Delineation Report from the CDFG.*
2. *Diane Kukol will obtain a letter of approval of the State Wetland Delineation Report from the RWQCB.*

Drafted by Strategic Initiatives based on the October 29, 2003 meeting of the SERRT. Ratified, as written, at the meeting on January 21, 2004.

Status of the Specific Plan and EIR Process

Neil Havlik indicated that drafts of the Airport Area Specific Plan, the Margarita Area Specific Plan and the combined EIR have been circulated for comment. These documents are scheduled to go to the Planning Commission for approval in December of this year. The City Council will likely take action on the combined EIR and the Margarita Area Specific Plan in January with action on the San Luis Obispo Airport Area Specific Plan shortly thereafter.

Status of Land Use Planning Process

Bill Almas indicated that Unocal's land use planning process was tracking the City process. Unocal recently sold a twenty acre parcel directly west of the tank farm operations area.

Preliminary Results of the Ecological Risk Assessment

Jennifer Holder and Bonner Anthony distributed the draft ecological risk assessment to the SERRT participants. Jennifer explained how the draft report was organized provided an overview of the following sections:

- Introduction
- Site Setting
- Problem Formulation
- Exposure Assessment
- Effects Assessment
- Risk Characterization
- Uncertainty Analysis
- Conclusions

Jennifer emphasized that the pERA was a screening level document and uses conservative assumptions. She indicated that reservoirs 5 & 7 and all surface tar expressions were excluded from the pERA and would be addressed separately by Unocal. Neil Havlik also questioned why these areas were not included in the pERA. Bill Almas indicated that they were not included because in was assumed that they would have to be addressed in some manner in the remediation phase of the process and would, therefore, be included in the EIR.

Neil Havlik emphasized that it is important to clearly state what was done in language that the public can understand. SERRT participants expressed concern that the terms "probable risk" and "possible risk" could be easily misunderstood.

The ERWG will have a brief conference call on Thursday, November 6th at 3:00 PM. The purpose of the call will be to discuss the extent of comments anticipated on the draft pERA.

Action Items:

1. Chuck Anders will coordinate a conference call with the ERWG to discuss the extent of comments anticipated on the pERA.

Drafted by Strategic Initiatives based on the October 29, 2003 meeting of the SERRT. Ratified, as written, at the meeting on January 21, 2004.

Preliminary Results of the Human Health Risk Assessment

Chuck Lambert distributed the draft human health risk assessment to the SERRT participants and reviewed the following sections of the draft report:

- *Objectives of the risk assessment*
- *HHRA Paradigm*
- *Selection of COPECs*
- *Data Analysis*
- *Conceptual Exposure Model*
- *Exposed Populations*
  - *Recreational*
  - *Offsite Residential*
  - *Construction Worker*
  - *Business Park Employee*
- *Soil Gas*
- *Dose-Response Assessment*
- *Risk Characterization*
- *Health Based Protective Concentrations*
- *Uncertainty Analysis*
- *Risk Conclusions*

It was agreed that a meeting of the HHRA Working Group would be convened within the next 10 days since many working group participants were not available to attend the SERRT meeting. Chuck Anders will schedule the meeting. It was also suggested that the San Luis Obispo Fire Department representative be invited to review the draft HHRA.

Action Items:

1. Chuck Anders will coordinate a meeting of the HHRA Working Group within the next 10 days to discuss the draft HHRA.

Risk Assessments Review Schedule

It was observed that many of the ERWG participants are committed to reviewing the ecological risk assessment for the Guadalupe Restoration Project during November and December. Therefore, it was agreed that the participants should complete their review of the risk assessments by the next SERRT meeting to be held on January 21, 2004. The participants should focus on the following questions:

1. Are the participants comfortable with the technical information in the report?
2. Are additional validation studies necessary? If so, what are they?
3. Is the available information adequate to make risk management decisions?

Action Items:

1. Participants will review the risk assessments and be prepared to discuss their comments at the January 21, 2004 SERRT meeting.

Drafted by Strategic Initiatives based on the October 29, 2003 meeting of the SERRT. Ratified, as written, at the meeting on January 21, 2004.

Winter Species Survey Proposal

The proposal for conducting a winter species survey was recently distributed for review and comments were requested by November 7th. Melissa Boggs-Blalack will not be back in the office to review the proposal until November 17th. It was agreed that John Ljung would check with David Wolff to see if he can wait for comments until after Melissa returns. If his schedule requires comments sooner, we will stay with the current schedule and any changes in the scope requested by Melissa will be incorporated after she returns.

Action Items:

1. John Ljung will check with David Wolff to determine when he needs comments on the winter species survey proposal.

Upcoming Meeting Dates and Agenda Items

ERWG Conference Call - November 6, 2003 (3:00 PM – 4:00 PM)

1. Review/approve September 25, 2003 meeting summary.
2. Discuss scope of comments anticipated on the draft pERA.
3. Confirm/revise review schedule.

HHRA Working Group Meeting - Date/Time to be Determined

1. Presentation of HHRA results
2. Questions/discussion
3. Confirm/revise review schedule.

SERRT Meeting - January 21, 2004 (9:30 AM – 2:30 PM)

1. Review/approve October 29, 2003 meeting summary.
2. Review/discuss comments on the draft HHRA.
3. Review/discuss comments on the pERA.
4. Discuss risk management/remediation activities and schedule
5. Next steps/action items

Drafted by Strategic Initiatives based on the November 6, 2003 ERWG conference call. Reviewed, revised, and ratified at the ERWG meeting on January 21, 2004.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Ecological Risk Assessment Working Group

Conference Call Summary

Date: **November 6, 2003**

Time: **3:00 PM – 3:30 PM**

Participants:

Name	Organization	Name	Organization
Chuck Anders	Strategic Initiatives	Neil Havlik	City of SLO
Bonner Anthony	BBL	Jennifer Holder	BBL
Regina Donohoe	CDFG	Diane Kukol	RWQCB

ERWG Business

The ERWG reviewed and ratified the October 25, 2003 ERWG conference call summary Version 2 as revised.

Discuss the Process for Review of the Draft Ecological Risk Assessment

In general, participants were pleased with the draft pERA and had not identified any significant problems during their preliminary review. The following review process was agreed to (contingent on Unocal's concurrence):

1. Participants will prepare a written memorandum discussing any significant comments. Editorial revisions can be submitted in a red-lined format if they feel it would be beneficial. Written comments (and red-lined revisions) are to be distributed to the ERWG no later than January 9, 2004)
2. A one-day ERWG meeting will be held on January 21, 2004 to discuss the issues identified in the written comments. The schedule to complete the review process will also be discussed, including the role-out to the public if there is adequate time. The meeting on January 21st will be from 9:30 AM – 4:00 PM and be held at the RWQCB offices in San Luis Obispo.
3. BBL will prepare a revised draft pERA based on the comments received prior to the 1/21 meeting, and distribute the draft for review (schedule to be determined on 1/21/04).
4. Participants will review the revised pERA and submit any additional comments (schedule to be determined on 1/21/04).
5. BBL will prepare a final draft pERA for ratification (schedule to be determined on 1/21/04).

Drafted by Strategic Initiatives based on the November 6, 2003 ERWG conference call. Reviewed, revised, and ratified at the ERWG meeting on January 21, 2004.

BBL indicated that they had identified one typo in the draft pERA. The assessment endpoint designations in the text box on page 6-12 that summarizes the Tier 2 wetland assessment results should be AE: W… instead of AE:T…

Action Items:

1. *Bonner Anthony will distribute the Word version of the text of the draft pERA to the ERWG.*
2. *Chuck Anders will discuss the proposed review schedule with Unocal and obtain their concurrence or suggested revisions.*
3. *ERWG members will prepare and distribute a* written memorandum discussing significant comments by January 9, 2004. Red-lined edits may also be submitted.

Upcoming Meetings and Conference Calls

ERWG Meeting – Wednesday January 21, 2004 from 9:30 AM – 4:00 PM at the RWQCB

1. Review/Ratify the 11/6/03 ERWG Conference Call Summary (Chuck Anders)
2. Review and Discuss Written Comments on the Draft pERA (Jennifer Holder/Bonner Anthony)
3. Discuss and Agree on the Review and Approval Process and Schedule (Chuck Anders)
4. Discuss the Roll-Out of the pERA to the Public (if time available)

Drafted by Strategic Initiatives based on the January 21, 2004 ERWG meeting. Reviewed, revised, and ratified at the SERRT meeting on March 23, 2004.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Ecological Risk Assessment Working Group

Meeting Summary

Date: **January 21, 2004**

Time: **9:00 AM – 12:15 PM**

Participants:

Name	Organization	Name	Organization
Chuck Anders	Strategic Initiatives	Neil Havlik	City of SLO
Bonner Anthony	BBL	Jennifer Holder	BBL
Melissa Boggs-Blalack	CDFG	Diane Kukol	RWQCB
Teri Copeland	SLO County Health Dept.	Chuck Lambert	McDaniel Lambert
Regina Donohoe	CDFG	John Ljung	Unocal
Bob Haddad	AGS	Rick Rittenberg	Unocal

ERWG Business

The ERWG reviewed and ratified the November 6, 2003 conference call summary, as revised.

Melissa Boggs-Blalack indicated that she had talked with Steve Henry with the US Fish and Wildlife Service (USFWS) regarding finding the fairy shrimp on the SLO Tank Farm site. Steve said that USFWS does not have the staff to get involved at this time. He indicated that they would become involved when Unocal proposed a remedial action. He also indicated that they could get involved in the process earlier if Unocal could financially support their participation.

Melissa felt it would be beneficial to have the USFWS involved earlier because it would speed up their response in the future. She felt that it would be important to get their input when Unocal begins thinking about remedial options. Melissa thought that the USFWS would want all suitable habitat surveyed, including the contaminated areas that were not included in the recent biological survey.

The ERWG agreed that it would be beneficial to involve the USFWS during the risk management/remediation phase if Unocal can get authorization to provide the funding.

Action Items:

1. *Unocal will determine if they can secure the funding to support the USFWS participation.*

Drafted by Strategic Initiatives based on the January 21, 2004 ERWG meeting. Reviewed, revised, and ratified at the SERRT meeting on March 23, 2004.

Review Status of Winter Species Survey

John Ljung announced that David Wolf would be starting the winter bird surveys at the SLO Tank Farm site on 1/23/03 and continuing on a weekly basis.

John also announced that the invertebrate biologist had begun the wet season surveys for the Morro shoulderband snail. He indicated that four Morro shoulderband snails were observed in two locations. Unocal will continue to conduct surveys to identify specific locations of the species. The final assessment of locations will be available after the rainy season and the report would most likely be available in mid-summer.

The ERWG agreed that the finding of the snail would be incorporated into the pERA. before the next red-lined draft is prepared. John Ljung will obtain a preliminary report on the locations of the shoulderband snail from the biologist. John will also set up a conference call with the biologist to discuss the finding. BBL will prepare a draft proposal for integrating the snail into the pERA for ERWG review and comment.

It was agreed that Melissa should continue to keep Steve Henry informed. She will also contact Lisa Mangione with the USACE to inform her of the findings of the fairy shrimp and Morro shoulderband snail to determine if they want to become more involved in the SERRT activities.

Action Items:

1. *John Ljung will set up a conference call with the biologist to discuss the shoulderband snail finding.*
2. *John Ljung will arrange for a preliminary report on the locations of the Shoulderband Snail from the biologist.*
3. *BBL will prepare and distribute a written approach to address the shoulderband snail in the pERA by 2/5/04.*
4. *The ERWG will provide comments to BBL via email on the written approach to address the shoulderband snail by 2/11.*
5. *Melissa Boggs-Blalack will continue to keep Steve Henry informed and also contact Lisa Mangione with the USACE to inform her of the findings of the fairy shrimp and Morro shoulderband snail to determine if they want to become more involved in the SERRT activities.*

Review Comments on Draft pERA

The following table provides a list of comments requiring further clarification or group discussion compiled by BBL and the agreements made by the ERWG. Other comments were considered editorial and will be addressed in the revised pERA draft.

Comment	***Group Agreement***
Executive Summary	
1. Level of technical detail and terminology in the Executive Summary.	Keep the tone and level of technical detail in the executive summary as is. Include a broader overarching document that addresses both risk assessments for the public. Suggest preparing a

Drafted by Strategic Initiatives based on the January 21, 2004 ERWG meeting. Reviewed, revised, and ratified at the SERRT meeting on March 23, 2004.

	binder that included both documents with the broader document as an overview. Audience for the pERA would be the technical layperson. Audience for the overarching document would be lay public. Include definitions of technical terms as necessary in the overarching document that is for public distribution. Agreed not to make any changes to the acronym list of the pERA (i.e., no glossary necessary). Call the overarching summary document the ”Public Outreach Document” (POD). Use “approximately 340 acres” to describe the site area throughout document.
2. Tables ES-1 and ES-2.	Revise tables ES-1 and ES-2 to include only colors and items in parentheses. Remove terms “possible” and “probable” in table and in text and replace with Level 1 and Level 2 throughout document to describe risk categories. Leave *de minimus* category as is. Define scenario 1 and 2, the term NA and the meaning of the parenthetical numbers in the tables. These revisions also apply to Tables 8-1 and 8-2.
3. Additional Figures	Simplify conceptual site model and risk summary figures. Add four summary figures for lead (8-2 and 8-3) and TPH (8-5 and 8-6).
Section 1	
3. Provide rationale for soil and sediment horizons used in ERA.	Agreed to include additional information in Section 4 and reference this description at appropriate places in sections 1 and 2.
4. Provide additional rationale for Scenario 1 and Scenario 2 distinctions (i.e., rationale for exclusion of operations area under scenario 2).	Leave as-is. (Chuck Lambert will review pERA to make sure that they are consistent.)
	Agreed to take personal names out of section 1.2 - Regulatory Framework.
Section 2	
5. Clarification of information provided in historical site reports.	Add specific information requested when available. Reference paraphrased information by referencing historical documents and/or authors when specifics are not readily available.
6. Clarify wetland boundaries used in the pERA.	Indicate “state and federal delineated wetlands” on figures where appropriate. Also, clarify in text. Include paragraph indicating the history of the wetland delineation. John will provide language to BBL by 1/30.

Drafted by Strategic Initiatives based on the January 21, 2004 ERWG meeting. Reviewed, revised, and ratified at the SERRT meeting on March 23, 2004.

7. Provide additional discussion regarding the limitations of the fairy shrimp survey locations.	Add language proposed by BBL. Also, include discussion on Morro shoulder band snail.
Section 3	
8. Clarify uncertainties regarding source of TPH in SW-1 and SW-2.	Include Diane's proposed revision since there are other analytical tests that could be done.
9. Assess potential hot spots for VOCs and PCBs.	Add hotspot map(s) is section 3. Include back of envelope calculations for PCBs in uncertainty analysis – section 7. Add sentence in 2nd paragraph in section 8 regarding VOCs and PCBs not being a problem.
10. Clarify comment # 25 from R. Donohoe and elaborate on implications of the CDFG Code 3005 (no-take of non-game species	Add footnote indicating that the assessment endpoints for population level assessments may not adequately address the CDFG code section 3005. (For birds and mammals only.)
Section 4 – Nothing requiring discussion	
Section 5 – Nothing requiring discussion	
Section 6 – Nothing requiring discussion	
Section 7 – Nothing requiring discussion	
Section 8	
11. Impact of CDFG no-take code on assessment of arsenic and lead.	Add sentence for both lead and arsenic that further hotspot evaluation may be warranted.
Additional Comments	
Agreed to take personal names out of section 1.2 - Regulatory Framework.	
Bob Haddad suggested that the document reflect Ecological Risk Assessment Working Group consensus decisions when ever appropriate to strengthen the document. BBL will review document and clarify where appropriate.	
Rick Rittenberg suggested that the text box on page 6-1 or something similar be included in the executive summary to provide an overview of the pERA process.	
John Ljung suggested clarifying the language in text box on page 2-1 to eliminate "due mainly to the fire".	
Melissa Boggs–Blalack suggested that all figures that deal with the Fairy Shrimp (Figures 6-9, 8-3, 8-4, and 8-6) should indicate that these are the locations where the listed species was observed.	
John Ljung suggested including a date on figure 2-1.	

See full 1/21/04 SERRT meeting summary for discussion of schedule for completion and review of revised pERA.

Drafted by BBL based on the January 28, 2003 ERWG conference call. Reviewed, revised, and ratified at the SERRT meeting on March 23, 2004.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Ecological Risk Assessment Working Group

Conference Call Summary

Date: **January 28, 2004**

Time: **1:00 PM – 2:30 PM**

Participants:

Name	Organization	Name	Organization
Bill Almas	UNOCAL	Jennifer Holder	BBL
Bonner Anthony	BBL	John Ljung	UNOCAL
Melissa Boggs-Blalack	CDFG	Christopher Rogers	Eco Analysts
Neil Havlik	City of SLO	Dave Wolff	Dave Wolff Consultant

Objectives: To discuss the surveys conducted to date and the natural history information for the Morro shoulderband snail with the field biologist.

Christopher Rogers, a field biologist with Eco Analysts, Inc., was enlisted to conduct site surveys for the Morro shoulderband snail. He clarified that he was conducting the surveys according to the guidelines specified by the USFWS for a protocol-level survey and had conducted three surveys to date with two more planned. Each survey consists of an evaluation of the entire site. Chris Rogers specified that some meandering transects were followed, but that he focused on areas of optimal habitat. Habitat would include areas that stay somewhat moist and provide cover, such as rocky areas and shrub cover with leaf litter or woody debris. He explained that the snails would not likely use the habitat in the wetland or open grassy areas of the site due to their moisture and cover requirements.

To date, the Morro shoulderband snail has been found near the northeast corner of the property, along the southeast border, and on the northeast corner of the south side of Tank Farm Rd. Two more surveys are planned to take place during or immediately after the next rain events at the site. Once these surveys are complete Chris Rogers said that he would have an adequate characterization of all locations where the Morro shoulderband snail might be found on site.

In addition to the discussion of the Morro shoulderband snail, the group discussed the protocol-level dry season fairy shrimp surveys conducted in August of 2003. Chris Rogers was also the biologist that conducted the fairy shrimp surveys. He clarified that there were two different criteria for the designation of “not suitable” which was applied to several of the wetland areas on site during the surveys. The first criterion was a lack of suitable biological habitat. The second criterion was based on the presence of petroleum. Based on his professional judgment, he felt that fairy shrimp would not be present in these areas.

Drafted by Strategic Initiatives based on the March 23, 2004 meeting of the SERRT. Reviewed, revised, and ratified at the SERRT meeting on May 25, 2004.

SLO Tank Farm Surface Evaluation, Remediation and Restoration Team

Draft Meeting Summary

Date: March 23, 2004

Time: 9:30 AM – 2:30 PM

Location: RWQCB Offices, San Luis Obispo

Participants:

Name	Organization	Name	Organization
Bill Almas	Unocal	Jennifer Holder	BBL
Chuck Anders	Strategic Initiatives	Diane Kukol	RWQCB
Bonner Anthony	BBL	Chuck Lambert	McDaniel Lambert
Melissa Boggs-Blalack	CDFG	John Ljung	Unocal
Jim Carlisle*	OEHHA	Lisa Mangione*	USACOE
Teri Copeland	SLO County Health Dept.	Rick Rittenberg	Unocal
Regina Donohoe	CDFG	Mike Rendina	Avocet Environmental
Bob Haddad	AGS	David Wolf**	DKW Environmental
Neil Havlik	City of SLO		

*via teleconference **Discussion of biological studies only

General Announcements/Review Previous Meeting Summaries and Action Items

The SERRT members reviewed, revised, and ratified the January 21, 2004 SERRT, ERWG, and HHRWG meeting summaries and the January 28, 2004 ERWG conference call summary. The participants also reviewed and updated the near-term action items in the meeting summaries. All action items have been completed or are no longer necessary except obtaining a preliminary report on the locations of the shoulderband snail. It was agreed that the location report would be delayed until the full report was available.

Neil Havlik updated the SERRT on the status of the Airport Area Specific Plan, the Margarita Area Specific Plan and the combined EIR. The San Luis Obispo Planning Commission is currently holding hearings on the Margarita Area Specific Plan and the combined EIR. City Council approval of these documents is anticipated by late spring or early summer. Approval of the Airport Area Specific Plan is expected by the end of 2004. Bill Almas asked if the discovery of the shoulderband snail was addressed in the EIR. Neil said that he would check and inform the SERRT.

The SERRT members discussed strategies to support Steve Henry's involvement in SERRT activities. John Ljung indicated that Unocal was willing to financially support Steve's participation. John and Rick Rittenberg will prepare a written request for Steve's participation and will establish a contractual mechanism to support USFWS involvement

as soon as possible. Unocal expressed their desire to fund Steve or a qualified contractor.

Bill Almas informed the SERRT that the SLO city council had recently increased the inclusional fee from 3% to 5%. This increase may impact the local support for annexation and it is possible that development of the site may take place under county jurisdiction instead of the city. The group questioned whether a representative from the County Planning and Building Department should be invited to participate in the SERRT activities.

Rick Rittenberg indicated that Unocal has been in discussions with the SLO County Airport regarding extension of the runway. The project may require realignment of the creek and could also impact the wetlands on the Tank Farm Road property. Lisa Mangione will check with the USACOE staff on the status of this activity.

Bill Almas indicated that Unocal has entered into a settlement agreement in the Holdgrapher lawsuit. The judges ruling on punitive damages, which is the last element of the case, is anticipated in April.

Action Items:

1. Neil Havlik will check to see if the shoulderband snail was addressed in the combined EIR and inform the SERRT.
2. John Ljung and Rick Rittenberg will prepare a written request for Steve Henry's participation in the SERRT and will establish a contractual mechanism to support his involvement as soon as possible.
3. Lisa Mangione will check with USACOE staff on the status of the airport runway extension.

Communications Protocol

The SERRT reviewed and approved the draft communications protocol. It was agreed that the document will be used as a general guideline for communication with the media and public. Bill Almas was selected as the designated SERRT spokesperson.

Draft Human Health Risk Assessment

Chuck Lambert reviewed the comments that were received on the draft HHRA version 1.1. Chuck indicated that version 1.1 reflected new EPA guidelines that resulted in slightly reduced risk levels. Originally the HHWG had decided to use exposure parameters from the California PEA guidance (1994/1999) for the HHRA. However, new USEPA dermal and soil guidance have recently appeared in OEHHA risk assessment documents. Jim Carlisle and Teri Copeland indicated that they supported the use of the new USEPA guidance.. It was also agreed to include an analysis of the 0 – 2 foot soil interval in the uncertainty section.

There was a discussion regarding consistent the use of the terms "surface expressions" and "surface seeps." It was agreed to use the term "surface expressions" in both the HHRA and pERA.

The SERRT conditionally approved the revised HHRA and proposed changes pending a final review by Jim Carlisle and Teri Copeland. Chuck Lambert will distribute the

updated HHRA version 2.0 by April 6. Jim Carlisle and Teri Copeland will provide their comments on version 2.0 to Chuck Anders by April 9. Chuck will distribute the comments to the full SERRT and arrange for a conference call on April 16 at 9:30 AM to discuss and ratify the HHRA.

Action Items:

1. Chuck Lambert will distribute the updated HHRA version 2.0 by April 6.
2. Jim Carlisle and Teri Copeland will provide their comments on version 2.0 to Chuck Anders by April 9.
3. Chuck Anders will distribute the comments to the full SERRT and arrange for a conference call on April 16 at 9:30 AM to discuss and ratify the HHRA.
4. Those members of the SERRT who are interested will participate in a conference call on April 16 at 9:30 AM to discuss and ratify the HHRA.

Draft Predictive Ecological Risk Assessment

Jennifer Holder and Bonner Anthony reviewed the comments that were received on the draft pERA version 1.1. The majority of the comments were addressed as requested and the specific text used to address each comment was provided by BBL in a handout. The following specific comments were discussed:

- It was agreed that simplified conceptual site model figures similar to the example provided in the executive summary of the draft pERA would be included for both the upland and wetland portions of the site. A complete list of assessment endpoints for each habitat will be added to the figures.

- BBL provided handouts of the tables ES-1 and ES-2 as revised based on ERWG comments. There was general concern regarding the potential for confusion in interpreting these tables due to the large amount of information conveyed. There were specific concerns about the accuracy of the color codes and the clarity of the footnotes. Regina Donohoe reviewed the tables for accuracy and provided her comments to BBL at the meeting. Other SERRT and/or ERWG members were asked to provide any suggestions or comments regarding these tables to BBL by Friday March 26th. BBL will revise the tables and redistribute to the SERRT by March 31st

- Lisa Mangione from the US Army Corp of Engineers (USACOE), indicated that she had a number of comments on the pERA. She indicated that many of her comments may be due to her lack of history with the development of the pERA. She expressed a specific concern about whether the pERA should address the potential for occurrence of specific species as opposed to species actually observed. Jennifer Holder indicated that the selection of representative receptors was based on several site-specific surveys and that receptors were selected to be conservative representatives of species occurring or potentially occurring on site.

- The SERRT felt that it was important that the USACOE and the USFWS have the opportunity to review the report and provide their comments prior to ratification. Jennifer Holder will contact Steve Henry to arrange a meeting with the two federal agencies in Ventura to discuss their comments. The other members of the ERWG

will participate in the meeting by conference call. The schedule and path forward for finalizing the pERA will be determined based on the outcome of the meeting.

Action Items:

1. The SERRT will provide any comments on tables ES-1 and ES-2 (also 8-1 and 8-2) to BBL by March 26.
2. BBL will revise tables based on comments received and distribute to the SERRT by March 31.
3. Jennifer Holder will contact Steve Henry to arrange a meeting with the USACOE and USFWS in Ventura to discuss their comments.
4. Chuck Anders will arrange a conference call for the SERRT subsequent to the meeting with the USACOE and USFWS to agree upon the path forward for finalizing the pERA.

Biological Survey Overview

David Wolf provided the following overview of the biological surveys at the SLO Tank Farm. Phase III is currently underway.

Phase I	Phase II	Phase III	Phase IV
Aquatic Invertebrates Aquatic Vertebrates Rare Plants Black Rail	Morro Shoulderband Snail (MSS) Dry Season Fairy Shrimp (FS)	Remaining 4 surveys for MSS* Winter Bird Survey	Dry Season FS Wet Season FS

* MSS was observed at three locations on site.

Public Outreach Document (POD) and Information Sheet

The SERRT discussed the draft POD prepared by Bob Haddad. Bob Haddad indicated that he liked the way Diane simplified the POD language. The participants questioned the need for an overarching document that summarizes both risk assessments since it is not likely that both risk assessments will be in the same binder. It was agreed that it would be more effective to beef-up the draft information sheet using the Guadalupe fact sheet as a template. More information will be required about the site history and risk assessment results. Bob Haddad will provide a revised draft of the information sheet to Maggie Cox by April 1. Chuck Lambert and BBL will provide revised risk assessment language to Bob by March 29. Chuck Anders will distribute the revised draft for review when complete.

It was agreed to add an additional question on the health implications of groundwater to the information sheet. Chuck Lambert will draft language and provide it to Bob.

Bill Almas expressed concern over the public's interpretation of the term "deed restriction" when referring to residential use. It was agreed to use the following language: "Unocal has agreed that the property will maintain a deed restriction forbidding residential development on any contaminated portions of the site. "

Melissa expressed concern that the term "voluntary participation" in the SERRT could be misinterpreted. It was agreed not to use the term "voluntary" and to state that "Unocal initiated these studies without a regulatory order and has worked collaboratively with the regulatory agencies."

Teri Copeland suggested using the term "potential" users since the public does not currently have access to the site.

Action Items:

1. Chuck Lambert and BBL will provide revised risk assessment language to Bob Haddad by March 29.
2. Bob Haddad will provide a revised draft of the information sheet to Maggie Cox by April 1.
3. Maggie Cox will revise the information sheet using the Guadalupe fact sheet as a template.
4. Chuck Anders will distribute the revised information sheet to the SERRT for review.

Next Steps

The SERRT discussed the next steps and whether the SERRT should continue in its present form. Diane Kukol reviewed the SERRT mission statement, which included the following activities

1. Evaluate potential impacts to human health, the environment, and water quality from existing on-site surface and near-surface petroleum related contamination related to tank farm operations,
2. Develop decision criteria and use these criteria to identify areas on the SLO Tank Farm that need surface remediation/restoration,
3. Evaluate appropriate surface remediation/restoration options where the impacts are determined to be unacceptable, and
4. Achieve multi-agency agreement on end points for surface remediation/restoration options.

The SERRT agreed to continue with the current configuration and consider adding an engineering component to evaluate alternative remediation strategies. Participants suggested adding a representative from the county Planning and Building Department since it is possible that development could take place under county jurisdiction. Teri Copeland observed that it will likely be necessary to assess the ecological and human health risks of alternative remediation strategies and continued participation of the risk assessment experts would be useful. Mike Rendina recalled that a preliminary assessment of remedial options was prepared in 1999.

The SERRT agreed that the next meeting of the SERRT should focus on defining the implications of the risk assessments for specific areas of the site. Diane Kukol recommended that each participant review the risk assessment results and prepare their own observations prior to the meeting. The participants would then determine who to add to the SERRT based on the discussions.

Drafted by Strategic Initiatives based on the March 23, 2004 meeting of the SERRT. Reviewed, revised, and ratified at the SERRT meeting on May 25, 2004.

Action Item:

1. SERRT members will review the risk assessment results and be prepared to discuss the implications for specific areas of the site at the next SERRT meeting.

Upcoming Meeting Dates and Agenda Items

SERRT Meeting – May 25 (9:30 AM – 3:30 PM) - Tentative

1. Review/approve March 23, 2004 SERRT meeting summary.
2. Ratify draft project information sheet.
3. Discuss implications of the risk assessments on specific areas of the site.
4. Discuss additional participants to be added to the SERRT.
5. Discuss the process to assess alternative remediation strategies.

Drafted by BBL and Strategic Initiatives based on the April 19, 2004 meeting of the ERWG and USACE. Reviewed, revised, and ratified at the SERRT meeting on May 25, 2004.

SLO Tank Farm Ecological Risk Work Group

Meeting Summary

Date: April 19, 2004

Time: 9:30 AM – 11:30 PM

Location: USACE Offices, Ventura, CA

Participants:

Name	Organization	Name	Organization
Chuck Anders*	Strategic Initiatives	Jennifer Holder	BBL
Bonner Anthony	BBL	Lisa Mangione	USACOE
Regina Donohoe*	CDFG	Rick Rittenberg	Unocal
Bob Haddad*	AGS	David Wolff*	DKW Environmental

*via teleconference

This meeting was arranged to discuss Lisa Mangione's comments on the pERA. Lisa's comments dealt primarily with biological resource issues. She had specific concerns about the following:

1) Lisa would like specific call outs for amphibians associated with AE W2 for aquatic vertebrates. *BBL agreed to make this clarification whenever necessary when discussing AE W2 in the pERA. Dave Wolff clarified that Larry Hunt was involved in the protocol surveys for the California red legged frog. The primary species observed during the surveys were bullfrogs, Pacific tree frogs and western toads*.

2) Lisa expressed concern regarding the "population-level" evaluation of non-listed species. She requested clarification regarding the terminology "population-level" in the pERA. *Jennifer Holder explained that the tools used in risk assessment are often limited to evaluation of individuals and it is necessary to extrapolate from this individual analysis to a population level. BBL agreed to add discussion to the uncertainty analysis addressing the necessary extrapolations from the individual to the population level in the pERA.*

3) Lisa asked if any analyses were conducted to evaluate potential cause and effect relationships between contaminant concentrations and presence/absence of species observed during biological surveys. *Dave Wolff explained that the surveys were not designed for that purpose and thus no specific correlation analyses could be conducted. BBL will add discussion to the uncertainty analysis to address this issue.*

4) Lisa asked about how the Morro Shoulderband Snail was addressed in the pERA. *BBL explained that the snail was addressed as a part of AE T2 (terrestrial invertebrates), recognizing that the benchmarks used to evaluate the snail are the same as those used to evaluated terrestrial invertebrates in general. Dave Wolff added that, based on recent development, the snails observed on site may not be the listed species of Shoulderband Snail based on the fact that they occur on a different substrate. A footnote will be added to the pERA to specify this change. Dave Wolff will provide specific language*. Lisa

Drafted by BBL and Strategic Initiatives based on the April 19, 2004 meeting of the ERWG and USACE. Reviewed, revised, and ratified at the SERRT meeting on May 25, 2004.

Mangione requested that the language Dave adds points out that Ventura FWS has indicated a Position Paper is forthcoming, however we have not seen anything official to date. Consequently, in order for the Corps to meet their statutory mandates they will continue to request information regarding H. morroensis from applicants for projects that require Corps authorization. The Corps will coordinate with Ventura FWS to the extent appropriate until they issue official correspondence regarding the matter.

5) Lisa had concerns about the exclusion of the operations area (Scenario 2), surface expressions and Tanks 5 and 7 from the risk evaluation. *The rationale for these exclusions was clarified and no action is required.*

6) Lisa pointed out that federal wetland delineations must be updated every 5 years*. It was acknowledged Corps verification of the delineation for the site will be required when a permit application is submitted*.

Information Needs for a Biological Opinion

Lisa explained that she would not be able to initiate Endangered Species Act consultation until an application was submitted for a defined project. She will continue with her current level of commitment to the process (i.e., review of project materials and participation as appropriate in meetings via conference call).

Schedule for Completion of pERA

It was agreed that the revised pERA would be reviewed and ratified at the SERRT meeting May 25th. Rick Rittenberg will follow up with Steve Henry of USFWS to request his comments by April 30th. BBL will distribute revised Table ES-1 and ES-2 by April 23rd. If necessary, a conference call will be arranged to discuss the revised tables; otherwise, the changes will be incorporated into the next draft of the pERA. BBL will post a red-lie version of the pERA to the web site by May 7th.

Action Items:

1. Rick Rittenberg will follow up with Steve Henry of USFWS to request any comments by 4/30/04.

2. BBL will distribute the revised Table ES-1 and ES-2 by 4/23/04. The ERWG will review the tables and if necessary there will be an ERWG conference call to discuss the changes. If not, changes will be incorporated into the next draft of the pERA.

3. BBL will post a red-line revision of the revised pERA to the web site by May 7th.

4. The SERRT will review and ratify the revised pERA at the next SERRT Meeting scheduled for May 25th.

Appendix B
Wildlife Species List for San Luis Obispo Tank Farm

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Appendix B

Wildlife Species Known to Occur or Potentially Occurring and their Associated Habitats

San Luis Obispo Tank Farm

Common Name	Scientific Name	Habitats				
		Observed	*Breeding*	*Terrestrial*	*Wetlands*	*Riparian*
INVERTEBRATES						
Longhorn Fairy Shrimp*	*Branchinecta longiantenna*				**X**	
Vernal Pool Fairy Shrimp*	***Branchinecta lynchi***	**X**			**X**	
Fairy Shrimp	***Linderiella occidentalis***	**X**				
Salt Marsh Skipper*	*Panoquina errans*				X	
Bay Checkerspot Butterfly*	*Euphydryas editha bayensis*			X		
NON-INSECTS						
Flatworms	--	**X**			X	
Oligochaete Worm	--	**X**			X	
Leeches	--	**X**			X	
Rams Horn Snails	--	**X**			X	
Morro shoulderband snail*						
Clam shrimp	***Helminthoglypta walkeriana***	**X**			X	
Water Fleas	--	**X**			X	
Copepods	--	**X**			X	
Ostracods (seed shrimp)	--	**X**			X	
Amphipods (scuds)	--	**X**			X	
Crayfishes	--	**X**			X	
Mites	--	**X**			X	
INSECTS						
Mayflies	--	**X**			X	
Dragonflies	--	**X**			X	
Damselflies	--	**X**			X	
Water Boatmen	--	**X**			X	
Backswimmers	--	**X**			X	
Water Striders	--	**X**			X	
Crawling Water Beetles	--	**X**			X	
Predaceous Diving Beetles	--	**X**			X	
Helophorid Beetles	--	**X**			X	
Water Scavenger Beetles	--	**X**			X	
Biting Midges	--	**X**			X	
Phantom Midges	--	**X**			X	
Nonbiting Midges	--	**X**			X	
Mosquitoes	--	**X**			X	
Dixid Midges	--	**X**			X	
Shore Flies	--	**X**			X	
AMPHIBIANS						
California Newt	*Taricha torosa*			X	X	X
Western Toad	***Bufo boreas***	**X**		X	X	X
California Red-legged Frog*	*Rana aurora draytonii*				X	
Pacific Treefrog	***Hyla (Pseudacris) regilla***	**X**	X	X	X	**X**
California Tiger Salamander	*Ambystma californiense*			X	X	
Bullfrog	***Rana catesbeiana***	**X**	X		X	**X**

Appendix B

Wildlife Species Known to Occur or Potentially Occurring and their Associated Habitats

San Luis Obispo Tank Farm

Common Name	Scientific Name	Habitats				
		Observed	*Breeding*	*Terrestrial*	*Wetlands*	*Riparian*
REPTILES						
Red-eared Slider	*Pseudemys scripta*	X			X	X
Western Pond Turtle*	*Clemmys marmorata*	X			X	X
Southwestern Pond Turtle*	***Clemmys marmorata pallida***	**X**			X	**X**
Western Fence Lizard	*Sceloporus occidentalis*	X	X	X		X
California Horned Lizard*	*Phrynosoma coronatum frontale*			X		
Sagebrush Lizard	*Sceloporus graciousus*	X		X		
Side-blotched Lizard	*Uta stansburiana*			X		
Western Skink	*Eumeces skiltonianus*			X		
Western Whiptail	*Cnemidophorus tigris*			X		
Southern Alligator Lizard	*Cerrhonotus multicarinatus*			X		X
Ringneck Snake	*Diadophis punctatus*			X		
Racer	*Coluber constrictor*			X		
Coachwhip	*Masticophis flagellum*			X		
California Whipsnake	*Masticophis lateralis*			X		X
Gopher Snake	*Pituophis melanoleucus*	X		X		
Garter Snake	*Thamnophis sp.*	X		X	X	
Common King Snake	*Lampropeltis getulus*			X		
Common Garter Snake	*Thamnophis sirtalis*			X	X	X
Western Terrestrial Garter Snake	*Thamnophis elegans*			X	X	X
Two-striped Garter Snake*	*Thamnophis hammondi*			X	X	X
Western Aquatic Garter Snake	*Thamnophis couchi*			X	X	X
Western Rattlesnake	*Crotalis viridis*			X		
BIRDS						
Pied-billed Grebe	*Podilymbus podiceps*	X	X		X	
Double-crested Cormorant*	*Phalacrocorax auritus*	X			X	
American Bittern	*Botaurus lentiginosus*	X			X	
Black-crowned Night Heron	*Nycticorax nycticorax*	X			X	X
Green Heron	***Butorides virescens***	**X**			**X**	**X**
Snowy Egret	***Egretta thula***	**X**		**X**	**X**	
Great Egret	***Casmerodius albus***	**X**		**X**	**X**	**X**
Great Blue Heron	***Ardea herodias***	**X**		**X**	**X**	
American wigeon	***Anas americana***	**X**			**X**	
Green-winged Teal	***Anas crecca***	**X**			**X**	
Mallard Duck	***Anas platyrhynchos***	**X**	**X**		**X**	**X**
Northern Pintail	*Anas acuta*	X			X	
Cinnamon Teal	***Anas cyanoptera***	**X**	**X**		**X**	
Common Merganser	***Mergus merganser***	**X**			**X**	
Northern Shoveler	*Anas clypeata*	X			X	
Gadwall	*Anas strepera*	X			X	
Scaup	*Aythya sp.*	X			X	
Bufflehead	*Bucephala albeola*	X			X	
Turkey Vulture	***Cathartes aura***	**X**		**X**	**X**	**X**
Golden Eagle*	*Aquila chrysaetos*	X		X		X
White-tailed Kite*	***Elanus leucurus***	**X**		**X**	**X**	
Northern Harrier*	***Circus cyaneus***	**X**		**X**	**X**	

Appendix B

Wildlife Species Known to Occur or Potentially Occurring and their Associated Habitats

San Luis Obispo Tank Farm

Common Name	Scientific Name	Habitats				
		Observed	*Breeding*	*Terrestrial*	*Wetlands*	*Riparian*
Sharp-shinned Hawk*	***Accipiter striatus***	**X**		**X**		**X**
Cooper's Hawk*	***Accipiter cooperii***	**X**		**X**		**X**
Red-shouldered Hawk	***Buteo lineatus***	**X**		**X**	**X**	**X**
Red-tailed Hawk	***Buteo jamaicensis***	**X**		**X**	**X**	**X**
Ferruginous hawk	***Buteo regalis***	**X**		**X**		
American Kestrel	***Falco sparverius***	**X**		**X**	**X**	
Merlin*	***Falco columbarius***	**X**		**X**		**X**
American Peregrine Falcon*	***Falco peregrinus anatum***	**X**		**X**	**X**	
Prairie Falcon*	*Falco mexicanus*			X		
California Quail	*Callipepla californicus*			X		X
Ring-necked Pheasant	*Phasianus colchicus*			X		
California Black Rail*	*Laterallus jamaicensis coturniculus*				X	
Virginia Rail	*Rallus limicola*	X	X		X	
Sora	*Porzana carolina*	X	X		X	
Common Moorhen	*Gallinula chloropus*				X	
American Coot	***Fulica americana***	**X**	**X**		**X**	
Killdeer	***Charadrius vociferous***	**X**	**X**	**X**	**X**	
Black-necked Stilt	*Himantopus mexicanus*	X			X	
Greater Yellowlegs	***Tringa melanoleucus***	**X**			**X**	
Spotted Sandpiper	*Actitis macularia*	X			X	
Western Sandpiper	***Calidris mauri***	**X**			**X**	
Least Sandpiper	*Calidris miniutilla*	X			X	
Pectoral Sandpiper	*Calidris melanotos*	X			X	
Long-billed Curlew	***Numenius americanus***	**X**		**X**		
Common Snipe	***Capella gallinago***	**X**		**X**	**X**	
Western Gull	*Larus occidentalis*	X		X	X	
California Gull	***Larus californicus***	**X**		**X**	**X**	
Ring-billed Gull	***Larus delawarensis***	**X**				
Rock Dove	***Columba livia***	**X**		**X**		
Mourning Dove	***Zenaida macroura***	**X**	**X**	**X**	**X**	**X**
Common Barn Owl	*Tyto alba*	X		X	X	X
Western Screech Owl	*Otus kennicottii*	X		X	X	X
Great Horned Owl	*Bubo virginianus*			X		X
Western Burrowing Owl*	***Speotyto cunicularia hypugea***	**X**		**X**		
Short-eared Owl*	*Asio flammeus*			X	X	
Black-chinned Hummingbird	*Archilochus alexandri*			X		X
Anna's Hummingbird	***Calypte anna***	**X**	**X**	**X**		**X**
Allen's Hummingbird	*Selasphorus sasin*			X		X
Belted Kingfisher	***Ceryle alcyon***	**X**			**X**	**X**
Northern Flicker	***Colaptes auratus***	**X**		**X**		**X**
Acorn Woodpecker	*Melanerpes formicivorus*					X
Nuttall's Woodpecker	***Picoides nuttallii***	**X**				**X**
Downy Woodpecker	*Picoides pubescens*	X				X
Hairy Woodpecker	***Picoides villosus***	**X**				**X**

Appendix B

Wildlife Species Known to Occur or Potentially Occurring and their Associated Habitats

San Luis Obispo Tank Farm

Common Name	Scientific Name	Habitats				
		Observed	*Breeding*	*Terrestrial*	*Wetlands*	*Riparian*
Western Kingbird	*Tyrannus verticalis*	X	X	X		X
Ash-throated Flycatcher	***Myiarchus cinerascens***	**X**	**X**	**X**		**X**
Western Wood-pewee	*Contopus sordioulus*					X
Black Phoebe	***Sayornis nigricans***	**X**	**X**	**X**	**X**	**X**
Say's Phoebe	***Sayornis saya***	**X**		**X**	**X**	
Pacific-slope Flycatcher	*Empidonax difficilis*					X
California Horned Lark*	*Eremophila alpestris actia*	X		X	X	
Horned Lark	***Eremophila alpestris***	**X**		**X**		
White-throated Swift	***Aeronautes saxatalis***	**X**				
Tree Swallow	***Tachycineta bicolor***			**X**	**X**	**X**
Violet-green Swallow	*Tachycineta thalassina*			X	X	X
Northern Rough-winged Swallow	***Stelgidopteryx ruficollis***	**X**		**X**	**X**	**X**
Cliff Swallow	***Hirundo pyrrhonota***	**X**	**X**	**X**	**X**	**X**
Barn Swallow	***Hirundo rustica***	**X**	**X**	**X**	**X**	**X**
Western Scrub Jay	***Aphelocoma californica***	**X**		**X**		**X**
American Crow	***Corvus brachyraynchos***	**X**		**X**	**X**	
Plain Titmouse	*Parus inornatus*	X		X		X
Chestnut-backed Chickadee	***Parus rufescens***	**X**				**X**
Bushtit	***Psaltriparus minimus***	**X**		**X**	**X**	**X**
Red-breasted Nuthatch	*Sitta canadensis*					X
House Wren	*Troglodytes aedon*	X		X		X
Bewick's Wren	***Thryomanes bewickii***	**X**	**X**	**X**		**X**
Rock wren	***Salpinctes obsoletus***	**X**		**X**		
Marsh Wren	*Cistothorus palustris*	X	X		X	
Ruby-crowned Kinglet	***Regulus calendula***	**X**		**X**		**X**
Blue-gray Gnatcatcher	*Polioptila caerulea*			X		X
Western Bluebird	***Sialia mexicana***			**X**		
Swainson's Thrush	*Catharus ustulatus*					X
Hermit Thrush	*Catharus guttatus*					X
American Robin	*Turdus migratorius*			X		X
Wrentit	*Chamaea fasciata*			X		X
Loggerhead Shrike*	***Lanius ludovicianus***	**X**		**X**		**X**
California Thrasher	*Toxostoma redivivum*			X		
American Pipit	***Anthus rubescus***				**X**	
Northern Mockingbird	***Mimos polyglottos***	**X**		**X**	**X**	**X**
Cedar Waxwing	*Bombycilla cedrorum*					X
European Starling	***Sturnus vulgaris***	**X**		**X**	**X**	**X**
Hutton's Vireo	***Vireo huttoni***	**X**				**X**
Gray vireo	***Vireo vicinior***	**X**		**X**		
Blue-headed vireo	***Vireo solitarius***	**X**		**X**		
Solitary Vireo	*Vireo solitarius*					X
Warbling Vireo	*Vireo gilvus*					X
Audubon's warbler	***Dendroica (coronata) auduboni***	**X**		**X**		**X**
Orange-crowned Warbler	*Vermivora celata*			X		X

Appendix B

Wildlife Species Known to Occur or Potentially Occurring and their Associated Habitats

San Luis Obispo Tank Farm

Common Name	Scientific Name	Habitats				
		Observed	*Breeding*	*Terrestrial*	*Wetlands*	*Riparian*
Yellow-rumped Warbler	*Dendroica coronata*			X		X
Townsend's Warbler	*Dendroica townsendi*					X
Yellow Warbler*	*Dendroica petechia*					X
MacGillivray's Warbler	*Oporonis tolmiei*					X
Wilson's Warbler	*Wilsonia pusilla*					X
Common Yellowthroat	***Geothlypis trichas***	**X**	**X**	**X**	**X**	**X**
Western Tanager	*Piranga ludoviciana*	X				X
Black-headed Grosbeak	*Pheucticus melanocephalus*	X		X		X
Blue Grosbeak	*Guiraca caerules*			X		X
Lazuli Bunting	*Passerina amoena*			X		X
Spotted Towhee	***Pipilo maculatus***	**X**		**X**		**X**
California Towhee	***Pipilo crissalis***	**X**		**X**		**X**
Savannah sparrow (Bryant's)	***Passerculus sandwichensis alaudinus***	**X**			**X**	
Savannah Sparrow	***Passerculus sandwichensis***	**X**		**X**		
Song Sparrow	***Melospiza melodia***	**X**	**X**	**X**	**X**	**X**
Lark Sparrow	***Chondestes grammacus***	**X**	**X**	**X**	**X**	**X**
Chipping Sparrow	***Spizella passerina***			**X**		
Rufous-crowned Sparrow	***Aimophila ruficeps***	**X**			**X**	
White-throated Sparrow	*Zonotrichia albicollis*			X		X
White-crowned Sparrow	***Zonotrichia leucophrys***	**X**		**X**		**X**
Golden-crowned Sparrow	***Zonotrichia atricapilla***			**X**		**X**
Fox Sparrow	***Passella iliaca***			**X**		**X**
Lincoln's Sparrow	*Melospiza lincolnii*			X	X	
Western Meadowlark	***Sturnella neglecta***	**X**	**X**	**X**	**X**	
Red-winged Blackbird	***Agelaius phoeniceus***	**X**	**X**	**X**	**X**	**X**
Tricolored Blackbird*	*Agelaius tricolor*				X	
Brewer's Blackbird	***Euphagus cyanocephalus***	**X**	**X**	**X**	**X**	**X**
Great-tailed Grackle	*Quiscalus mexicanus*	X				
Brown-headed Cowbird	***Molothrus ater***	**X**		**X**		**X**
Bullock's Oriole	*Icterus bullockii*	X		X		X
Hooded Oriole	*Icterus cucullatus*			X		X
House Sparrow	*Passer domesticus*	X	X			X
Pine Siskin	*Carduelis pians*					X
American Goldfinch	***Carduelis tristis***	**X**		**X**		**X**
Lesser Goldfinch	***Carduelis psaltria***	**X**	**X**	**X**		**X**
Lawrence's Goldfinch	*Carduelis lawrencei*			X		
Purple Finch	*Carpodacus purpureus*			X		X
House Finch	***Carpodacus mexicanus***	**X**	**X**	**X**	**X**	**X**
MAMMALS						
Virginia Opossum	*Didelphis virginiana*	X	X	X	X	X
Ornate Shrew	*Sorex ornatus*			X	X	X
Broad-footed Mole	*Scapanus latimus*			X	X	X
Bat	*Family Chiroptera*	X		X	X	X

Appendix B

Wildlife Species Known to Occur or Potentially Occurring and their Associated Habitats

San Luis Obispo Tank Farm

Common Name	Scientific Name	Habitats				
		Observed	*Breeding*	*Terrestrial*	*Wetlands*	*Riparian*
Yuma Myotis	*Myotis yumanesis*			X	X	X
California Myotis	*Myotis californicus*			X	X	X
Big Brown Bat	*Eptesicus fuscus*			X	X	X
Red Bat	*Lasiurus borealis*			X	X	X
Hoary Bat	*Lasiurus cinereus*			X	X	X
Townsend's Big-eared Bat*	*Pleucotus townsendii*			X	X	X
Pallid Bat	*Antrozous pallidus*			X		
Brazilian Free-tailed Bat	*Tadarida brasiliensis*			X	X	
Audubon's Cottontail	*Sylvilagus audubonii*	X		X		
Black-tailed Hare	*Lepus californicus*	X		X		
California Ground Squirrel	*Spermophilus beecheyi*	X	X	X		
Fox Squirrel	*Sciurus niger*					X
Botta's Pocket Gopher	*Thomomys bottae*	X	X	X	X	
California Pocket Mouse	*Perognathus californicus*			X		X
Western Harvest Mouse	*Reithrodontomys megalotis*	X	X	X	X	X
Deer Mouse	*Peromyscus maniculatus*			X		
Dusky-footed Woodrat	*Neotoma fucipes*					X
California Vole	*Microtus californicus*	X	X	X	X	
Muskrat	*Ondatra zibethica*	X			X	X
Black Rat	*Rattus rattus*			X		
Norway Rat	*Rattus norvegicus*			X		X
House Mouse	*Mus musculus*			X		
Coyote	*Canis latrans*	X		X	X	
Gray Fox	*Urocyon cinereoargenteus*			X		
Red Fox						
Raccoon	*Procyon lotor*	X		X	X	X
Striped Skunk	*Mephitis mephitis*	X		X	X	
Mountain Lion	*Felis concolor*			X		
Bobcat	*Felis rufus*			X		
Domestic Cat	*Felis catus*			X		
Cow	*Bos tarus*			X	X	
Mule Deer	*Odocoileus hemionus*			X	X	X
Black-tailed Deer	*Odocoileus hemionus columbianus*	X		X	X	X
FISH						
Prickly Sculpin	*Cottus asper*				X	
Three-Spine Stickleback	***Gasterosteus acculeatus***	**X**			X	**X**
Carp	***Cyprinus carpio***	**X**			**X**	
Speckled dace	*Rhinichthys osculus*				X	
Southern Steelhead	*Oncorhyncus mykiss frontale*	X			X	
Mosquito Fish	***Gambusia affinis***	**X**			**X**	
PLANTS						
Green Wattle	***Acacia decurrens***	**X**				
Water Plantain	***Alisma plantago-aquatica***	**X**			**X**	
Common Ragweed	***Ambrosia psilostachya***	**X**		**X**		

Appendix B

Wildlife Species Known to Occur or Potentially Occurring and their Associated Habitats

San Luis Obispo Tank Farm

Common Name	Scientific Name	Habitats				
		Observed	*Breeding*	*Terrestrial*	*Wetlands*	*Riparian*
Scarlet Pimpernel	***Anagallis arvensis***	X				
Mayweed	***Anthemis cotula***	X				
Marsh Sandwort	*Arenaria paludicola*				X	
California Sagebrush	***Artemisia californica***	X		X		X
Mugwort	***Artemisia douglasiana***	X				
Narrow-Leaf Milkweed	***Ascelpias fascicularis***	X				X
Australian Saltbush	***Atriplex semibaccata***	X				
Slender Wild Oats	***Avena barbata***	X		X		
Coyote Brush	***Baccharis pilularis* var. *consanguinea***	X		X		
False Brome Grass	***Brachypodium distachyon***	X				
Blue-Eyed Grass	*Sisrynchium bellum*	X		X		
Black Mustard	***Brassica nigra***	X				X
Rip-Gut Brome	***Bromus diandrus***	X		X		
Soft Chess	***Bromus hordeaceus***	X		X		
Foxtail Chess	***Bromus madritensis* ssp. *rubens***	X		X		
San Luis ObispoMorning Glory*	***Calystegia subacaulis* ssp. *episcopalis***	X		X		
Italian Thistle	***Carduus pycnocephalus***	X		X		
San Luis Obispo Sedge	*Carex obispoensis*					X
Purple Star-Thistle	***Centaurea calcitrapa***	X				
Tocalote	***Centaurea melitensis***	X				
Yellow Star-Thistle	***Centaurea solstitialis***	X		X		
Congdon's Tarplant*	***Centromadia parryi* ssp. *congdonii***	X			X	
Pineapple Weed	*Chamomilla suaveolens*	X				
California Goosefoot	***Chenopodium californicum***	X				
Chicory	***Chicorium intybus***	X				
Brewer's Spineflower	*Chorizanthe breweri*			X		
Chorro Creek Bog Thistle	*Cirsium fontunale var. obispoense*				X	
Bull Thistle	***Cirsium vulgare***	X		X		
Poison Hemlock	***Conium maculatum***	X				X
Field Bindweed	***Convolvulus arvensis***	X				
Horseweed	***Conyza canadensis***	X				
Brass Buttons	***Cotula coronopifolia***	X			X	
Water Pygmy	*Crassula aquatica*				X	
Artichoke Thistle	***Cynara cardunculus***	X				
Umbrella Sedge	***Cyperus eragrostis***	X				
Nutsedge	*Cyperus esculentus*				X	
Fuller's Teasel	***Dipsacus sativus***	X				
Saltgrass	***Distichlis spicata***	X			X	

Appendix B

Wildlife Species Known to Occur or Potentially Occurring and their Associated Habitats

San Luis Obispo Tank Farm

Common Name	Scientific Name	Habitats				
		Observed	*Breeding*	*Terrestrial*	*Wetlands*	*Riparian*
San Luis Obispo Serpentine Dudleya	*Dudleya abramsii ssp. Bettinae*			X		
Spikerush	***Eleocharis macrostachya***	X			X	
Creeping Wildrye	*Elymus tritcoides*	X		X		
Panicled Willow-Herb	***Epilobium brachycarpum***	X				
Slender Buckwheat	***Eriogonum elongatum***	X				
Storksbill	***Erodium botrys***	X				
Red-Stemmed Filaree	***Erodium cicutarium***	X		X		
Hoover's Button Celery*	***Eryngium aristulatum* var. *hooveri***	X				
California Poppy	***Eschscholzia californica***	X		X		
Eucalyptus	***Eucalyptus* spp.**	X				X
Narrow-Leaved Filago	***Filago gallica***	X				
Fennel	***Foeniculum vulgare***	X		X		
Alkali Heath	*Frankenia salina*	X			X	
Cudweed	***Gnaphalium luteo-album***	X			X	
saw-toothed goldenbush	***Hazardia squarrosa***	X				
Chinese pusley	***Heliotropium curassavicum***	X				
hayfield tarweed	***Hemizonia congesta* ssp. *luzulifolia***	X				
Fascicled Tarweed	***Hemizonia fasciculata***	X				
Telegraph Weed	***Heterotheca grandiflora***	X				
Perennial Mustard	***Hirschfeldia incana***	X		X		
Meadow Barley	***Hordeum brachyantherum***	X			X	
Mediterranean Barley	***Hordeum marinum*** ssp.gussoneanum	X				
Barnyard Foxtail	***Hordeum murinum* ssp. *leporinum***	X		X		
Rough Cat's Ear	***Hypochaeris radicata***	X				
Southern California Black Walnut	***Juglans californica* var. *californica***	X				X
Toad Rush	***Juncus bufonius***	X			X	
Rush	*Juncus ensifolius*	X				
Brown-Headed Rush	***Juncus phaeocephalus***	X			X	
Slender Rush	***Juncus tenuis***	X			X	
Prickly Lettuce	***Lactuca serriola***	X				
Wild Pea	***Lathyrus* sp.**	X				
Jones's Layia	*Layia jonesii*			X		
Italian Ryegrass	***Lolium multiflorum***	X		X		
Lomatium	*Lomatium sp*	X				
Bird's-Foot Trefoil	***Lotus corniculatus***	X			X	
Spanish Clover	***Lotus purshianus***	X				
Succulent Lupine	***Lupinus succulentus***	X				
Lupine	*Lupinus bicolor*	X		X		X
Purple Loosestrife	***Lythrum hyssopifolium***	X				

Appendix B

Wildlife Species Known to Occur or Potentially Occurring and their Associated Habitats

San Luis Obispo Tank Farm

Common Name	Scientific Name	Habitats				
		Observed	*Breeding*	*Terrestrial*	*Wetlands*	*Riparian*
Alkali-Mallow	***Malvella leprosa***	X				
Horehound	***Marrubium vulgare***	X				
Bur-Clover	***Medicago polymorpha***	X				
Alfalfa	*Medicago sativa*	X				
White Sweetclover	***Melilotus alba***	X		X		
Indian Melilot	***Melilotus indica***	X				
Monkeyflower	*Mimulus guttatus*	X			X	X
Purple Needle Grass*	***Nassella pulchra***	X		X		
Nodding Needle Grass	*Nassella cernua*	X		X		
Foothill Needle Grass	*Nessella lepida*	X		X		
Bermuda Buttercup	*Oxalis pes-caprae*	X				X
Paspalum	***Paspalum* sp.**	X				
Fountain Grass	***Pennisetum setaceum***	X				
Fewflower	*Petunia parviflora*	X			X	
Phalaris	***Phalaris* sp.**	X				
Frogfruit	*Phyla nodiflora*	X			X	
Bristly Ox Tongue	***Picris echioides***	X				
Popcornflower	*Plagiobothrys undulatus*	X			X	
Cut-Leaved Plantain	***Plantago coronopus***	X		X		
Narrow-Leaved Plantain	***Plantago lanceolata***	X		X		
Common Plantain	***Plantago major***	X		X		
Sycamore	***Platanus racemosa***	X				X
Common Plantain	***Plantago major***	X				
Sycamore	***Platanus racemosa***	X				
Common Knotweed	***Polygonum arenastrum***	X				
Smartweed	***Polygonum* sp.**	X				
Rabbitfoot Grass	***Polypogon monspeliensis***	X			X	
Fremont Cottonwood	***Populus fremontii***	X			X	X
Silverleaf	***Potentilla anserina***	X			X	
Pacific Silverweed	*Potentilla anserina spp pacifica*	X			X	
Woolly Marbles	***Psilocarphus brevissimus***	X			X	
Coast Live Oak	***Quercus agrifolia***	X				
California Buttercup	***Ranunculus californicus***	X		X		
Wild Mustard	***Raphanus sativus***	X				
Radish	*Raphanus spp.*	X				X
Castor Bean	***Ricinus communis***	X				
Watercress	*Rorippa nasturtium-aquaticum*	X			X	X
Gambel's Water Cress	*Rorippa gambelli*	X			X	X
Sheep Sorrel	***Rumex acetosella***	X				

Appendix B

Wildlife Species Known to Occur or Potentially Occurring and their Associated Habitats

San Luis Obispo Tank Farm

Common Name	Scientific Name	Habitats				
		Observed	*Breeding*	*Terrestrial*	*Wetlands*	*Riparian*
Curly Dock	***Rumex crispus***	**X**			**X**	
Fiddle Dock	***Rumex pulcher***	**X**				
Arroyo Willow	***Salix lasiolepis***	**X**			**X**	**X**
Purple Sage	*Salvia leucophylla*	X				X
Adobe Sanicle	*Sanicula maritima*			X	X	
Pepper Tree	***Schinus molle***	**X**				
Common Tule	***Scirpus acutus***	**X**			**X**	
Common Threesquare	*Scirpus pungens*	X				
Prairie Bulrush	***Scirpus robustus***	**X**			**X**	
Milk Thistle	*Silybum marinum*	X				
Common Sow Thistle	***Sonchus asper***	**X**				
Prickly Sow Thistle	***Sonchus oleraceus***	**X**				
Hedge Nettle	*Stachys ajugoides var ajugoides*	X				
Poison Oak	***Toxicodendron diversilobum***	**X**				**X**
Tree Tobacco	*Nicotiana glauca*	X				X
Strawberry Clover	***Trifolium fragiferum***	**X**				
Red Clover	***Trifolium pratense***	**X**				
White Clover	***Trifolium repens***	**X**				
Owl's Clover	*Castilleja densiflora ssp. Obispoensis*	X		**X**		
Cattail	***Typha latifolia***	**X**			**X**	X
Woolly Vetch	***Vicia villosa***	**X**				
Purple Vetch	*Vicia benghalensis*	X		X		
Annual Fescue	*Vulpia sp.*	X				
Rat-Tail Fescue	***Vulpia myuros***	**X**				
Cocklebur	***Xanthium strumarium***	**X**			**X**	

* Indicates a special status species.

Bold text indicates observed during 2003 Biological Surveys (Rincon 2003a,b, and c).

Other biological surveys include: EDAW 1999 and ENTRIX 1998

Terrestrial Habitat includes annual grassland, ruderal, and disturbed/industrial areas

Wetlands include seasonally ponded wetlands, freshwater emergent wetlands, and aquatic areas

Riparian includes areas immediately adjacent to stream corridors

Appendix C
Data Verification and Analysis Technical Memorandum

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Draft Data Verification and Analysis Technical Memorandum

San Luis Obispo Tank Farm
San Luis Obispo County, California

The objective of this technical memorandum is to describe: (1) the process used to compile and verify data in the primary San Luis Obispo Tank Farm (SLO Tank Farm) database, and (2) the subsequent modifications of the database to support risk assessment activities. Both of these processes are important in the development of data outputs for the predictive ecological risk assessment (pERA) for SLO Tank Farm. It is envisioned that this technical memorandum will become an attachment to the pERA, and is a joint work product of England Geosystem, Inc. (England Geosystem), and Blasland, Bouck & Lee, Inc., (BBL).

The process used to develop pERA datasets for the SLO Tank Farm is illustrated in Figure 1. This included compiling and verifying data points from historical data collection activities into a primary database that is administered by England Geosystem (the data compilation and verification process is described in Section 1 by England Geosystem). Data resulting from ongoing sampling activities, such as the groundwater monitoring program, are added to the primary database by England Geosystem as they are generated. The primary database was downloaded by BBL, and modified to facilitate its use in risk assessment. This resulted in the development of a secondary database that can be accessed at The San Luis Obispo Tank Farm website administered by BBL. Data were then extracted from this secondary database to develop pERA-specific datasets (the development of the secondary database and the pERA datasets is described by BBL in Section 2).

1.0 Development of Primary Database - Data Compilation and Verification

To support various project needs, the environmental monitoring data for the SLO Tank Farm and vicinity was formally assembled and is maintained in the primary electronic database by England Geosystem. The information in the primary database includes:

- Geographic information for environmental sampling locations;
- Well completion data;
- Chemical analytical results of soil, surface petroleum, ground water, and surface water; and
- Fluid level monitoring information.

Section 1 of this memo documents the tasks undertaken by England Geosystem to compile and verify the accuracy of the primary environmental monitoring database. The purpose of the data management system (DMS) designed by England is to provide a centralized, managed location for historical and recently acquired environmental data for the SLO Tank Farm and vicinity. Establishing and using a consistent, verified data source ensures that all data analyses and reports are prepared using the same information. As with any long running environmental project, the compilation of the San Luis Obispo Tank Farm DMS has been an evolutionary process. Therefore, the data, especially the historical data, come from a variety of sources with varying levels of data quality. To establish confidence in the completeness and quality of the data in the primary database, England Geosystem compiled all available data sources to ensure that the database included all available information, and subsequently performed verification of the SLO Tank Farm DMS.

1.1 Data Compilation

The SLO Tank Farm primary database presently consists of 48,092 records. As indicated above, the data includes geographic information for environmental sampling locations, well completion data, fluid level monitoring data, and chemical results for soil, surface petroleum, groundwater, surface water and other miscellaneous sampling points. The database includes samples from locations outside the Tank Farm property boundary so that off-site, down-gradient data sources such as ground water monitoring wells are included. The data is managed within a Microsoft Access-based system with ESRI ArcView 8 and ArcIMS interfaces.

Prior to the initiation of SLO Tank Farm pERA activities, England Geosystem maintained an "informal" site-related database. However, no effort to identify and include all site-related data had been undertaken. In order to ensure the completeness and accuracy of the primary database for use in site risk assessments, England Geosystem performed the following tasks:

- All of the known and/or available original data sources were compiled and catalogued. A bibliography of the reports whose data are included in the database is presented in the attached reference list.
- Chains-of-custody (COC) and analytical laboratory reports for samples collected at the subject property were compiled from the original source reports. The COCs were reviewed to determine whether the requested field and/or laboratory data was incorporated in the existing "informal" database.
- Data not previously included in the "informal" database were electronically uploaded or manually entered into the database depending upon the data source. 14,435 records were identified that had not previously been included in the "informal" database. Generally, groundwater and surface water monitoring data were uploaded using an Excel spreadsheet provided by Unocal's consultant. Historical soil data were generally manually transcribed directly from the original sources into the database. Some of the more recent (post-1999) soil and surface petroleum analytical data were available electronically and were uploaded. Approximately 10 percent of the electronically uploaded and manually entered data points were manually checked against the original analytical laboratory reports to ensure that the transfers and entries occurred correctly.
- Analyte names were standardized using CAS numbers, if available. If there was no CAS number (e.g., TPH C_{10}-C_{40}), a unique identification number was created and included as the CAS number.

The data compilation process was designed to establish the highest degree of confidence in the DMS. Therefore, the individual data records comprising the primary database were checked for completeness, consistency and correctness. During the process, 41,741 database records were examined and compared to the original laboratory reports[1] where possible. In instances that the original laboratory reports were not available, summary tables included in one or more reports were used as the data source.[2] Only 6,351 records could not be checked because the original source of that data was not available for examination. All data that have been compared with source information includes a chain-of-custody reference number as part of the record. Data that could not be checked because the source information was not available do not include a chain-of-custody reference number.

[1] Primary sources, as opposed to secondary sources such as tabular summaries, were used to validate the data when ever possible.
[2] This was generally only the case for some of the older groundwater monitoring data.

1.2 Data Verification

Once the primary database was largely compiled, completeness and accuracy were verified using various computer application modules including:

- Missing Data Analysis (QMDA) to identify required data fields that do not contain data in the following fields:
  - Sample station location, sample identification, and date collected/analyzed;
  - Matrix type;
  - Analyte name;
  - Result value and units; and
  - Sample depth for soil samples.

  Identified data discrepancies within a record such as a reported analytical method with no reported result, unusual detection limits, analysis date prior to collection date, etc. were corrected using original sources.
- Outlier Data Analysis (QODA) to identify data that exceed data thresholds (e.g., fluid levels that are impossibly high or low, etc.). Outlier data were manually checked for accuracy and corrected as necessary.
- Data Validation Analysis (QDVA) to query data validation flags (i.e., qualifier flags provide data users with information about the quality of the data).
- Non-detect Assignment (QNDA) to assign a value to non-detected chemical concentrations (i.e., half the detection limit). This is typically done to facilitate the calculation of statistics from data sets containing nondetectable concentrations and does not affect the full detection limit reported in the database.

Once the data set was determined to be complete, five percent of the records (approximately 2,500 records) were randomly extracted and compared to the original data sources (i.e., laboratory or field reporting sheets). The review indicated an error rate of significantly less than 1 percent of the extracted electronic data (0.05 percent of the total number of records in the database). This error rate was less than the 0.5 percent error rate established in the proposed scope of work, so no further accuracy evaluation was conducted.

2.0 Development of Secondary Database and pERA Datasets

The primary SLO Tank Farm database posted on the England Geosystem website was downloaded by BBL on February 13, 2003.[3] A number of modifications were made to this database and to subsequent database addenda, in order to ensure that all data analysis and interpretation conducted for the pERA accurately reflects site conditions, as well as to simplify the data querying process. These modifications, detailed in Section 2.1, resulted in the creation of the secondary database accessible on the SLO Tank Farm project website administered by BBL.

[3] The number of records in the analytical portion of the database downloaded on February 13, 2003 was 30,174. The total number of records downloaded (including the well construction data, sample information, monitor stations and field monitoring data files) was 33,335. After this date, changes to the primary database relevant to the pERA were to be provided to BBL directly, rather than via repeated downloads of the primary database from the England Geosystem website. For example, results of the March 2003 surface water and the June 2003 soil and surface tar sampling events were/will be supplied electronically to BBL by England Geosystem as addenda to the primary database. Other changes to the primary database not relevant to the pERA, such as the addition of records from subsequent groundwater sampling events, have not been incorporated in the secondary database.

The pERA datasets were subsequently extracted from this secondary database, as outlined in Section 2.2.

2.1 Development of Secondary Database

The secondary database developed by BBL for the pERA was drawn exclusively from the analytical portion of the England Geosystem database, which includes all analytical data associated with the SLO Tank Farm site as described in Section 1. Modifications included:

- Excluding some records not pertinent to the pERA;
- Differentiating among media;
- Converting soil and sediment results from wet weight to dry weight;
- Identifying on-site versus offsite locations;
- Designating former "Operations Area" locations,
- Creating consistent analyte naming conventions;
- Creating "Sum" analytes for TPH and PAHs; and
- Designating wetland and riparian habitat locations.

2.1.1 Record Exclusion

Only records with "primary" and "field duplicate" sample types were included in the secondary database. Sample types other than "primary samples" in the primary database as downloaded by BBL included: blank (a single unknown water blank record); equipment blank (42 water records); field blank (5 water records); trip blanks (46 water records); and laboratory duplicate (4 water records associated with March 1998 sampling of SW-2). No "field duplicate" samples were identified in the primary database.[4] Because all data had been validated prior to inclusion in the primary database and addenda and the QA/QC samples are not needed for risk analyses, it was not necessary to include these samples in the secondary database.

In order to exclude laboratory analytical recovery records from the secondary database, records with "%" reported in the "Result Value Units" field were excluded form the secondary database. This change eliminated 129 records.[5] Another group of records included in the primary database but omitted from the secondary database are the soil leachate results conducted on the Background 1 through 8 samples. These data are not pertinent to the risk assessment, and resulted in 102 records being eliminated from the secondary database. Finally, 20 records for which no analyte was reported in the primary database as downloaded by BBL are excluded from the secondary database.[6]

2.1.2 Media differentiation

Because the primary database matrix designation of "water" did not differentiate between surface water and groundwater results, BBL designated the following historical sampling locations (in consultation with Mike Rendina of England Geosystem) as surface water stations in the

[4] Field duplicates collected as part of the March 2003 surface water sampling event (April 2003 report/addendum) are included in the secondary database. Seventeen equipment blank records and 5 trip blank records included in the April 2003 addendum are not included in the secondary database.

[5] Analytes with "%" result units included Decachlorobiphenyl, 2,4,5,6-Tetrachloro-m-xylene, 2,4-DCPA, Toluene-d8, 2,4,6-Tribromophenol, Phenol-d6, 1,2-Dichloroethane-d4, 2-Fluorobiphenyl, Nitrobenzene-d, 4-Bromofluorobenzene, Sulfur, Terphenyl-d14. Matrices included soil, groundwater, and other solid waste.

[6] Post February 13, 2003 examination of the primary database indicates that the 20 records eliminated from the secondary database were all for groundwater collected from Well #s 1 through 4, and included the following analytes: Langlier index corrosivity, odor, 96 Hr LC50, reactive cyanide, reactive sulfide, and flashpoint.

secondary database: Storm 1, 2, and 3; Surface 1 through 9; SW-1 E&A, SW-2 E&A, and SW-3 E&A; and SW-1 through 10. The matrix for the remaining "water" stations was designated as groundwater in the secondary database.

2.1.3 Soil and sediment wet-to-dry weight conversion

Based on conversations with Mike Rendina, it was determined that all soil and sediment analytical results in the primary database are reported in wet weight. For the purposes of the pERA, it was necessary to convert these values to dry weight. Therefore all soil and sediment results in the secondary database (including non-detected values) are in reported dry weight, and were converted using the wet-to-dry conversion factor of 0.799. This value was developed in 2001 by England Geosystem based on moisture data available from nearby the site (Tank Farm Road), and its use agreed upon by the Ecological Risk Working Group (ERWG) at the 3/11/03 meeting.

2.1.4 On-site versus off-site location designation

At the 1/28/03 meeting the ERWG decided that only samples within the actual SLO Tank Farm boundary would be included in the pERA (i.e., the Forest property and Martinelli properties would not be included in the pERA). Because the primary database includes both on- and off-site samples, a geo-referenced site boundary provided by England Geosystem was used to distinguish between on- and off-site sample locations in the secondary database. However, some stations are located very close to the site boundary, and on- versus off-site designations were determined based on consultation with Mike Rendina. Sample location clarifications were made as follows: MW-49, MW-50, and MW-56, along the northwestern border of the site, were all identified as off-site; B-37 and B-57 through B-60, located in Tank Farm Road (between the boundary fences), were considered off-site. In the primary database (as downloaded by BBL from England) there are six station identifications for which there is no location information (stations ES-1 through 3, and GB-11 through 13, with 78 associated records). No on-site or off-site designation has been included in the secondary database for these groundwater stations.[7] Finally, historical surface water station locations SW-5, -6, and -8 were identified as off-site during the preparation of the March 2003 Surface Water Sampling and Analysis Plan. All other samples were clearly identified as on- or off-site based on the site boundary as shown in Figure 2.

2.1.5 "Former Operations Area" location designation

Based on discussions with the ERWG on the 3/18/03 conference call, the ERWG agreed that the pERA will include two exposure scenarios: (1) site-wide including the Operations Area, and (2) site-wide excluding the Operations Area. The former Operations Area, in the northwest corner of the site, illustrated in Figure 2, was identified by England Geosystem based on review of historical photos and plans. Samples located within this boundary were designated within the Operations Area in the secondary database.

2.1.6 Creation of consistent naming conventions

Because TPH has been historically collected using a number of different methods and various analytical laboratories, the carbon fractions reported are not always consistent. For surface water specifically, the extractable TPH results were frequently reported as the fraction ranges actually detected (as opposed to the C10-C40 range). Therefore, both the historical data associated with the primary database and the Spring 2003 sampling addendum include multiple carbon range "analytes" for the extractable TPH analysis, including C8-C40, C10-C40, C11-C32, C14-C32, C11-C34, etc. So that all surface water extractable TPH results could be queried using a single

[7] Groundwater data are included in the secondary database for completeness, but are not included as a part of the dataset for the pERA.

analyte, the extractable range TPH analytes were all re-named "C10-C40" in the secondary database (77 records in the primary database as downloaded by BBL, and 12 records in the April 2003 addendum). Changing the analyte name did not alter the corresponding results in any way. Similarly, the three silica gel TPH carbon range analytes reported for surface water in the primary database (Silica Gel C8-C40, C18-C32, and C20-C32) all have been renamed "Silica Gel TPH (C10-C40)".[8]

Similarly, any time "TPH" was reported as the analyte with no specified carbon range identified (analytical methods included EPA 418.1, 8015 and 8270) in the primary database, it was re-named C10-C40 in the secondary database. This change was not matrix specific, and applied to a total of 28 soil records, 3 of which are relevant to the pERA (i.e., on-site at less than or equal to 5 feet depth, see Section 2.2), 3 groundwater records, and 6 NAPL/pure product records. While a variety of purgeable and extractable TPH carbon ranges are specifically reported for non-pERA relevant soil samples, simply changing the "TPH" analyte resulted in all TPH results for soil and sediment samples less than or equal to five feet falling into the following four carbon ranges in the secondary database: C4-C10, C10-C25, C25-C40, and C10-C40. In addition, TPH carbon range analytes reported for the five riparian locations (at less than or equal to ten feet depth, see Section 2.2) included only C10-C25 and C25-C40. Thus, no additional analyte name changes were necessary in the secondary database to consistently capture all the soil and sediment TPH samples pertinent to the pERA.

Other analytes reported in the primary database as downloaded by BBL and the surface water addendum that were renamed for consistency in the secondary database include "Nitrate as N" (21 converted to nitrate) and "Nitrite as N" (23 converted to nitrite).

Finally, to aide in data querying, the secondary database includes a field that assigns individual analytes to the following suites, as appropriate: metals, inorganics, physical, herbicides, pesticides, VOCs, SVOCs (excluding PAHs), PAHs, PCBs, and TPH.

2.1.7 Creation of Sum TPH and Sum PAH records

Ecotoxicological benchmarks available for ecological risk assessment of petroleum contamination are often based on a total or combined measure of the various constituents of petroleum. Thus for the purposes of the pERA, it was necessary to combine some of the available site data to define two new analytes in the secondary database, Sum TPH and Sum PAH, so that the data could be compared to available benchmarks. The "Sum TPH (C10-C40)" analyte was created in the secondary database by summing the C10-C25 and C25-C40 analytes for all samples in which they were reported.[9] Any non-detected values were summed at half the detection limit. As indicated above, TPH results for samples pertinent to the pERA were renamed in the secondary database so that the following four carbon ranges resulted: C4-C10, C10-C25, C25-C40, and C10-C40. Summing the C10-C25 and C25-C40 results allows for comparison with the measured C10-C40 results and other whole TPH benchmarks. Because the C4 – C10 carbon range was generally not detected in early soil samples, the majority of the samples collected for the site were not analyzed for this fraction. Of the soil samples collected on-site from depths less than or equal to five feet (i.e., pERA relevant), C4-C10 TPH results are reported for only 47 samples, while Sum TPH C10-C40 and measured C10-C40 results are

[8] Changes to the Silica Gel TPH analytes names were made for both surface water (65 records from the primary database and 10 records in the April 2003 addendum) and groundwater (322 records).

[9] This change was made regardless of matrix. The C10-C25 and C25-C40 results were reported for 615 samples in the primary database, and thus resulted in the creation of 615 Sum TPH (C10-C40) records in the secondary database.

available for 234 samples. Moreover, TPH in the C4-C10 range was detected in only five of the 47 samples, with concentration ranging from 22.5 to 538 mg/kg dry weight. The highest concentration was detected in the Trench 6 sample from 4 feet; however it comprises only 1.56% of the total TPH (C4-C40) detected at that location. For these reasons, the C4-C10 carbon range was excluded from the sum TPH calculation.

The secondary database "Sum PAH" analyte was created by summing the following 16 analytes: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorine, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene.[10] Any non-detected values were summed at half the detection limit. For locations where naphthalene was measured via both the 8260 (VOC) and 8270 (SVOC) method, the result associated with the 8270 analysis was used in the summation. All naphthalene analyses were non-detect except 1 sample, thus the inclusion of naphthalene in the sum PAH calculation consisted of ½ the detection limit for the 8270 method (which was generally higher than the 8260 detection limits). Summing these individual PAHs into Sum PAH in this manner allows for consistency with available literature-based PAH toxicity benchmarks. In cases where the available toxicity benchmark for sum PAH is based on a different set of individual PAHs, a revised sum will be calculated for comparison purposes and will be clearly identified as such in the pERA.

2.1.8 Habitat designations

The pERA requires the identification of locations within wetland and riparian habitats (see Section 2.2). In the secondary database, all on-site soil and sediment locations within the footprint of the federally or state-delineated wetlands are classified as wetland locations. In addition, based on consultation with Mike Rendina, the following 5 locations have been classified in the secondary database as located within riparian habitat: B-63, S-48, S-51, S-67, and Background-8.

2.2 Development of pERA Datasets from the Secondary Database

Because the pERA is only concerned with media to which ecological receptors may be exposed, many of the data in the secondary database are not relevant for the purposes of the risk assessment. For this reason, specific data have been extracted from the secondary database for use in the pERA, and are described in this section.

Based on agreements from the 1/28/03 ERWG/Human Health Work Group (ERWG/HHWG) meeting, three media types were identified for use in the ecological risk assessment: soil, sediment, and surface water. At this meeting, it was also decided that only on-site data will be included in the pERA, and that the areas where remediation is currently planned (i.e., Tanks 5 and 7) will be excluded from the risk analysis. In addition, surface tar expressions will be excluded and any toxicological or physical hazards associated with these areas will be addressed outside of the pERA process. The following data were extracted from the primary database to evaluate the general habitats/exposure scenarios identified for the pERA:

- All on-site soil and sediment samples collected from depths less than or equal to 5 feet were used to assess exposure to terrestrial receptors.

[10] This change resulted in the creation of 251 Sum PAH records in the secondary database.

- All on-site soil and sediment samples collected from depths less than or equal to 0.5 feet that fall within the footprint of federal and state-delineated wetlands were used to assess exposure to wetland receptors.
- All on-site soil and sediment samples collected from depths less than or equal to 10 feet and located within riparian habitat were used to assess exposure to riparian plants.
- All on-site surface water samples collected from all depths were used to assess exposure to aquatic receptors (all surface water metals data are filtered).

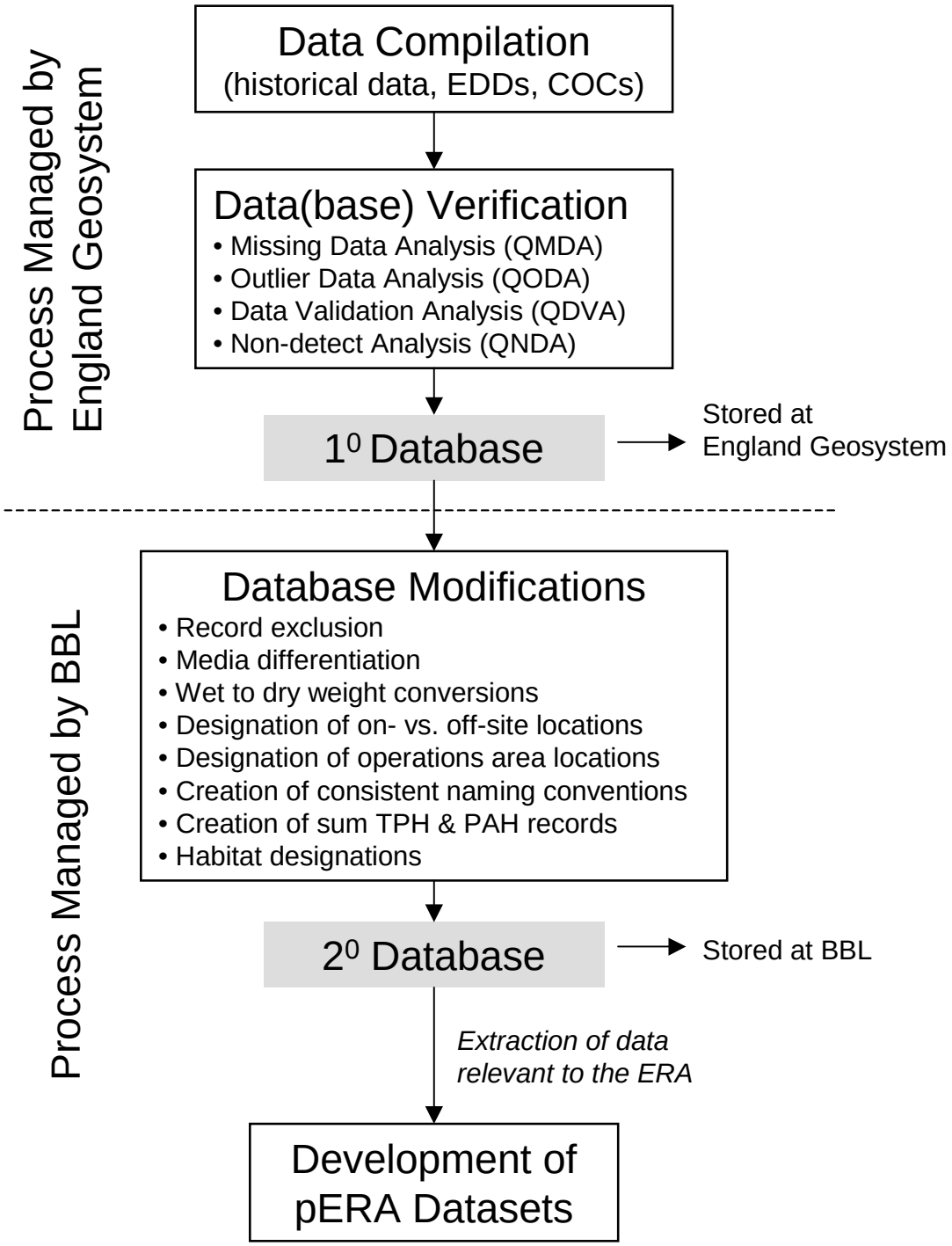
Summary statistics and exposure point concentrations were developed using the pERA dataset with the following guidelines:

- Non-detects are reported in both the primary and secondary databases at the detection limit. For any calculations that required the use of non-detected values (averages, sums, etc.), half the detection limit was used.
- Field duplicate samples were averaged.
- There are 17 samples (11 soil, 3 sediment, and 3 surface water) in the pERA dataset where naphthalene was analyzed by both the 8260 and 8270 methods. If naphthalene was detected, the maximum detected concentration was used in the exposure point concentration calculation. If naphthalene was not detected in either sample, half of the minimum non-detected concentration was used in the exposure point concentration calculation.
- Samples from multiple depths at a single location were treated as independent samples when calculating integrated exposure estimates (i.e., 95% UCLs or means). In order for the exposure estimate to represent the integrated exposure potential at the site, it must capture the true variability of the dataset. Because there was no clear pattern of higher or lower constituent concentrations at shallow or deeper depths, the exclusion of samples at depth or combining multiple depth samples from a single location into one data value may misrepresent the variability of the data at the site. For this reason, samples at multiple depths for single sample locations were considered independent.
- 95% UCL calculations: Contaminant distributions (normal, lognormal, neither) were determined based only on detected concentrations. Once the distribution was identified, the following methods were used to calculate 95% UCL concentrations (with non-detects included at half the detection limit):
    - Normally distributed – Student's-t method
    - Lognormally distributed – Land's (H-statistic) method
    - Neither/Distribution unknown – Bootstrap method via EPA's ProUCL program.

3.0 Conclusions

The objectives of this memo were to describe the process England Geosystem used to compile and verify data in the SLO Tank Farm database, and the subsequent database modifications and data extraction steps used by BBL to support risk assessment activities. The processes described herein were undertaken to ensure that the complete collection of SLO Tank Farm data is accurately applied in the predictive Ecological Risk Assessment.

Figure 1. SLO Tank Farm Database Process



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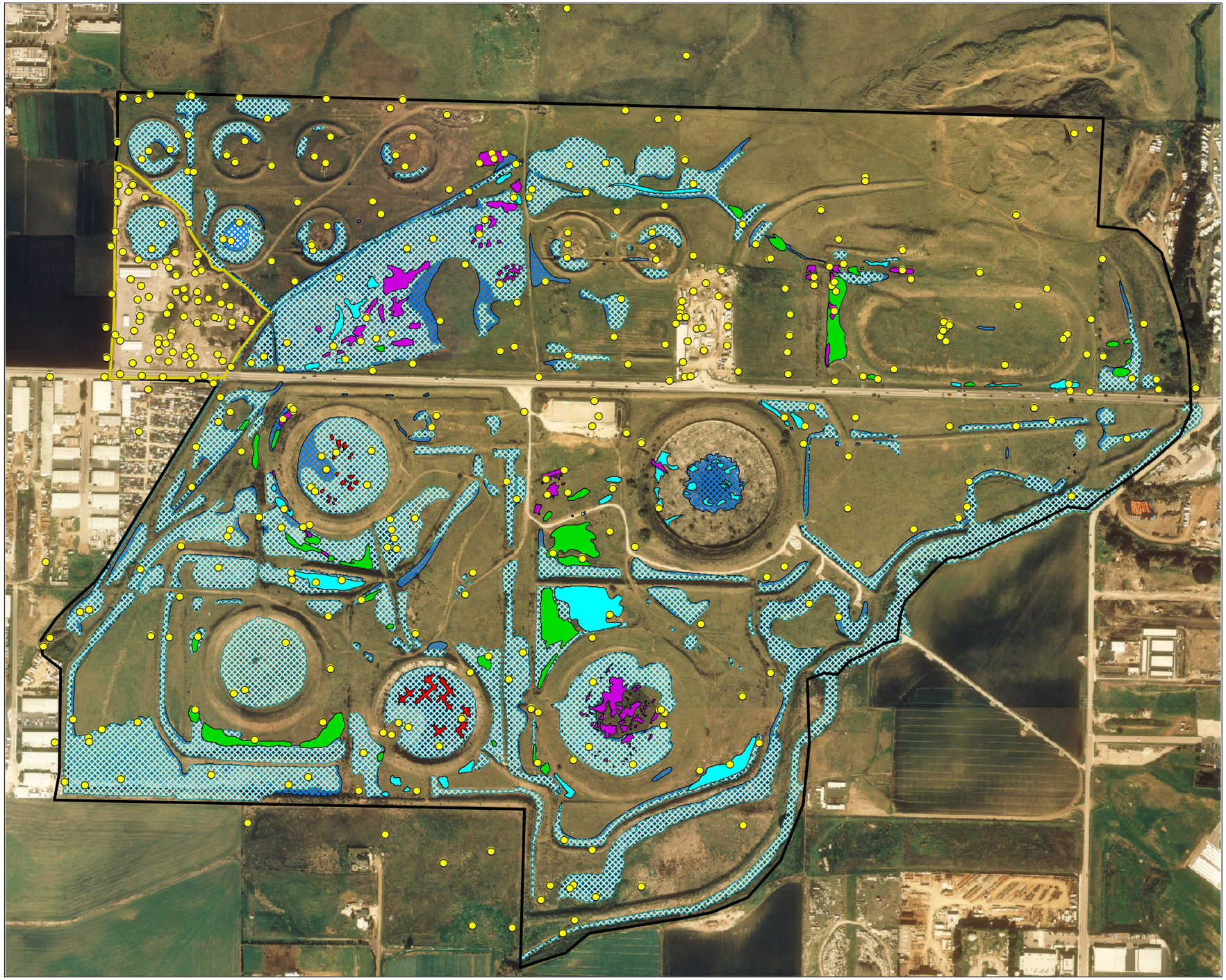

Figure 2.

San Luis Obispo Tankfarm
San Luis Obispo, CA

Legend

- Sample locations
- Operations Area
- Siteboundary
- Wetlands (Federal designation)
- Wetlands (California State designation)

Seeps

- Liquid crude oil. Capable of generating 'Free' droplets of oil.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Solid, former crude oil.

Appendix D

Dioxin Compounds in Soil at the San Luis Obispo Tank Farm

BBL®
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DIOXIN COMPOUNDS IN SOIL AT THE UNOCAL SAN LUIS OBISBO TANK FARM

July 30, 2003

Prepared for the San Luis Obispo Tank Farm - Surface Evaluation, Restoration, and Remediation Team

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1.0 SUMMARY OF THE ISSUE

Process knowledge and analogy can be used to draw conclusions about site contamination. These conclusions are as valid as those based solely on sampling and analysis results and can be used to make remediation decisions.

In this paper, process knowledge and analogy are used to evaluate the potential presence of dioxin compounds in soil at the Unocal San Luis Obispo Tank Farm (Tank Farm). No analytical data exist regarding the formation of dioxin compounds during the uncontrolled combustion of crude oil. However, by using process knowledge and analogy, it is reasonable to conclude that dioxin compounds could have been produced and deposited onto soil during the burning of crude oil in the 1926 event fire at the site. However, the lack of atmospheric chlorine and the very low crude oil chlorine concentration would limit the amount of dioxin compound formation and the fire as a dioxin source to soil. It is also known through process knowledge that 1) any dioxin compounds that may have been produced have been decreasing in concentration over the past 75 years due to soil mixing and biodegradation processes and 2) other dioxin sources account for an ambient background concentration in Tank Farm soil. Because of these factors, soil sampling and analysis for dioxin compounds would be problematic to interpret. Laboratory analysis cannot distinguish between residual dioxin from the Tank Farm fire event in 1926 and that which has been deposited since the fire from other sources. Concentrations of dioxin compounds in soil are expected to be within the range of ambient background concentrations.

2.0 INTRODUCTION

Statement of the Issue
The evaluation of potential human and ecological exposure to contaminants is dependent upon an adequate understanding of contaminant concentration and spatial distribution. Understanding can be gained through various lines of evidence, including process knowledge, analogy, and sampling and analysis. Process knowledge is based on an understanding of the formation and fate of contaminants. Analogy is information gained from the study of other sites with characteristics similar to the site in question. Sampling and analysis provide site and sample-specific concentration data. Each of these methods individually or in combination can be adequate to characterize a site.

Several questions have been raised regarding the issue of dioxin compounds in soil at the Tank Farm. Specifically:

Are dioxin compounds present in Tank Farm soil?
At what concentrations do dioxin compounds exist?
What sources might have contributed to dioxin levels in soil?
Are conclusions based upon process knowledge and analogy sufficient to make remediation decisions at the Tank Farm site?

These issues are addressed in this paper.

Literature Citations
There are many literature references and review papers on dioxin compounds. In general, the information for this paper comes from the following citations:

USEPA Draft Dioxin Reassessment. Draft Exposure and Human Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) and related Compounds.

Database of Sources of Environmental Releases of Dioxin like Compounds in the United States (EPA/600/C-01/012, March, 2001)

When specific references are used in the text, they are cited and listed in the Reference section. Several additional references that address the degradation of dioxin compounds in soil and background levels in soil are also provided.

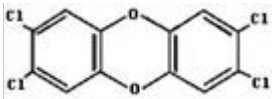
Considerable professional experience, although unpublished, is used in this paper. Specifically, a study of the presence of dioxin compounds at a site where refined petroleum hydrocarbons were burned serves as an analogy for the Tank Farm site.

Outline of Paper
The remainder of this paper is divided into the following sections:

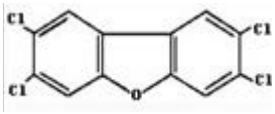
- Background on Dioxin Compounds. This section provides a description of the nomenclature used to describe dioxin compounds.
- Sources of Dioxin Compounds in Soil. This section provides a discussion of various combustion types and their potential to contribute dioxin compounds to environmental samples.
- Expected Concentrations of Dioxin Compounds in Tank Farm Soil. This section provides some estimates of concentration ranges for dioxin compounds that might be found in Tank Farm Soil.
- Conclusions. This section provides answers to the four questions posed above.

3.0 BACKGROUND ON DIOXIN COMPOUNDS

The term “dioxin compounds” refers to a class of related chemicals that share similar chemical structures. The ‘backbone’ molecules are either dioxin or furan, shown below, each with four chlorine atoms in the 2,3,7,8-configuration.



Dioxin



Furan

The number of chlorines on either the dioxin or furan molecule determines its chemical properties, toxicity, and persistence in environmental samples. The dioxin and furan molecules can have up to 8 chlorines each. There are 75 combinations of chlorine on dioxin (called dioxin congeners) and 135 combinations of chlorine on furan (called furan congeners). The term "congener" refers to closely related compounds that share a similar molecular configuration, but are not identical (i.e. congeners share an identical formula).

Dioxin and furan congeners are present in environmental samples in complex mixtures. In many cases, the source of the dioxin compounds produces a congener mixture that is characteristic of that type of source. For example, sources of combustion of organic material (wood, petroleum hydrocarbons) produce a mixture that contains mostly octa-substituted (eight chlorines) congeners. Laboratory analytical reports will list the dioxin and furan congeners with tetra- (four), penta- (five), hexa- (six), hepta- (seven), and octa- (eight) chlorines that occupy the 2,3,7 and 8 positions. It is the 2,3,7,8-substituted dioxin and furan congeners that are of greatest interest in human and ecological risk assessments. Because the toxicity of the individual 2,3,7,8-substituted dioxin congeners can vary greatly, knowledge of the concentrations of each of these congeners is important. In general, dioxin or furan congeners with more chlorine are considered to have lower toxicity.

A process has been developed to evaluate the toxicity of dioxin compound mixtures for use in risk assessment. Each of the 2,3,7,8-substituted dioxin and furan compounds is given a weighting factor, termed a Toxicity Equivalency Factor (TEF). Each congener concentration is then multiplied by its TEF and the products are summed to get a toxicity-weighted total concentration for that sample. The concentration sum is termed Toxicity Equivalence (TEQ) when based on the TEF scheme. There are different TEF schemes that have been proposed and adapted by agencies world-wide. The consistent component of all these schemes is the interpretation of dioxin compounds with a greater number of chlorines as being less toxic than dioxin compounds with lower number of chlorines.

Soils and sediments are common receptors or sinks for dioxin from environmental sources. Airborne releases of dioxin as particulates will eventually fall back to earth and deposit in soil. Sources of these airborne releases may be nearby or distant, and are typically associated with combustion. The result is 'background' levels of dioxin compounds in soil that are derived from various sources that have similar congener patterns. It therefore is not possible to determine the source of the individual dioxin congeners in the dioxin compounds found in a soil sample when the source characteristics are similar.

Once dioxin compounds enter the soil, several environmental mechanisms affect the resulting concentrations. If sources of airborne dioxin compounds are continuous, the soil concentration of dioxin compounds will increase over time in areas impacted by that continuous source. For example, since gasoline and diesel engines are common sources of dioxin compounds, areas adjacent to roads with high traffic can have higher soil concentrations than areas distant from roads. Other mechanisms will act to decrease soil concentrations. For example, soil mixing, either from grading or mechanical wear (e.g. vehicle driving on dirt roads) will decrease the concentrations of dioxin compounds in soil. In addition, there is evidence of biological degradation of dioxin compounds in soil. Reported half-lives of dioxin congeners have ranged

from years to decades in various types of soil and sediment (see dioxin degradation references). Environmental half-life, the time it takes for natural degradation processes to decrease concentrations by half, is shorter for all congeners when the moisture content of soil is high.

4.0 SOURCES OF DIOXIN COMPOUNDS IN SOIL

Analyses of water, soil, sediment, air, biological tissue, and human tissue samples have indicated that dioxin compounds are ubiquitous in the environment. The source of dioxin compounds can be both natural and anthropogenic (i.e., due to human activities). However, it is not always possible to differentiate between the two sources in environmental or biological samples.

Natural Sources
Natural sources of dioxin compounds are generally associated with combustion. When organic materials are burned in the presence of air, chlorinated dioxin compounds are produced. Organic materials include plants (e.g. brush fires) and wood (e.g. forest fires). Volcanoes are another natural source of dioxin.

Naturally-produced dioxin compounds need a source of chlorine molecules. The chlorine can come from the air. Airborne concentration estimates are currently in the parts per billion of total chlorine (Khalil and Rasmussen, 1997; Ministry for the Environment 2000; and AFEAS 2000) and are greater now than in the early part of the 20th century prior to extensive organo-chlorine chemical manufacturing. The burning material itself (e.g., wood) can also be the source of the chlorine.

Dioxin may also be present naturally in deposits of subsurface soil and rock. Samples of both excavated clays and shales, previously unexposed to modern atmospheric sources of dioxin compounds, have been found to contain dioxin compounds. At some sites, water erosion can cut channels down to these subsurface sources, bringing the sediment and the dioxin to the surface. The excavation of ball clay and its subsequent uses in animal feed as a binding agent has been found to be a source of dioxin compounds in our food supply.

Anthropogenic Sources
Anthropogenic sources are varied but are typically also associated with combustion. Common combustion sources include vehicles (gasoline and diesel engines), building fires, municipal waste burning, power generation plants, and cement kilns. Non-combustion sources include pulp and paper mill effluents and selective pesticide (2,4-D) application. Each of these sources, especially mobile (e.g., vehicles) and stationary (e.g., power plants or incinerators) add to the concentration of dioxin compounds in soil.

Crude Oil Combustion as a Source of Dioxin Compounds
There are no studies that have measured dioxin levels directly formed as a result of crude oil combustion. Therefore, this issue must be addressed through the use of analogy and process knowledge.

It is known that the combustion of organic material has the potential to form dioxin. However, a source of chlorine molecules is necessary. In a fire today, the atmosphere could provide that source. Chlorine concentrations in the air are in the range of parts per billion. However, most of the atmospheric chlorine is a result of the release of anthropogenic chlorine-containing compounds to the air. Since these chlorine-containing compounds came into use after the Tank Farm fire in 1926, atmospheric chlorine levels may have been too low to contribute to dioxin compound formation at that time.

Another potential source of the chlorine molecules could have been the crude oil itself. There are no measurements of chlorine concentration in the crude oil stored at the Tank Farm at the time of the fire. However, there are some measurements available for chlorine in crude oil. These data show that concentrations range from 100 to 2000 parts per million (APS 1999). These low levels of chlorine in crude oil suggest that the production of chlorinated dioxin compounds during the fire would have been very limited. This is further supported by data on Polychlorinated Biphenyl fires that have produced only parts per billion levels of dioxin compounds in soil.

The mechanism of dioxin formation during combustion has been extensively studied for municipal solid waste incinerators and applied to other combustion sources. In addition to the need for a source of chlorine in order for chlorinated dioxin compounds to be formed, the conditions of the combustion process is an important consideration. Incinerators must carefully control both the temperature of combustion and the cooling of combustion gases. When uncontrolled combustion occurs (e.g. burning wood or the tank farm fire) incomplete combustion and the rapid cooling of the smoke lead to low rates of dioxin formation. One reported formation rate for burning wood is 4 ng dioxin TEQs/kg wood. At this formation rate a fire would need to consume 250 million kg of combustible material to produced one gram of dioxin. During a fire greater than 70% of the formed dioxin would be in gaseous state versus particulates and would therefore be most likely to be carried from the source area by the wind for deposition at a remote location.

The evidence suggests that the combustion of crude oil during the Tank Farm fire could have resulted in the formation of dioxin compounds. However, the lack of atmospheric chlorine and the very low crude oil chlorine concentration combined with the uncontrolled combustion would limit the amount of dioxin compound formation. Therefore, the Tank Farm fire would not have been expected to be a large dioxin source to Tank Farm soil.

5.0 EXPECTED CONCENTRATIONS OF DIOXIN COMPOUNDS IN TANK FARM SOIL

Process knowledge and analogy lead to the conclusion that dioxin compounds are present in Tank Farm soil. This section considers the various possible sources of the dioxin compounds, their relative significance in terms of soil concentrations, and the concentrations that would be expected to be present in soil today.

Dioxin Accumulation
One of the sources of dioxin to consider is the Tank Farm fire of 1926. It was reported at the time that a lightening strike to one of the tanks ignited the fire, which then spread to other tanks, consuming the wooden covers and causing the crude to boil-over the concrete and earthen containments. These breaches resulted in the release of burning oil to the land surface. Dioxin compounds that might have been formed would have been carried in the smoke, most likely moving in the air and being deposited both at the site and downwind. In addition, some of the burned residue may have remained on the ground, becoming mixed into the soil when the site was graded after the fire. However, the limited source of chlorine molecules would make the crude oil combustion only a minor source of dioxin compounds.

Other sources of dioxin compounds in Tank Farm soil are the vehicle traffic on Tank Farm road and airplanes flying over the site. These adjacent sources, in addition to regional sources, would contribute to soil concentrations of dioxin on a continuous basis.

These possible sources of dioxin compounds to Tank Farm soil are all combustion-related. Therefore, it is expected that the congener mixture would be similar for all these sources, i.e., there would be larger percentages of the congeners with seven or eight chlorines. Since dioxin compounds from each source would have the same congener pattern, it is not possible to distinguish the relative contribution of each source to Tank Farm soil.

Dioxin Reduction
While there are continuous sources adding dioxin compounds to soil, there are also processes acting to decrease concentrations. The two major processes are dilution by soil mixing and environmental degradation. It has been reported that after the Tank Farm fire, soil berms were re-constructed and additional secondary berms were added to minimize the possibility of released oil flowing off-site. Soil from on-site was used to re-construct and make new berms. Therefore, it is likely that any dioxin deposited on the soil surface from the Tank Farm fire would have been mixed into the soil during berm construction.

The second process acting to decrease dioxin compound concentrations in soil is degradation. Environmental half-lives of dioxin compounds, although varying between congeners, could conservatively range from years up to several decades for the most persistent congener (see degradation references). Since multiple environmental half-lives have passed since the fire, it is expected that few of the dioxin compounds that may have been produced during the fire still remain in Tank Farm soil.

The total concentrations of dioxin compounds in Tank Farm soil are expected to be similar to background concentrations. These background concentrations will range from non-detect (with a total detection limit of around 0.1 parts per billion) to hundreds of parts per billion.

6.0 CONCLUSIONS

The following conclusions can be drawn from the information presented in this paper:

- Process knowledge and analogy can be used to draw conclusions about existing site dioxin contamination. These conclusions are as valid as those based solely on sampling and analysis results and can be used to make remediation decisions.

- The combustion of crude oil during the Tank Farm fire could have resulted in the formation of dioxin compounds. However, the lack of atmospheric chlorine and the very low crude oil chlorine concentration would limit the amount of dioxin compound formation. The Tank Farm fire is not expected to be a large dioxin source to Tank Farm soil.

- Concentrations of dioxin compounds in Tank Farm soil are expected to be within the range of ambient background concentrations, which have not been found to be a significant risk to human health or the environment.

- The processes of dioxin reduction in soil, coupled with continuous sources contributing to background dioxin levels, make the interpretation of soil sampling and analysis results for dioxin compounds problematic. It is not possible for laboratory analyses to distinguish residual dioxin from the 1926 Tank Farm fire from dioxin that has been deposited since the fire from other sources.

7.0 REFERENCES

General References

USEPA Draft Dioxin Reassessment. Draft Exposure and Human Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) and related Compounds. http://cfpub.epa.gov/ncea/cfm/part1and2.cfm?ActType=default

Database of Sources of Environmental Releases of Dioxin like Compounds in the United States *(EPA/600/C-01/012, March, 2001).* http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=55405

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Appendix E

Characterization of Total Petroleum Hydrocarbon Detected in Surface Water from Unocal's Former San Luis Obispo Tank Farm

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MEMORANDUM

TO: ECOLOGICAL RISK ASSESSMENT WORKING GROUP, SERRT

FROM: BOB HADDAD

SUBJECT: CHARACTERIZATION OF TOTAL PETROLEUM HYDROCARBONS DETECTED IN SURFACE WATER FROM UNOCAL'S FORMER SAN LUIS OBISPO TANK FARM – VERSION 2.0

DATE: OCTOBER 4, 2003

CC:

INTRODUCTION

At the request of the Ecological and Human Health Risk Assessment Working Groups of the Surface Evaluation, Remediation, and Restoration Team (SERRT), analytical data from surface water samples recently collected at Unocal's former San Luis Obispo Tank Farm (SLO-TF) facility (the Site) have been reviewed and are discussed[1]. One of the ongoing questions regarding detectable concentrations of Total Petroleum Hydrocarbons (TPH) in the surface waters at this Site is the source of the detectable TPH. Historical analyses (England & Associates, 1999[2]) have demonstrated that there are very few surface water TPH detections in the C4-C10 (volatile organic compound range; detection limits usually $\leq$100 µg/L). This finding is consistent with the hypothesized source, age, and degree of weathering of most of the Site petroleum (see England & Associates, 1999). However, low level concentrations (e.g., $\leq$1-2 mg/L) of TPH in the C10-C40 carbon range have been sporadically encountered in some of the Site's surface water bodies.

These findings of TPH detections have been investigated closely because they appear to be inconsistent with expectations based on our understanding that *most* of the petroleum at the Site is related to/sourced from the crude oil releases associated with the 1926 fire (see England & Associates, 1999). In a few spatially localized locations, sources of these C10-C40 hydrocarbons may have been derived from activities associated with the former fire school. However, based on groundwater hydrology, it is unlikely that this spatially localized source can account for the majority of the detectable C10-C40 TPH detections. In addition, invariably, the treatment of the surface water samples with silica gel (for the removal of polar compounds; e.g., see references in EPA Method 418.1) results in the removal of detectable TPH from the samples (detection limits

[1] See the following: England Geosystem, Inc. (2003a). Final Sampling and Analysis Plan (Version 1.1), Supplemental Evaluation of Surface Water, Unocal San Luis Obispo Tank Farm, San Luis Obispo, California.), in-field measurements; England Geosystem, Inc. (2003b). Field Measurements and Observations Supplemental Evaluations of Surface Water, Unocal San Luis Obispo Tank Farm; and England Geosystem, Inc. (2003c). Transmittal of Results, Supplemental Evaluation of Surface Water, Unocal San Luis Obispo Tank Farm, San Luis Obispo, California.

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≤100 µg/L). Such a finding (i.e., that most of the low-level TPH detections are associated with polar material) is not inconsistent with the local habitat from which the various surface water samples were collected. This habitat includes shallow ephemeral ponds intimately associated with vegetation (both terrestrial and aquatic) and often impacted by cattle use. Thus one likely source of the "polar" material may be biologically derived. Another potential source may be the biological degradation of existing petroleum compounds. The process of aerobic oxidation could result in a compound being made more polar in nature. A final source could be polar compounds derived directly from the petroleum in the soils. However, given the 70+ years since the original release of the crude oil to the environment, it is likely that any water soluble compounds associated with the original source would have long since been removed.

The analysis presented in this memorandum was developed to provide information to the risk assessors regarding the nature and potential sources of the surface water extractable organic material. Specifically, the objectives of this review were to:

- Characterize extractable organic matter from the various surface water bodies in terms of the concentration of Total Petroleum Hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs), and organic aliphatic and aromatic fractions;
- Compare the TPH concentrations measured in samples before and after treatment of the extract with silica gel; and
- Use Gas Chromatography Mass Spectrometry (GCMS) data to evaluate the nature and potential sources of the detected TPH in samples with elevated TPH concentrations.

RESULTS AND DISCUSSION

GENERAL RESULTS

The data evaluated in this analysis were derived from surface water samples collected from the Site in March, 2003. The reader is directed to review England Geosystem, Inc. (2003a) for information on the study design and sampling techniques. Figure 1 provides the locations of the collected samples. Field measurements, field observations, and field photos can be found in England (2003b). The laboratory analytical data are presented in England (2003c). In brief, the study was designed to collect and analyze surface water samples from most of the existing surface water bodies at the Site. Surface water samples were collected from 10 on-site locations, with replicate samples collected from the north wetland and Reservoir 3. Based on information presented by England Geosystem, Inc. (2003b), the timing of the sampling event occurred near the end of the rainy season.

These samples were subjected to various analyses including TPH and BTEX[3], PAHs, metals, and general minerals. Additionally, information on size, depth, color clarity, water temperature, pH, specific conductivity, turbidity, salinity, total dissolved solids, and dissolved oxygen were collected in the field. For those samples where the TPH concentration was ≥1 mg/L, the solvent extract was fractionated by the Laboratory into aliphatic and aromatic organic fractions (Haddad,

[3] Benzene (B), Toluene (T), Ethylbenzene (E), and sum Xylenes (X)

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2000). The current memorandum focuses on the organic results, including TPH, BTEX, PAHs, and the aliphatic and aromatic organic fractions; subsequently the reader is referred to England Geosystem, Inc. (2003b, c) for a review of all available results.

TPH AND BTEX RESULTS

Table 1 provides the following information:

- Measured results for TPH in the C4-C10 range;
- Measured results for TPH in the C10-C40 - range prior to and following the use of silica gel;
- Measured results in terms of C10-C40 carbon distribution for aliphatic and aromatic hydrocarbon fractions; and
- Measured results for BTEX.

The finding that the surface water TPH C4-C10 results were all non-detect (d.l. <100 μg/L) is consistent with historical data and with our working hypothesis regarding the source and nature of the bulk of the hydrocarbons found in the environmental media at the Site. The BTEX data are also within historical detections. Toluene has historically been the only BTEX compound consistently detected in Site surface waters and even it has been found episodically in some of the Sites surface water. There is no obvious reason for these toluene detections. Assuming that the source is the original crude, one would expect to see xylenes as well as toluene since xylenes are likely to have a greater concentration in the original crude oil. The absence of detectable concentrations of any other BTEX compounds (d.l. <0.5 μg/L) coupled with the absence of a detectable C4-C10 TPH concentration further confuses the issue of a toluene source. One important point to note is that toluene is found in many adhesives and thus can be a common cross contaminant. The trip blank illustrates that that these detections are not related laboratory issues. Of specific interest is the fact that toluene was detected only in surface waters from three locations north of Tank Farm Rd and that the detection was replicated in a laboratory blind replicate of the North Wetland sample (compare toluene concentration in North Wetland sample [0.7 μg/L] and the replicate sample concentration [NW-1, 0.9 μg/L]).

The C10-C40 TPH results are also consistent with historical findings. Generally, the samples are mostly characterized as having low concentrations (<0.4 mg/L) of TPH with one or two samples containing TPH concentrations in the 1-2 mg/L range. TPH was detected in 8 of the 10 locations sampled at the Site. As presented in Table 1, two locations (see Figure 1; SW-1 and SW-4) had detectable TPH concentrations > 1 mg/L. Samples from the remaining 5 locations (SW-2, SW3, SW-10A, Cow Pond, and Reservoir 3) had TPH concentrations less than 0.5 mg/L (Table 1). When treated with silica gel, samples from all locations where TPH was originally detected decreased to concentrations below the 100 μg/L detection levels. The observation that the all of the non-silica gel detectable TPH is characterized as being polar in nature is also consistent with historical findings. This observation does not appear to be a function of the original non-silica gel TPH concentration.

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PAH RESULTS

PAHs were measured using the Single Ion Monitoring Mode (SIMM) Method to increase the sensitivity of the analyses. Each sample was analyzed for the 16 priority pollutant PAHs[4]. The results (Table 2) illustrate that none of the 16 PAHs were detected (d.l. <0.01 μg/L) in any of the surface water samples analyzed from the Site.

ALIPHATIC AND AROMATIC ORGANIC FRACTION RESULTS

For purposes of the Human Health Risk Assessment, determination of the aliphatic and aromatic organic fractions in the surface water samples was conducted for samples containing > 1 mg/L TPH. The sensitivity of the analytical methods used to obtain and quantify the aliphatic and aromatic organic fractions (Haddad, 2000) precluded fraction determination for samples with lower TPH concentrations. Table 1 presents the results for samples SW-4 and SW-1. These results illustrate that there were no detectable concentrations of either aliphatic or aromatic organic material in either of the samples. This finding is consistent with the fact that no detectable amount of TPH remained in the samples following silica gel removal of polar compounds.

GCMS ANALYSIS AND DISCUSSION

Based on the TPH, PAH, organic fraction results presented above, three samples were chosen for evaluation based on mass spectral analysis. This involves an analysis of the mass spectra obtained from the GCMS analysis for each sample. In practice, the GCMS data file is reviewed with the objective of using mass spectra to identify compounds in the sample. This is similar to the more familiar analysis for Tentatively Identified Compounds (TICs) sometimes requested of environmental laboratories. The major difference is that many of the compounds associated with petroleum or with natural biological processes are not identified in standard environmental mass spectral databases, thus an understanding of mass spectral analysis is necessary to deduce the chemical structure from the mass spectra.

The mass spectral analyses presented here were performed using HP Chemstation software with low resolution mass spectra. The data files used for each sample were those from the analysis for which the C10-C40 TPH concentration was derived. Given the distribution of the C10-C40 TPH concentrations as described above, this analysis has focused on the two samples with C10-C40 TPH concentrations >1 mg/L; SW-4, 1.9 mg/L and SW-1, 1.3 mg/L. Mass spectra from the next highest concentration sample, SW-2 (0.36 mg/L) were also reviewed.

For this analysis, the criterion used to verify an identification was a ≥90% match between the mass spectra for the unknown compound and the standard mass spectra for a specific compound. The standard mass spectra were derived from the National Institute of Standards and Technology (NIST) mass spectral library. The complexity of the samples confirms their derivation from natural sources and also makes exact identifications difficult. As these samples were not subjected to any specific separations chemistry and were analyzed using low resolution

[4] Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene.

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techniques, identification of specific compounds must be considered tentative. However, because compound identification requires a relatively high match criterion of ≥90% and spectral subtraction processes were not used, confidence in the identifications presented here is high.

SW-4

This sampling location is located along the southwest boundary of the Site (see Figure 1) and represents the nature of the surface water that has flowed southward across the western part of the Site to the location where it flows southwest off of the Site. Figure 2 is a photo of the sampling location.

The total ion current (TIC) for SW-4 is presented in Figure 3 and as noted on the figure, this water sample was quantified as having the highest C10-C40 TPH concentration (1.9 mg/L) of all 10 sampling locations. In addition to the C10-C40 TPH concentration, Figure 3 is annotated with the surface water temperature, pH, dissolved oxygen content, and salinity at the time of collection. Also presented in this figure are the structures of most of the major compounds identified by mass spectral analysis.

The general distribution presented in Figure 3 is of a mixture that is characterized by multiple discrete peaks with little or no unresolved complex mixture (e.g., broad hump, UCM). Mass spectral analysis has identified most of the major peaks as either alkanoic or alkenoic acids (i.e., fatty acids). The major peaks in Figure 3 have been identified as either C16 fatty acids (peaks A and B) or C18 fatty acids (peaks C and D). There is also some evidence for a C14 fatty acid. The large peak eluting just before 26 minutes (at the end of the chromatogram) has been identified as cholesterol. Comparisons of the unknown mass spectra and the standard mass spectra along with the 'degree of match' between these spectra are presented in Figures 4 through 8.

The compounds tentatively identified in this sample are all consistent with biological sources. In fact, it's interesting to speculate that the relative dominance of fatty acids may be indicative of bacterial biomass. There was no evidence for any of the polar (or more water soluble) compounds associated with direct partitioning from petroleum sources. Specifically, there was no identification of quinolines, indoles, carbazoles, etc. in this sample.

SW-1

This sampling location is located in the northeast portion of the Site, near the northwest corner of the 'racetrack' (see Figure 1). Figure 9 is a photo of the sampling location. This location is a relatively small (3 ft by 2 ft) waterbody that appears to be approximately a foot deep. The source of this water is unclear, but may be related to water pipelines in the vicinity.

The total ion current (TIC) for SW-1 is presented in Figure 10. This water sample had the second highest C10-C40 TPH concentration (1.3 mg/L) at the Site (Table 1). As with the SW-4 TIC, Figure 10 is annotated with information regarding the C10-C40 TPH concentration, surface water temperature, pH, dissolved oxygen content, and salinity at the time of collection. Unlike SW-4, this sample contained no resolvable peaks (besides those associated with the internal standards). Instead, the SW-1 TIC is characterized by a UCM that extends from approximately EC15 to >EC30. The UCM is unimodal with its maximum eluting just beyond where EC25 would elute.

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Mass spectral analysis shows that the mixture represented in the UCM is too complex to identify in terms of specific compounds. Such a finding is common with petroleum impacted soils and is related to the complexity associated with the petroleum mixture. The UCM has been reported to contain a complex mixture of non-polar branched and cyclic compounds. Thus on the face of it, the organic material obtained from SW-1 appears consistent with a petroleum-derived source. However, there are some inconsistencies worth noting.

The first and most obvious problem with identification of the UCM in SW-1 as petroleum sourced is the fact that the distribution is characterized by dissolved compounds greater than pentadecane (nC15). In fact, hydrocarbons have very limited solubility in water and this solubility decreases as a function of decreasing aromaticity and increasing molecular weight. Theoretically, the solubility of nC15 is extremely low (5.0×10^{-5} mg/L; Gustafson *et al*., 1997). While this is a theoretical value for a straight chain hydrocarbon, when coupled with the facts that (1) there were no detected PAHs in this sample (d.l. $\leq$0.00001 mg/L; Table 2) and (2) there were no aliphatic or aromatics detected in this sample (d.l. $\leq$0.100 mg/L; Table 1), the consideration that the material detected in this sample is derived from hydrocarbons seems unlikely.

The second problem is that the mass spectral analysis showed no evidence for any identifiable petroleum compounds or any of the polar compounds that might be expected to partition from petroleum into water.

Despite these concerns, a non-hydrocarbon source cannot be concluded. However, it is of interest to note that this pond has a substantial amount of subsurface aquatic flora. An additional potential source for the complex mixture represented by the UCM maybe the ubiquitous and complex geopolymers known as fulvic and humic acids. Unfortunately, further resolution of the source of this material will require additional analytical work.

SW-2

This sampling location is located at the northeast end of the North Marsh complex (see Figure 1). Figure 11 is a photo of the sampling location and shows the juxtaposition of marsh and terrestrial vegetation with the pond. Also evident are cattle tracks through the pond.

The total ion current (TIC) for SW-2 is presented in Figure 12. This water sample had the third highest C10-C40 TPH concentration (0.36 mg/L) at the Site (Table 1). As with the other TIC figures, Figure 12 is annotated with the C10-C40 TPH concentration, surface water temperature, pH, dissolved oxygen content, and salinity at the time of collection.

The TIC for this sample is characterized by both a minor, very broad UCM and resolved peaks. Mass spectral analysis did not allow unequivocal identification of all of the resolved peaks. However, enough information was present in the mass spectra to identify peaks as general types of compounds. As illustrated in Figure 12, one group of peaks eluting at about 15 minutes has spectra consistent with unsaturated alkanes. Another group has spectra consistent with unsaturated straight and branched alkanoic acids. In addition, caprolactam and some type of sterol were also identified. Caprolactam ($C_6H_{11}ON$) is a precursor to synthetic fiber production (specifically nylon 6) and is also used in brush bristles, textile stiffeners, film coatings, synthetic

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leather, plastics, plasticizers, paint vehicles, cross-linking for polyurethanes, and in the synthesis of lysine. (U.S. Department of Health and Human Services, 1993; US EPA, 1988).

As for the SW-1 sample, PAHs were not detectable in the SW-2 sample. Aliphatic and aromatic organic fractionation was not performed on this sample because the TPH concentration fell well below the 1 mg/L threshold for being able to conduct this analysis. The UCM extends over the same carbon range as was estimated for SW-1: EC15 to >EC30, with the same concerns about the potential for hydrocarbons to comprise the hump. As seen in Figure 11, this is a very heavily vegetated pond and it seems possible that geopolymers are a likely source of the UCM. In support of this potential source, pictures of vials containing the water collected at each of the stations are presented in England Geosystem, Inc. (2003b). Both the SW-1 and SW-2 samples (along with most other samples) are clear with a yellow tint. This coloration is consistent with the potential presence of fulvic and humic acids (the original term for these acids denoted as being degradation products of plants was gelbstoff or yellow stuff).

CONCLUSIONS

The results presented above show that the surface water collected from around the Site during March 2003 contained no detectable concentrations of PAHs, C4-C10 TPH, or BEX. Toluene was detected in 3 of the 10 locations and C10-C40 TPH was detected in 8 of the 10 surface water sampling locations; with two samples having C10-C40 TPH concentrations >1 mg/L and the remaining 6 locations (8 samples) have concentrations <0.4 mg/L. Following treatment of the sample with silica gel, C10-C40 TPH was not detected in any of the 10 samples. Neither aliphatic nor aromatic organic material was detectable in the two samples with TPH concentrations >1 mg/L. Due to analytical sensitivity concerns, organic fractionations were not conducted on samples with TPH concentrations <1 mg/L.

Mass spectral analyses of the three surface waters samples show that the water contains organic matter of quite different origins. The organic matter in the SW-4 sample (water with highest TPH concentration) was dominated by compounds clearly associated with biological (bacterial) processes. This sample had no UCM. The organic matter in the SW-1 sample (next highest TPH concentration) was dominated by a UCM with unimodal distribution ranging from EC15 to >EC30. The lack of any detectable PAHs or aliphatic/aromatic material suggests that the hump may not be related to petroleum. Further, the higher molecular weight material that comprises the UCM is clearly polar in nature (it was all removed by extraction onto silica gel). Potential sources of high molecular weight, complex organic matter may include compounds derived from the oxidation of original non-polar hydrocarbons and non-hydrocarbon related geopolymers identified as fulvic and humic acids. The presence of extensive terrestrial and aquatic vegetation at the SW-1 location is consistent with the possibility that degraded plant material (or gelbstoff) is present in the water at this location. Thus, while a hydrocarbon source cannot be entirely ruled out for this sample, the location and chemistry suggest that the UCM may be related to complex organic acids derived from the degradation of plants. A similar conclusion is proposed for the SW-2 sample. This location had the third highest TPH concentration of 0.36 mg/L and had a TIC characterized by both resolved peaks and a minor UCM. Again, given the lack of PAHs, the presence of biologically-related compounds (e.g., fatty acids and sterols) and the presence of extensive vegetation near the pond, it is most likely that the detectable TPH in this sample is attributable to biological products, including the fulvic and humic geopolymers. However. The

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possibility of some influence of polar material derived from hydrocarbon degradation cannot be conclusively ruled out without additional analyses.

Thus, based on the data presented above, the water samples from this site appear to have low levels of organic material (measurable as C10-C40 TPH). The lack of detectable aliphatic/aromatic material, detectable PAHs, and the removal of this organic material by silica gel coupled with the insights gained from the mass spectral analysis, the site observations, and field observations of water color and clarity suggest that the petroleum is unlikely to be a major source of the organic material found in the water from the Site. However, further analyses would be required to make conclusive determinations regarding the source of the TPH at SW1 and SW2.

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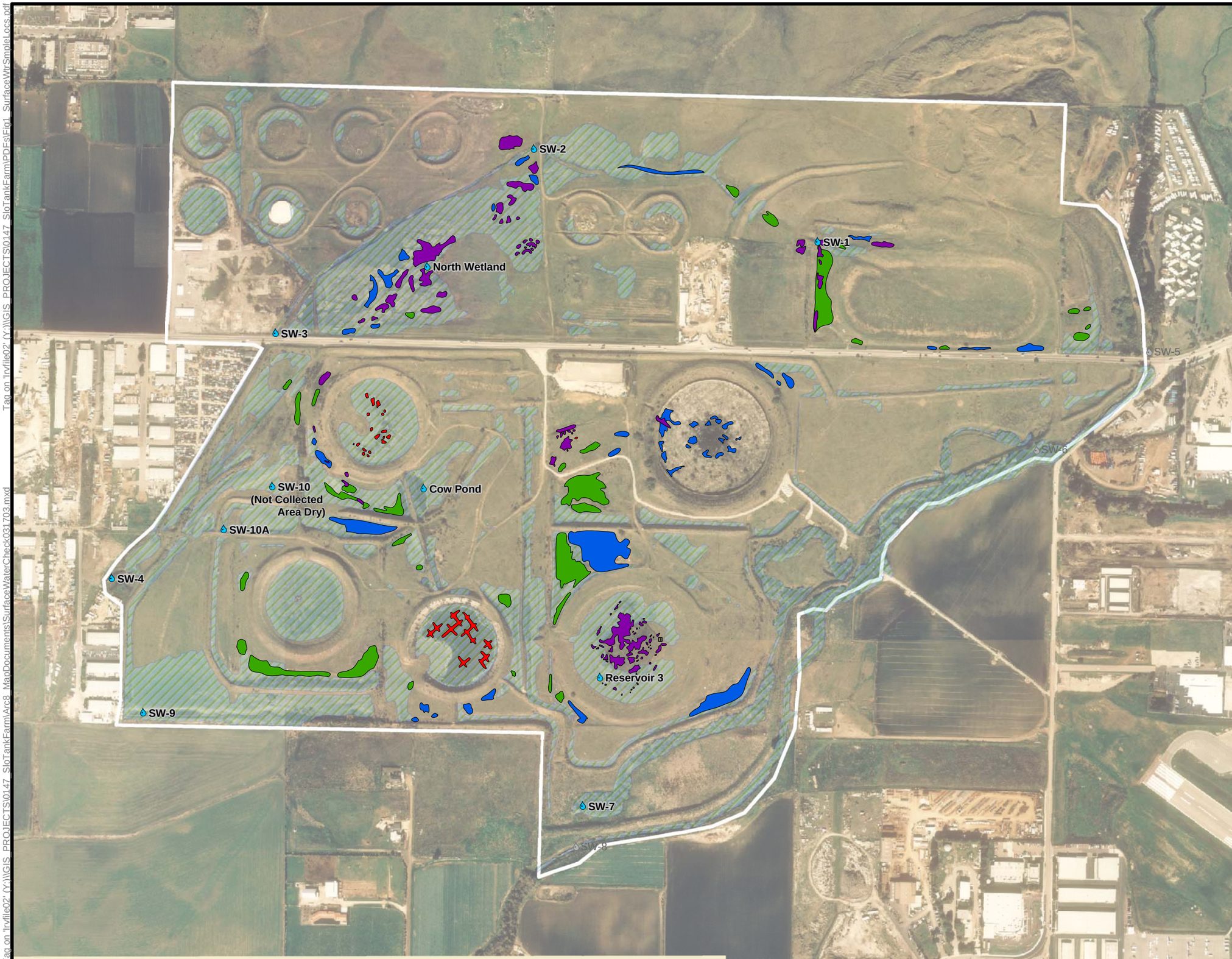

N

EXPLANATION

- SURFACE WATER SAMPLE LOCATION
- NOT INCLUDED IN STUDY

SEEPS:

- Liquid crude oil. Capable of generating 'Free' droplets of oil.
- Pliable, highly weathered crude oil. Evidence of recent plastic flow.
- Pliable, highly weathered crude oil. No evidence of recent plastic flow.
- Solid, former crude oil.
- WETLANDS

500 250 0 500
Feet

FIGURE 1

SURFACE WATER SAMPLE LOCATIONS

FORMER UNOCAL TANK FARM
SAN LUIS OBISPO, CALIFORNIA

UNOCAL CORPORATION
CENTRAL COAST GROUP
SAN LUIS OBISPO, CALIFORNIA

ENGLAND GEOSYSTEM
ENVIRONMENTAL ENGINEERING

Tag on 'Irvfile02' (Y:)\IGIS_PROJECTS\0147_SloTankFarm\Arc8_MapDocuments\SurfaceWaterCheck031703.mxd

Tag on 'Irvfile02' (Y:)\IGIS_PROJECTS\0147_SloTankFarm\PDFs\Fig1_SurfaceWtrSmpleLocs.pdf

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Figure 2. SW-4 Site Photo.

Figure 3. SW-4 Total Ion Current.

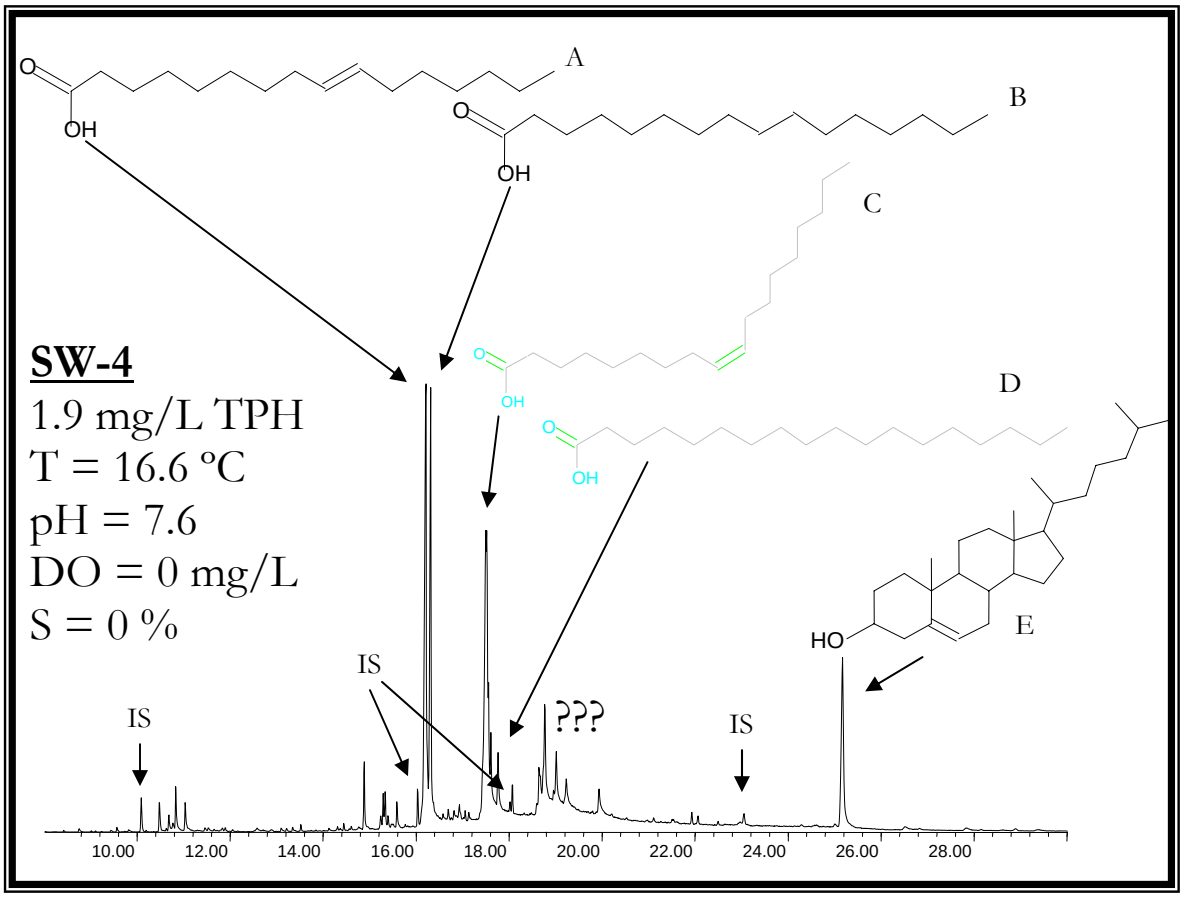

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Figure 4. Mass spectral identification for Figure 2, peak A – Hexadecenoic Acid.

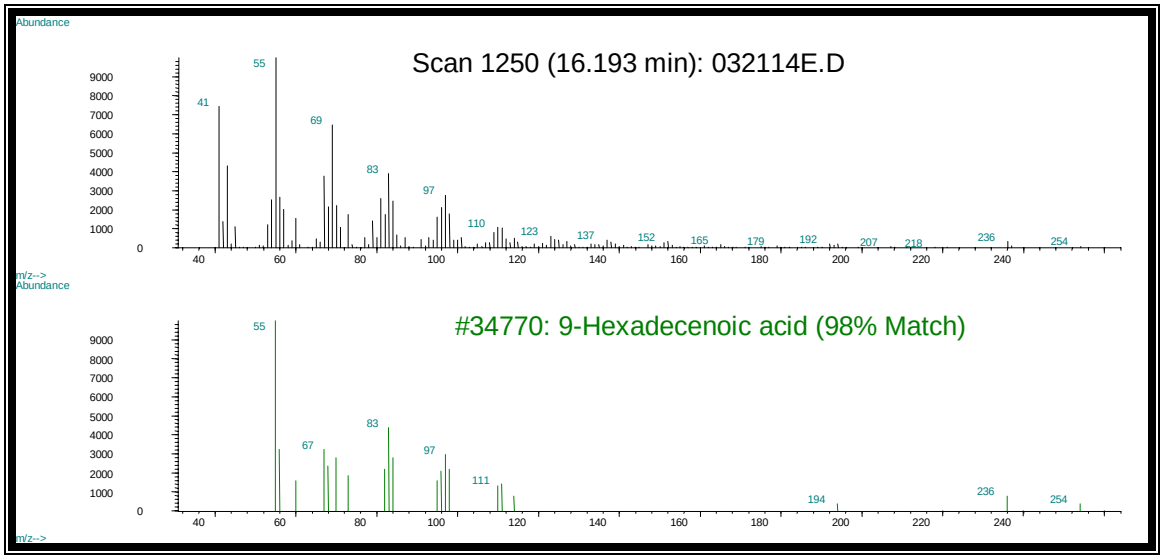

Figure 5. Mass spectral identification for Figure 2, peak B – Hexadecanoic Acid.

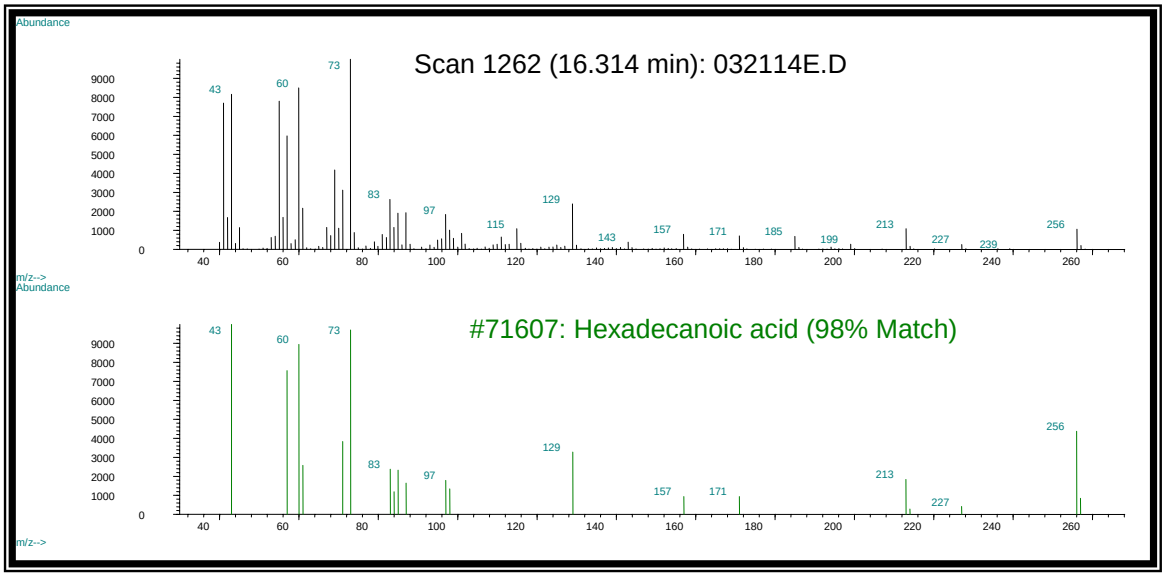

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Figure 6. Mass spectral identification for Figure 2, peak C – Oleic Acid.

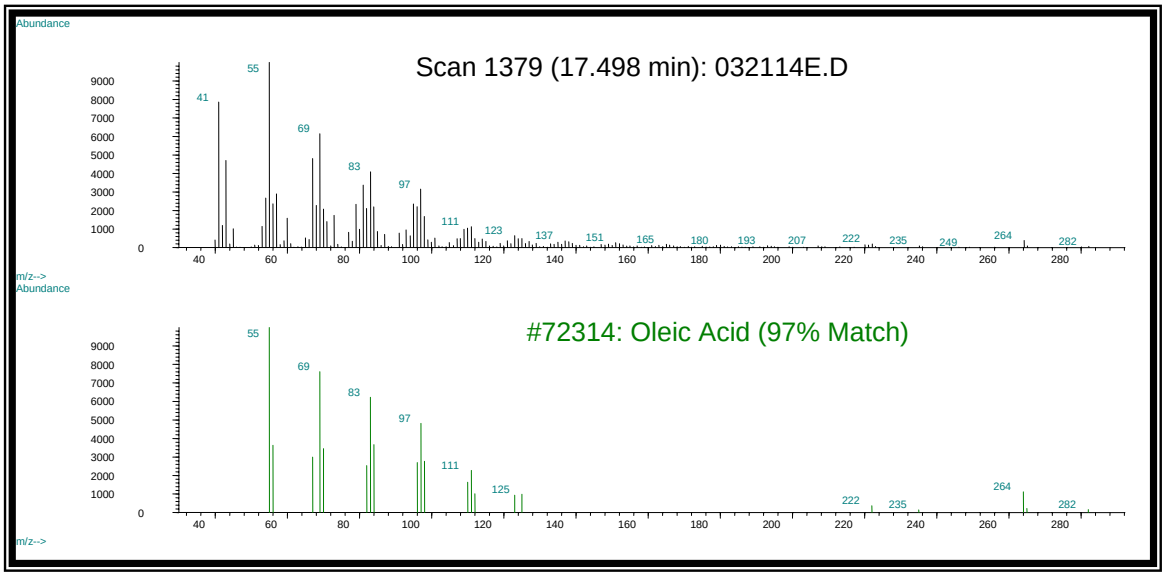

Figure 7. Mass spectral identification for Figure 2, peak D – Octadecanoic Acid.

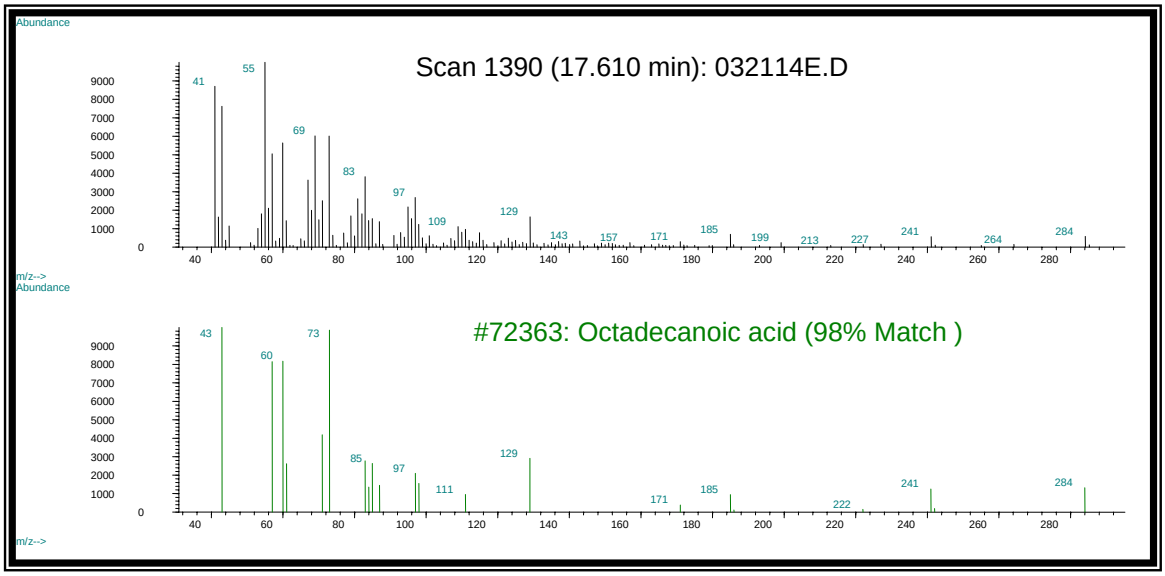

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Figure 8. Mass spectral identification for Figure 2, peak D – Cholesterol.

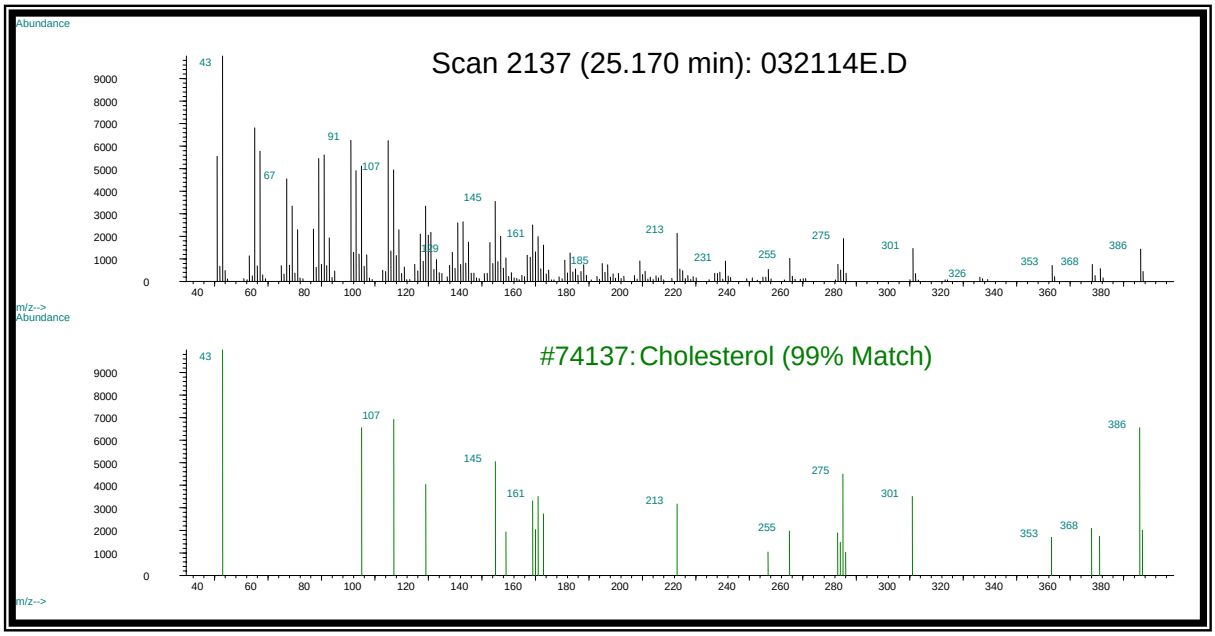

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Figure 9. SW-1 Site Photo.

Figure 10. SW-1 Total Ion Current.

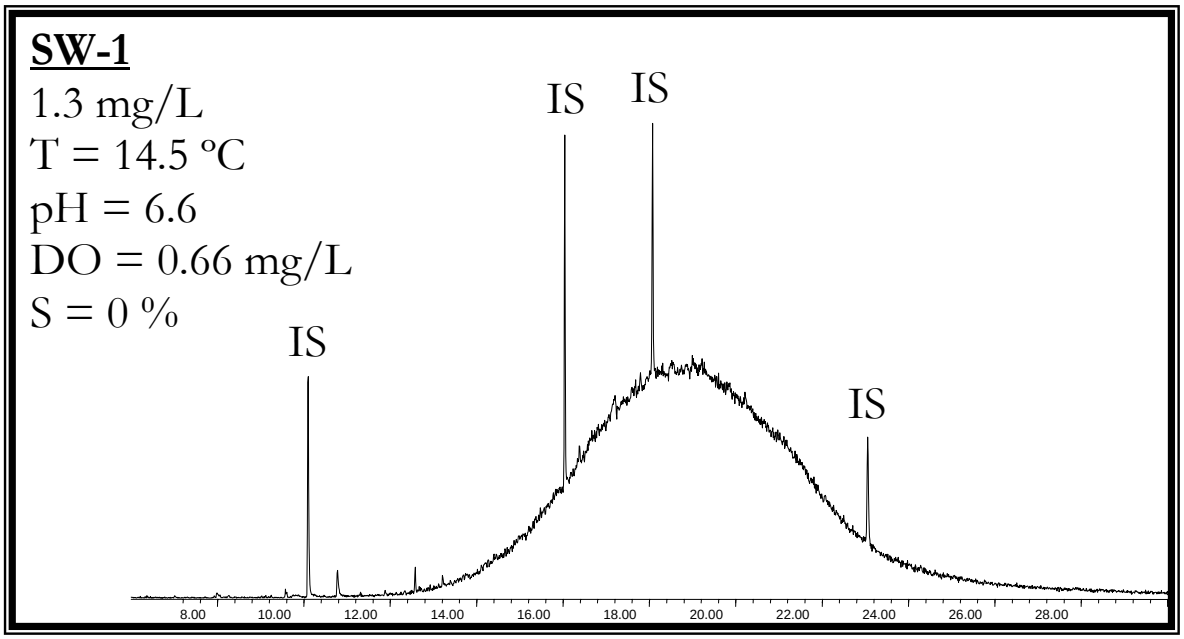

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Figure 11. SW-2 Site Photo.

Figure 12. SW-2 Total Ion Current.

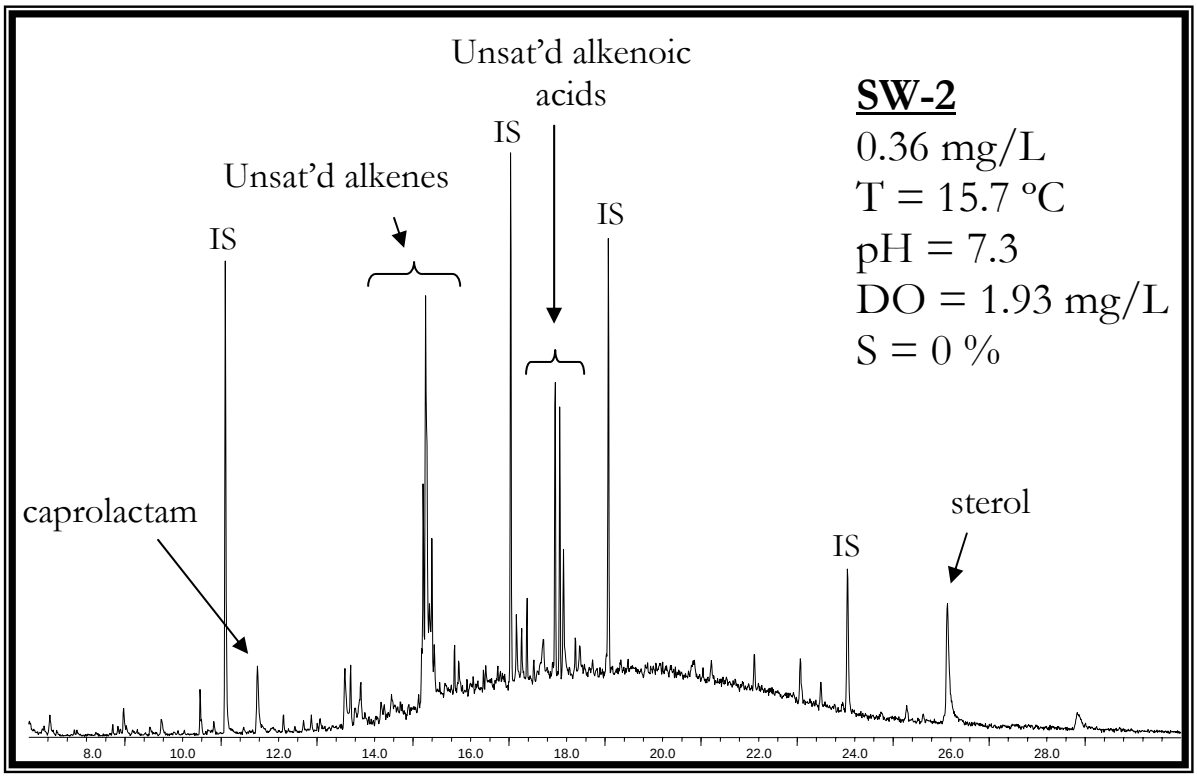

Table 1
Analytical Results TPH and BTEX
Units in ug/L

Table 1. TPH, BTEX, and Organic Fraction Results

Sample ID	TPH[2] (C_4-C_{10})	TPH[2] (C10-C_{40})	Hydrocarbon Range	TPH (C10-C_{40}) w/ Silica Gel	Aliphatic Hyrocarbons[4]					Aromatic Hyrocarbons[4]					Benzene	Toluene	Ethylbenzene	Total Xylenes
					>C_{10}-C_{40}	>C_{10}-C_{12}	>C_{12}-C_{16}	>C_{16}-C_{21}	>C_{21}-C_{40}	>C_{10}-C_{40}	>C_{10}-C_{12}	>C_{12}-C_{16}	>C_{16}-C_{21}	>C_{21}-C_{40}				
SW-1	<100	**1300**	C_{14}-C_{34}	<100[3]	<100	<10	<20	<20	<50	<100	<10	<20	<20	<50	<0.5	**1.5**	<0.5	<0.5
SW-2	<100	**360**	C_{14}-C_{34}	<100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.5	**7.1**	<0.5	<0.5
SW-3	<100	**130**	C_{16}-C_{32}	<100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.5	<0.5	<0.5	<0.5
SW-4	<100	**1900**	C_{12}-C_{32}	<100	<100	<10	<20	<20	<50	<100	<10	<20	<20	<50	<0.5	<0.5	<0.5	<0.5
SW-7	<100	<100	NA	<100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.5	<0.5	<0.5	<0.5
SW-9	<100	<100	NA	<100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.5	<0.5	<0.5	<0.5
North Wetland	<100	**250**	C_{14}-C_{32}	<100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.5	**0.7**	<0.5	<0.5
Cow Pond	<100	**240**	C_{14}-C_{32}	<100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.5	<0.5	<0.5	<0.5
Reservoir 3	<100	**250**	C_{14}-C_{32}	<100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.5	<0.5	<0.5	<0.5
NW-1[1]	<100	**220**	C_{14}-C_{32}	<100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.5	**0.9**	<0.5	<0.5
R-3[1]	<100	**210**	C_{14}-C_{32}	<100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.5	<0.5	<0.5	<0.5
Trip Blank	<100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.5	<0.5	<0.5	<0.5
SW-10A	<100	**300**	C_{14}-C_{32}	<100	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.5	<0.5	<0.5	<0.5

Notes: NA indicates Not Applicable.
NT indicates Not Tested.
(1) NW-1 is a duplicate sample from the North Wetland and R-3 is a duplicate sample from Reservoir 3.
(2) TPH C_4-C_{10} quantitated against gasoline. TPH C_8-C_{40} quantitated against crude oil.
(3) Extract treated with Silica Gel (EPA 3630) prior to analysis.
(4) Only samples containing greater than or equal to 1000 ug/L of TPH (C_8-C_{40}) were tested for TPH fractions.

Table 2
Analytical Results PNAs
Units in ug/L

Table 2. Polycyclic Aromatic Hydrocarbon Results.

Sample ID	SW-1	SW-2	SW-3	SW-4	SW-7	SW-9	North Wetland	Cow Pond	Reservoir 3	NW-1(2)	R-3(2)	SW-10A
Acenaphthene(1)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a) anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b) fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(ghi) perylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k) fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,h) anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes: Analyzed in Selected Ion Monitoring (SIM) Mode.
(1) All results are in units of μg/L.
(2) NW-1 is a duplicate sample from the North Wetland and R-3 is a duplicate sample from Reservoir 3.

Appendix F

San Luis Obispo Tank Farm Selection of Receptors of Concern Technical Memorandum

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engineers & scientists

SLO Tank Farm Selection of Receptors of Concern
Technical Memorandum

San Luis Obispo Tank Farm
San Luis Obispo County, California

This memo proposes specific receptors of concern (ROC) for the predictive Ecological Risk Assessment (pERA) for the San Luis Obispo Tank Farm (SLO Tank Farm, the site), and provides the rationale for their selection. Because it is impractical to assess the toxic effects of chemicals of potential ecological concern (COPECs) to all exposed ecological receptors, a subset of potential receptors was chosen. These "receptors of concern" represent the assessment endpoint identified during the problem formulation process, and are analogous to the "representative species" defined by DTSC (1996) as follows:

- species that represent a functional group of organisms at the site for the evaluation of assessment endpoints; and
- species that are chosen based primarily on their function in the ecosystem and secondarily on taxonomic relatedness and known or presumed similarities in physiology and life history.

Receptors of concern represent the valued receptor in the quantitative phase of the pERA. Receptors of concern were chosen for each of the assessment endpoints (AEs), and were meant to be representative of a particular ecological guild. Because they represent a larger group, ROCs were selected so that they maximize exposure, thus producing conservative estimates of risk. For those AEs that are generic in nature (e.g. plants and invertebrates), selection of representative receptors is not necessary; therefore, the focus of this memorandum is the selection of ROCs for AEs that require a specific receptor as part of the exposure modeling. This includes all AEs that focus on upper trophic-level groups.

A review of previous species lists generated for the SLO Tank Farm (Entrix, 1998; EDAW, 1999) identifies a large number of species that could potentially be present at the site during the year. In order to focus the selection of ROCs on those receptors that are commonly exposed to contaminants at the site, the pERA will focus on those species that have been observed onsite and are common visitors. Avian and mammalian species that have been observed at the SLO Tank Farm site were identified from the following three sources:

- Entrix's 1998 "Scoping Ecological Risk Assessment for Unocal Tank Farm Road Site San Luis Obispo, CA", which includes the results of field surveys characterizing habitats and identifying wildlife present at the site.
- EDAW Inc.'s 1999 " Key Biological Resources Issues and Preliminary Restoration Concepts for the Proposed Unocal Tank Farm Development and Ecological Preserve", which includes the results of vegetation mapping surveys and associated wildlife species, as well as summaries of the findings of the Entrix surveys.
- Avian species observed during Rincon Associates' black rail survey conducted in May 2003.

Tables 1 and 2 provide a summary of the species observed onsite, organized according to AE. For each AE where special-status species were actually observed or could be found onsite, both standard and special-status ROCs were selected. In general, ROCs were selected for each AE from this subset of species based on one or more of the following criteria:

- Receptor observed breeding onsite. Species breeding onsite are likely to experience greater exposure and have life history stages (young) that may be more sensitive to site-associated contaminants.
- Receptor has feeding strategy likely to maximize exposure to site-associated contaminants and has diet preferences that are representative of the guild in question.
- Receptor has a small relative body size. Smaller species have larger chemical absorbing surfaces per unit volume than larger species (Suter, 1993).
- Receptor has a small relative home range. Animals with smaller home ranges are likely to spend more time foraging on the site than animals with larger home ranges.
- Receptor-specific life history data (exposure parameters) are readily available.

The specific rationale for the selection of each proposed wetland and terrestrial ROC is described below. Tables 3 and 4 include the life history parameters that will be used to model contaminant exposures for each of the selected ROCs. Dietary composition is presented as proportions (Pveg, Pinv, and Pvert), and is used to determine exposure from each food type. All food ingestion rates (IR) are based on equations presented in Nagy (2001), and are presented on a dry weight basis. Nagy (2001) derived allometric equations estimating food uptake for 90 different taxonomic, dietary, and habitat groupings of species based on field feeding rate measurements for mammals, birds, and reptiles. Body weights (bw) selected for food chain modeling are the lower of male and females, if sexual dimorphism is evident. Exposure from incidental soil/sediment ingestion (IRs) is incorporated into the model by multiplying the percent of incidental soil/sediment ingestion and the food ingestion rate. To ensure conservativeness, initial food chain exposure estimates will be calculated assuming a site use factor (SUF) of one. Subsequent evaluations and/or discussion of uncertainty in the pERA may include wildlife exposure estimates using on site use factors based on the home ranges reported in Tables 3 and 4. Any utilization of home range information will include a discussion of uncertainties of study conditions relative to the SLO Tank Farm site. Home ranges were not immediately available for several ROCs, but will be developed later if deemed necessary.

<u>Wetland ROC Selection</u>

Herbivorous Birds: Seven herbivorous birds have been observed in wetland habitats onsite (Table 1). No special-status species were identified inhabiting or potentially inhabiting the site. Only the mallard and the red-winged black bird have been identified breeding onsite. Although it has a larger relative body size than the red-winged black bird, the mallard forages primarily in the wetland, whereas the black bird may forage in

terrestrial portion of the site as well. Given that it likely spends more time feeding in the wetland habitat, the mallard is proposed as the ROC for herbivorous birds.

Exposure parameters for the mallard are presented in Table 3. Dietary composition, body weight, and home range are from the species account in the *Wildlife Exposure Factors Handbook* (US EPA, 1993). Mallards have varied diets throughout the year (US EPA, 1993). Outside of the breeding season (when they have a higher invertebrate component to their diet), adults tend to forage mainly on plant matter. Since invertebrate-eating birds are being examined as a separate AE, the diet of non-breeding adults when they have the highest estimated vegetation ingestion (US EPA, 1993) was selected as the most appropriate dietary composition for this AE. The food ingestion rate is based on Nagy's (2001) equation for all birds, as no equation for Anseriformes is available. Body weight and home range information are also from US EPA (1993). The percent sediment ingestion is that reported for the mallard by Beyer et al. (1994). Both the percent soil ingestion and home range are the same values used by CH2M Hill (2003) for the Guadalupe Oil Field ERA (GOF ERA). The soil-to-plant and sediment-to-invertebrate bioaccumulation factors (BAFs) reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for the ROC.

Insectivorous Birds: Sixteen insectivorous birds have been observed onsite in wetland habitats (Table 1). No special-status species were identified inhabiting or potentially inhabiting the site. The following species were observed breeding onsite: American coot, killdeer, common yellowthroat, Virginia rail, marsh wren, and pied-billed grebe. Sediment-feeding birds that probe the sediments are likely to have the greatest exposure to site-related contaminants due to the relatively high incidental sediment ingestion associated with this feeding strategy. Of the 6 birds identified breeding onsite, the killdeer is expected to have the highest rate of exposure based on body size and the potential for incidental sediment ingestion based on its feeding strategy. However, limited life history information is available. Other insectivorous birds observed onsite with feeding strategies similar to the killdeer are the sandpipers. More complete life history information is available for the western sandpiper, which has a smaller body size than the killdeer. Therefore, the western sandpiper is proposed as the ROC for insectivorous birds, as it is expected to provide the most conservative estimate of exposure for this guild.

Exposure parameters for the western sandpiper are presented in Table 3. Dietary composition and body weight are from the species account in the *Birds of North America* series (Wilson, 1994). No explicit home range information is available, but will be developed later, if necessary. The food ingestion rate is based on Nagy's (2001) equation for Charadriiformes. The percent sediment ingestion is that reported for the western sandpiper by Beyer et al. (1994). The sediment-to-invertebrate BAFs reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for this ROC.

Carnivorous Birds: Eleven carnivorous birds have been identified as observed onsite (Table 1), although none have been observed breeding onsite. While the black rail was

initially identified onsite based on a call heard during the Entrix surveys, no black rails were observed onsite during the May 2003 black rail survey (Rincon Associates 2003). The only other special-status species observed onsite were the double-crested cormorant and California gull. The cormorant was not selected as a special-status ROC because the wetland habitat at the site does not have water deep enough or contains sufficient fish to provide quality foraging habitat for cormorant (they pursue fish underwater). Although the California gull has been observed in ruderal and aquatic areas of the site, it was not selected as a special-status ROC for wetland carnivorous birds because its feeding strategy indicates that it is unlikely to have significant exposure to wetland-associated contaminants (the California gull feeds primarily on garbage and carrion, supplemented by earthworms, insects and birds, not wetland associated prey). A special status insectivore is an AE being evaluated under the terrestrial scenario, which would be protective of exposure to the California gull. Therefore, no special-status ROCs were selected for this AE.

Of the remaining carnivorous wetland birds, the belted kingfisher has a relatively small body size, and exposure parameters are available. While the belted kingfisher was identified by Entrix (1997) as inhabiting both riparian and aquatic habitats, based on its feeding strategy (it requires tall perches next to water bodies) it is unlikely to forage significantly within the wetlands found onsite due to the lack of trees next to open water. They are more likely to frequent the riparian zone on the south edge of the site next to the East Fork Creek, which is not included in this pERA. Therefore, the belted kingfisher is not proposed as the ROC for carnivorous birds. Instead, the great blue heron is proposed as the ROC. While the great blue heron has a larger relative body size than other wetland carnivorous birds, it is the only other carnivorous bird that is a standard risk assessment ROC for which life history data are readily available.

Exposure parameters for the great blue heron are presented in Table 3. Fish are the preferred prey for the heron (US EPA, 1993), but are limited to a few areas at the Site. Other components of the heron's diet include amphibians, reptiles, crustaceans, insects, birds, and mammals (US EPA, 1993). The studies reported in US EPA, 1993 indicate that invertebrates make up only a small fraction of the diet. Based on the paucity of fish at the Site, amphibians are assumed to comprise 100% of the heron's diet. Body weight and home range information are from US EPA (1993). The food ingestion rate is based on Nagy's (2001) equation for carnivorous birds. No soil ingestion information for the heron, or similar feeding carnivorous species, was obtained. Because the heron does not generally probe the sediments to capture its prey, it is assumed that the percent sediment ingested by non-probing aquatic birds (e.g., ducks) is a conservative surrogate. Beyer et al. (1994) report values of <2.0 to 3.3 for these birds, and the midpoint of this range was selected for the heron. No explicit home range information was obtained, but will be determined later if necessary. Because the heron is assumed to be eating amphibians, which are exposed to wetland contaminants in a manner similar to invertebrates and because no species-specific BAFs exist, the sediment-to-invertebrate BAFs reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for this ROC.

Omnivorous Mammals: The raccoon is the only omnivorous mammal that has been identified inhabiting wetland areas on the site (Table 1), and is therefore proposed as the ROC for this guild.

Exposure parameters for the raccoon are presented in Table 3. Because this AE is meant to represent species with the most varied diet (e.g., omnivorous), the study reported in US EPA (1993) indicating the greatest variety of prey types was selected as the most appropriate dietary composition. The values from this study reported in US EPA (1993) totaled 1.007, therefore the diet was normalized to 1.0. Body weight and home range values are also from US EPA (1993). The food ingestion rate is based on Nagy's (2001) equation for omnivorous mammals. The percent sediment ingestion is that reported for the raccoon by Beyer et al. (1994). The soil-to-plant, sediment-to-invertebrate, and sediment-to-vertebrate BAFs reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for this ROC.

Terrestrial ROC Selection

Herbivorous Birds: Fourteen herbivorous bird species have been observed in terrestrial habitats onsite. The following have been identified as breeding onsite: mourning dove, house finch, lesser goldfinch, lark, house and song sparrows, and Anna's hummingbird. The song sparrow is proposed as the ROC because it is a ground feeder, has a small relative body size, and exposure parameters are readily available. The only other bird for which exposure parameters are available is the mourning dove, which is larger than the song sparrow. No special status terrestrial herbivorous birds were identified as inhabiting or potentially inhabiting the site.

Exposure parameters for the song sparrow are presented in Table 4. Dietary composition and body weight are from the species account in the *Birds of North America* series (Arcese et al., 2002). Because this AE is meant to represent avian species with an herbivorous diet, the study indicating the highest estimated vegetation ingestion was selected as the most appropriate dietary composition. The food ingestion rate is based on Nagy's (2001) equation for passerines. No soil ingestion information specific to the song sparrow is available. Because both the song sparrow and wild turkey glean food from the ground or low plants, percent soil ingestion reported for the wild turkey by Beyer et al. (1994) is used as a surrogate. No explicit home range area information was available, but will be developed later, if necessary. The soil-to-plant and soil-to-invertebrate BAFs reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for this ROC.

Herbivorous Mammals: Five herbivorous mammal species have been identified inhabiting terrestrial areas on the site, but only the California vole and Botta's pocket gopher have been observed breeding onsite (Table 2). The vole is proposed as the ROC because it has the smallest relative body size and home range. No special status terrestrial herbivorous mammals were identified inhabiting or potentially inhabiting the site.

Exposure parameters for the California vole are presented in Table 4. Dietary composition, body weight, and home range are from the species report compiled in Cal/Ecotox (2003). Studies summarized in Cal/Ecotox (2003) indicated that the vole's diet is comprised entirely of vegetation. The body weight selected is from the range reported for non-breeding females from Contra Costa, CA; the home range is also the midpoint of range reported for females in Contra Costa, CA over a two-year period. The food ingestion rate is based on Nagy's (2001) equation for Rodentia. The percent soil ingestion is that reported for the meadow vole by Beyer et al. (1994). The soil-to-plant BAFs reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for this ROC.

Insectivorous Birds: Twenty-five insectivorous bird species have been observed in terrestrial habitats onsite (Table 2). Two are special-status species: California horned lark and loggerhead shrike. Neither of these birds has been observed breeding onsite, and they have similar body sizes and feeding strategies. Because life history data are readily available for only the loggerhead shrike, it is proposed as the special-status ROC. Of the non-special status species remaining, the following were observed breeding onsite: western meadowlark, black phoebe, Brewer's blackbird, western kingbird, cliff and barn swallow, ash-throated flycatcher, and Bewick's wren. As discussed for wetland insectivorous birds, ground-feeding birds are likely to have greater exposure to site-related contaminants than birds that catch their prey in the air. Although the western meadowlark has a relatively larger body size than other insectivorous birds, it is proposed as the ROC because it forages from the ground and life history data are readily available.

Exposure parameters for the loggerhead shrike are presented in Table 4. Dietary composition and body weight are from the species account in the *Birds of North America* series (Yosef, 1996). Because this AE is meant to represent avian species with an insectivorous diet, the study indicating the highest estimated invertebrate ingestion was selected as the most appropriate dietary composition. The values reported in Yosef (1996) totaled only 0.97, therefore the remainder of the diet was allocated proportionally between invertebrates and vegetation. The body weight is the mean of two values reported (not gender specific). The food ingestion rate is based on Nagy's (2001) equation for passerines. No soil ingestion information specific to the loggerhead shrike was identified. The shrike favors large insects and is not a prober, but rather flies directly to prey on ground or in shrubs (Zeiner et al., 1990b); therefore it is assumed to have no incidental soil ingestion. No explicit home range data was available; this value will be determined later if necessary. The soil-to-invertebrate and soil-to-vertebrate BAFs reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for this ROC.

Exposure parameters for the western meadowlark are presented in Table 4. Dietary composition and body weight are from the species account in the *Birds of North America* series (Lanyon, 1994). Dietary composition is from a study of the annual diet of adult western meadowlarks in California. The body weight is the average of two means reported for females. The food ingestion rate is based on Nagy's (2001) equation for passerines. No soil ingestion information specific to the western meadowlark was

identified. Although the insectivorous American woodcock predominantly probes for prey (US EPA, 1993) while the western meadowlark gleans food from the ground and plants in addition to probing the soil (Zeiner, 1990b), the percent soil ingestion reported by Beyer et al. (1994) for the American woodcock is used as a conservative surrogate. No explicit home range data was available; this value will be determined later, if necessary. The soil-to-plant and soil-to-invertebrate BAFs reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for this ROC.

Insectivorous Mammals: The only terrestrial insectivorous mammal species actually observed onsite are bats (Table 2). However, because bats generally catch their prey on the fly, they are not likely to experience significant exposure to site related contaminants and therefore are not proposed as the ROC. Ground-feeding insectivorous mammals that are likely to inhabit the site include the ornate shrew and broad-footed mole. The ornate shrew is proposed as the ROC for terrestrial insectivorous mammals because it has a small relative body size and home range. No special-status terrestrial insectivorous mammals have been identified inhabiting or potentially inhabiting the site.

Exposure parameters for the ornate shrew are presented in Table 4. Dietary composition is from Harris (Zeiner, 1990a). The ornate shrew was also modeled as exclusively insectivorous in the GOF ERA (CH2M Hill, 2003). The body weight is the midpoint of the range reported for adult females in the Cal/Ecotox (2003) species report. The food ingestion rate is based on Nagy's (2001) equation for insectivorous mammals. No percent soil ingestion was identified for the ornate shrew, therefore the value used by US EPA (2000) to model contaminant exposure to the short-tailed shrew in the development of Eco-SSLs was used as a surrogate.[1] No home range information was identified, but will be developed later if necessary. The soil-to-invertebrate BAFs reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for this ROC.

Carnivorous birds: Twelve carnivorous bird species have been identified as observed on the site (Table 2), although none have been observed breeding onsite. Five of these birds – Cooper's hawk, sharp-shinned hawk, white-tailed hawk, golden eagle, and northern harrier – are special status species. The northern harrier is recommended as the special status terrestrial carnivorous bird ROC because it has among the smallest relative body size, and exposure parameters are available. Of the remaining carnivorous terrestrial birds, the American kestrel is proposed as the ROC because it has a relatively small body size and exposure parameters are readily available.

Exposure parameters for the northern harrier are presented in Table 4. Dietary composition, body weight, and home range are from the species account in the *Birds of North America* series (MacWhirter and Bildstein, 1996). Predominant prey types include small and medium sized mammals, birds, reptiles, amphibians, and during the breeding

[1] The Eco-SSL used unpublished data from C. Garten to estimate soil ingestion by the short-tailed shrew; based on the monte carlo simulation this resulted in an 90th percentile soil ingestion rate of 3.01%.

season, small amounts of insects (MacWhirter and Bildstein, 1996). As in the GOF ERA (CH2M Hill, 2003), this analysis assumes that the harrier feeds exclusively on vertebrate species. The body weight is the mean value reported for adult males. The home range is the median value in MacWhirter and Bildstein (1996), and was also used in the GOF ERA (CH2M Hill, 2003). The food ingestion rate is based on Nagy's (2001) equation for carnivorous birds. No soil ingestion information specific to the northern harrier was identified. However, based on its diet and feeding strategy (hunts on the wing), incidental soil ingestion is assumed to be zero. This assumption was also used in the GOF ERA (CH2M Hill, 2003). The soil-to-vertebrate BAFs reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for this ROC.

Exposure parameters for the American kestrel are presented in Table 4. Dietary composition is from the species account in US EPA (1993). Because this AE is meant to represent avian species with a carnivorous diet, the study indicating the highest estimated vertebrate ingestion was selected as the most appropriate dietary composition. The values from this study reported in US EPA (1993) totaled only 0.963, therefore the remainder of the diet was allocated proportionally. Body weight is the average for males reported in the species account in the *Birds of North America* series (Smallwood and Bird, 2002). The food ingestion rate is based on Nagy's (2001) equation for carnivorous birds. No soil ingestion information specific to the American kestrel was identified. Both US EPA (1993) and Smallwood and Bird (2002) suggest the kestrel only occasionally captures small prey from the ground with is beak. Therefore, the percent soil ingestion for the kestrel is assumed to be zero. No home range information was identified, but will be developed later if necessary. The soil-to-invertebrate and soil-to-vertebrate BAFs reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for this ROC.

Carnivorous Mammals: The only carnivorous mammal species observed on the site are the striped skunk and coyote (Table 2). Neither has been observed breeding onsite, although life history data are available for both. While the skunk has a smaller relative body size and home range, its diet is not likely to include as great a proportion of higher trophic level animals as the coyote. Because mammals whose diets are comprised of non-vertebrate organisms are already assessed as AEs, it is recommended that the species with the greatest proportion of vertebrates in its diet be selected as the ROC. Data summarized by Cal/Ecotox (2003) indicates that the majority of the coyote's diet is comprised of terrestrial vertebrates. Cal/Ecotox (2003) suggests that vertebrates and carrion comprise only approximately 29-37% of the skunk's diet. Thus the coyote is proposed as the carnivorous mammal ROC. No special-status terrestrial carnivorous mammals have been identified inhabiting or potentially inhabiting the site.

Exposure parameters for the coyote are presented in Table 4. Dietary composition, body weight, and home range values are from the species report compiled in Cal/Ecotox (2003). The dietary composition is based on a California department of Fish and Game study that reported the overall % volume of stomach contents of coyotes in the California coastal region. Ten percent of the volume is identified as miscellaneous, which in this

analysis is assumed to be invertebrate prey. The dietary composition reported in Table 4 is slightly different from that used in the GOF ERA (74% vertebrates, 24.5% vegetation, and 0.95% invertebrates; CH2M Hill, 2003), which appears to have relied on studies reporting the % occurrence of prey in scats. The study based on stomach volume as opposed to scat was selected because scat composition represents what remains following completion of the digestive process, while stomach contents may only be partially digested and should be more representative of dietary intake. The body weight is average of three means reported for California adult females. The home range is the mean values reported for adults from an Arizona study. The food ingestion rate is based on Nagy's (2001) equation for carnivorous mammals. Because no soil ingestion information specific to the coyote was identified, that reported for the red fox by Beyer et al. (1994) is used as a surrogate (this value was also used in the GOF ERA [CH2M Hill, 2003]). Soil-to-plant, soil-to-invertebrate, and soil-to-vertebrate BAFs reported in Table 5 of the Benchmarks and BAF memo (BBL, August 2003) will be used to model prey tissue concentrations for this ROC.

Summary

This memorandum proposes ROCs for selected AEs for the SLO Tank Farm sERA, and their associated life history parameters that will be used to model contaminant exposure in the pERA.

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Table 1. Wetland Receptor of Concern Selection Summary

Assessment Endpoint	Potential Surrogate Species	On Site Observed[1]	On Site Breeding	Special Status?	Exp Param Readily Avail?[2]	Feeding Requirements	Relative body size[3]	Relative Home range size[3]	Relative soil exp[3,4]	Comments
Wetland Evaluation										
Primary Consumers										
Survival, growth and reproduction of herbivorous bird populations.	Red-winged blackbird	**X**	X			predominantly plants; insects, spiders	S			breeds in wetland area, but also inhabits upland areas
	mallard	**X**	X		Hill, 2003; EPA, 1993; Cal/Ecotox	predominantly plants; insects, snails	L	M	M - 3.3%	Selected as ROC because observed breeding onsite, resides primarily in wetland and feeds almost exclusively on plants; although relatively large body size, has medium home range and exposure parameters are available.
	northern pintail	X				plants, insects, crustaceans, mollusks	L	L		
	green-winged teal	X				predominantly plants; insects, other invertebrates	M	L	S (teal <2%)	
	cinnamon teal	**X**	X			predominantly plants; mollusks, insects	M		S (teal <2%)	
	gadwall	X				predominantly plants; insects, mollusks, crustaceans	L	S		
	Sora	X	X			predominantly plants; mollusks, insects	S	S		
Secondary Consumers										
Survival, growth and reproduction of insectivorous bird species*	American coot	**X**	X			plants, insects, small fish	M		S	forages underwater
	killdeer	**X**	X		Cal/Ecotox (lim); SS Cal/Ecotox (plover)	insects, crustaceans, mollusks, plants	S		L	forages at sed surface; gleans, and probes shallowly
	common yellowthroat	**X**	X							
	greater yellowlegs	X				insects, small fish, crustaceans	S			forages in shallow water just below surface; probing uncommon
	spotted sandpiper	X			EPA, 1993	insects, small fish	VS		L	gleans and probes in mud and shallows
	western sandpiper	X			BNA, #90	insects, mollusks, crustaceans, worms	VS		VL (18%)	Although not observed breeding onsite, selected as ROC because observed onsite, has among smallest body size, and significant exposure via sediment is anticipated. Exposure parameters available.
	pectoral sandpiper	X								
	least sandpiper	X				crustaceans, worms, insects	VS		L (7.9%)	gleans and probes in mud and shallows
	common snipe	X				insects, earthworms, crustaceans, mollusks; sometimes fish and plants	S		L (7.9%)	gleans and probes in mud and shallows
	black-necked stilt	X				insects, crustaceans, mollusks, sm fish	S		L (7.9%)	gleans and probes in mud and shallows
	northern shoveler	X				phyto & zooplankton, crustaceans, insects, mollusks, plants, sm fish	M		VS	strains from water
	bufflehead	X				aquatic insects, gastropods, fish, plants	M		S	feeds underwater and from bottom
	scaup	X			EPA, 1993	mollusks, insects, crustaceans, plants	L		S	mostly gleans from bottom

Table 1. Wetland Receptor of Concern Selection Summary (continued)

Assessment Endpoint	Potential Surrogate Species	On Site: Observed[1]	On Site: Breeding	Special Status?	Exp Param Readily Avail?[2]	Feeding Requirements	Relative body size[3]	Relative Home range size[3]	Relative soil exp[3,4]	Comments
Secondary Consumers (continued)										
	Virginia rail	X	X			plants, insects, slugs, snails, crustaceans	S			
	marsh wren	X	X		EPA, 1993	insects, spiders; rarely plants	VS		S?	gleans from foliage, ground, water
	pied-billed grebe	X	X			insects, crustaceans, fish, amphibians, mollusks, plants	M		S?	feeds underwater and from bottom
Tertiary Consumers										
Survival, growth and reproduction of carnivorous bird species*	great blue heron	**X**			Hill, 2003; EPA, 1993	fish, rodents, amphibians, snakes, lizards, insects, crustaceans, sm birds	L			Although it has a relatively large body size, selected as ROC because observed onsite and exposure parameters are available.
	black-crowned night heron	X				fish, crustaceans, insects, amphibians, reptiles, sm mammals, sm birds	M			
	green heron	X								
	great egret	**X**				fish, amphibians, snakes, snails, crustaceans, insects, sm mammals	M			
	snowy egret	X				fish, crustaceans, insects, amphibians, reptiles, worms, snails, sm mammals	S			
	red-shouldered hawk	X				sm mammals, snakes, lizards, amphibians, birds, insects	M			
	American bittern	X				insects, amphibians, fish, crayfish, sm mammals, snakes, birds	M			
	belted kingfisher	X			EPA, 1993	predominantly fish; invertebrates, reptiles, amphibians	S			Not likely to feed in site wetland areas due to lack of trees on which to perch.
	double-crested cormorant	X		X	Cal/Ecotox	predominantly fish; crustaceans, amphibians	L			Not likely to feed in site wetland areas due to shallow water and paucity of fish.
	California gull	X		X		garbage, carrion, earthworms, insects, birds	M			
	Western gull	X				fish, invertebrates, sm birds, scavenger	M			
Survival, growth and reproduction of omnivorous mammal species	raccoon	X			EPA, 1993	crayfish, fish, arthropods, amphibians, sm mammal, birds & eggs, plants			M (9.4%)	Appropriate ROC because observed on-site and exposure parameters are available. No other mammalian omnivores identified onsite.

[1]Bold text indicates observed on-site during 2003 California black rail survey.
[2]SS: surrogate species.
[3]VS = Very Small; S=Small; M=Medium; L=Large; VL = Very Large
[4]Percentages from Beyer et al., 1994.

* Assessment endpoint may include protection of individual threatened, endangered or special status species as appropriate.

Table 2. Terrestrial Receptor of Concern Selection Summary

Assessment Endpoint	Potential Surrogate Species	On Site		Special Status?	Exp Param Readily Avail?[2]	Feeding Requirements	Relative body size[3]	Relative Home range size[3]	Relative soil exp[3]	Comments
		Observed[1]	Breeding							
Primary Consumers										
Survival, growth and reproduction of herbivorous bird populations.* No T&E species identified	mourning dove	**X**	X		Cal/Ecotox	predominantly plants; snails, insects	L			ground feeder
	house finch	**X**	X			predominantly plants; insects	S			gleans from plants and ground
	American goldfinch	**X**				non-breeding predominantly plants; breeding - plants, insects	S			gleans from plants and ground
	lesser goldfinch	X	X			predominantly plants; insects	S			plucks from plants, gleans from ground
	rock dove	X				plants, human scraps	VL			ground feeder
	brown-headed cowbird	X				non-breeding predominantly plants; breeding - plants, insects, spiders	M			predom ground feeder
	savannah sparrow	X				non-breeding predominantly plants; breeding - plants, insects, snails, spiders	S			gleans from ground and picks from plants
	lark sparrow	**X**	X			non-breeding predominantly plants; breeding - plants, insects	S			gleans from litter and picks from plants
	song sparrow	**X**	X		Cal/Ecotox	non-breeding predominantly plants; breeding - plants, insects, spiders	S			Selected as ROC because observed breeding onsite and has small relative body size and appropriate feeding strategy (ground feeder).
	white-crowned sparrow	X				primarily plants; breeding also insects, spiders	S			gleans from ground and low plants
	house sparrow	X	X			predominantly plants; insects, human scraps	S			gleans from ground and foliage
	California Towhee	**X**				plants, insects	M			gleans from litter and picks from plants
	spotted towhee	**X**								
	Anna's hummingbird	**X**	X			nectar, insects, spiders	VS			inapp diet - mostly nectar
Survival, growth and reproduction of herbivorous mammal populations	California vole	X	X		Cal/Ecotox	strictly herbivore	VS	S	M (vole - 2.4%)	Selected as ROC because observed breeding onsite, has smallest relative body size and home range, and exposure parameters are available.
	Botta's pocket gopher	X	X			strictly herbivore	S	S		
	black-tailed hare (jackrabbit)	X			Hill, 2003	strictly herbivore	M	M		
	Audubon's cottontail	X			Cal/Ecotox; SS EPA, 1993	strictly herbivore	L	M		
	black-tailed deer	X				strictly herbivore	VL	L	S (deer <2%)	
Secondary Consumers										
Survival, growth and reproduction of insectivorous bird species*	California horned lark	**X**		X		breeding predominantly insects, snails, spiders; nonbreeding - insects, plants	M		L	ground feeder
	western meadowlark	**X**	X		Cal/Ecotox	animal matter - 63%, plants - 37%	L		L	Although relatively large in body size, selected as ROC because observed breeding onsite, has feeding strategy (primarily from ground) likely to result in greatest exposure to site-related contaminants, and exposure parameters available.

Table 2. Terrestrial Receptor of Concern Selection Summary (continued)

Assessment Endpoint	Potential Surrogate Species	On Site Observed	On Site Breeding	Special Status?	Exp Param Readily Avail?[2]	Feeding Requirements	Relative body size[3]	Relative Home range size[3]	Relative soil exp[3]	Comments
Secondary Consumers (continued)										
Survival, growth and reproduction of insectivorous bird species*	Black pheobe	**X**	X			predominantly insects; small fish	S			
	loggerhead shrike	X		X	Cal/Ecotox	predominantly insects; sm birds, mammals, reptiles, fish, carrion	M		L	Selected as special status ROC because observed onsite, has similar body size and feeding strategy (primarily from ground) to other onsite T&E species, and exposure parameters are available.
	Brewer's blackbird	**X**	X			summer predominantly insects, spiders, crustaceans; fall/winter mostly plants	M/L		L	gleans from ground/low veg
	Bullock's oriole	X				genus - predominantly insects; fruits, nectar				
	European starling	**X**				breeding predominantly insects; nonbreeding - insects, plants	L		L	forages from ground/plucks from shrubs
	northern mockingbird	**X**				breeding predom insects, earthworms, snails; nonbreeding - includes plants	M		L	prey from ground, gleans from foliage
	western tanager	X				predominantly insects; plants	M		S	gleans from mid/upper tree canopy/hawks
	black-headed grosbeak	X				breeding predominantly insects; nonbreeding - insects, plants	M		M	gleans from foliage; ground; hawks from air
	western kingbird	X	X			predominantly insects; occasionally plants	M		S	hawks flying insects
	cliff swallow	**X**	X			predominantly insects; occasionally plants	S		S	hawks flying insects
	Barn swallow	**X**	X			predominantly insects; occasionally plants	S		S	hawks flying insects
	northern rough-winged swallow	**X**				insectivore	S		S	hawks flying insects
	tree swallow	**X**				approx 80% insects, 20% plants	S		S	hawks flying insects
	bushtit	**X**			Cal/Ecotox (lim)	mostly insects, spiders; also plants, nectar	VS		S/M	gleans mostly from trees/shrubs; sometimes ground
	Plain titmouse	X				insects, spiders, plants	S		S	gleans mostly from trees
	chestnut-backed chickadee	X				insects, spiders, some plants	S		S	gleans from trees
	downy woodpecker	X				predominantly beetles, ants, caterpillars; plants	M		S	gleans from foliage and branches in mid to upper canopy
	Nuttall's woodpecker	X				predominantly insects; plants, sap	M		S	
	ash-throated flycatcher	**X**	X		SS Cal/Ecotox	predominantly insects; occasionally plants	M		S	hawks flying insects
	ruby-crowned kinglet	X				insects, arthropods; some plants	VS		M	gleans from foliage; hawks from air
	Bewick's wren	**X**	X			insects, spiders, other sm invertebrates; rarely plants	S		M	gleans mostly within shrubs
	California scrub jay	**X**				plants, insects, other invertebrates, sm vertebrates, eggs	VL		L	gleans/picks from ground

Table 2. Terrestrial Receptor of Concern Selection Summary (continued)

Assessment Endpoint	Potential Surrogate Species	On Site: Observed[1]	On Site: Breeding	Special Status?	Exp Param Readily Avail?[2]	Feeding Requirements	Relative body size[3]	Relative Home range size[3]	Relative soil exp[3]	Comments
Secondary Consumers (continued)										
Survival, growth and reproduction of insectivorous mammal species	ornate shrew				Hill, 2003; Cal/Ecotox; SS in EPA, 1993	insects, other invertebrates	S	S		Selected as ROC. Although not observed onsite, feeds on ground rather than flying, therefore more likely exposure to site-related contamination than bat. Has smallest relative body size and home range, and exposure parameters available.
	broad-footed mole				Cal/Ecotox (lim)	earthworms, insects, spiders, centipedes, plants, sm mammals	M			
	bat	X				insectivore	M	M		
Tertiary Consumers										
Survival, growth and reproduction of carnivorous bird species*	American kestrel	**X**			EPA, 1993; Cal/Ecotox	sm mammals, birds, insects, earthworms, reptiles, amphibians	S			Selected as ROC because observed onsite, has relatively small body size and exposure parameters are available.
	red-tailed hawk	**X**			EPA, 1993	sm mammals, birds, reptiles, amphibians, carrion	L			
	Cooper's hawk	**X**		X		sm birds, mammals, reptiles, amphibians	M			
	sharp-shinned hawk	X		X		sm birds, mammals, insects, reptiles, amphibians	S			
	white-tailed kite	X		X						
	turkey vulture	**X**				primarily carrion; plants, birds & eggs, mammals	L			
	golden eagle	X		X		mostly mammals; birds, reptiles, carrion	VL			
	northern harrier	X		X	Hill, 2003	small mammals, reptiles, amphibians, birds	M			Selected as special status ROC because observed onsite, has similar body size and feeding strategy to other onsite T&E species, and exposure parameters are available.
	great-tailed grackle	X				insects, crustaceans, sm fish, sm animals, carrion, plants	S			
	common barn owl	X				primarily sm mammals; insects, crustaceans, reptiles, amphibians	M			
	screech owl	X				sm mammals, birds, reptiles, amphibians, arthropods	S			
	American crow	**X**				plants, insects, birds & eggs, carrion, sm vertebrates, garbage	M			
Survival, growth and reproduction of carnivorous mammal species	striped skunk	X			Cal/Ecotox	insects, small mammals & verts, eggs, crustaceans, plants, carrion	M	M		
	coyote	X			Hill 2003; Cal/Ecotox	mammals, carrion, insects, reptiles, plants, birds & eggs	L	L		Selected as ROC because observed onsite, large relative proportion of diet is vertebrates, and exposure parameters available.

[1]Bold text indicates observed on-site during 2003 California black rail survey.

[2]SS: surrogate species.

[3]VS = Very Small; S=Small; M=Medium; L=Large; VL = Very Large

* Assessment endpoint may include protection of individual threatened, endangered or special status species as appropriate.

Table 3.
Wetland Receptor-Specific Exposure Parameters
SLO Tank Farm, San Luis Obispo, CA

Parameter	Symbol	(units)	Mallard		Western Sandpiper		Great Blue Heron		Raccoon	
Diet										
Proportion of Diet - Invertebrates	Pinv	unitless	0.078	[a]	1	[f]	0		0.17	[k]
Proportion of Diet - Plants	Pveg	unitless	0.92	[a]	0		0		0.58	[k]
Proportion of Diet - Vertebrates	Pvert	unitless	0		0		1	[h]	0.24	[k]
Ingestion Rate of Food	IR	(kg/day DW)	0.075	[b]	0.006	[b]	0.14	[b]	0.14	[b]
Body Weight	bw	(kg)	1.04	[a]	0.024	[f]	2.2	[i]	5.4	[k]
Media Uptake										
Fraction of Soil Ingested (% diet)	sfr	%	3.3	[c]	18	[g]	2.7	[j]	9.4	[g]
Incidental Soil Ingestion Rate	IRs	(kg/day)	0.0025	[d]	0.001	[d]	0.004	[d]	0.014	[d]
Site Usage										
Home Range	hr	(ha)	468	[a]					39	[k]
Site Use Factor	SUF	(unitless)	1	[e]	1	[e]	1	[e]	1	[e]

Notes:

kg/day = kilograms per day.
Kg = kilograms.
DW = dry weight
ha = hectares.

[a] US EPA, 1993. Dietary composition from study of non-breeding adults which provides the highest estimated seasonal vegetation ingestion rate (Dillon, 1959).
"Other" category assumed to be invertebrates.
Body weight is average female body weight (less than male; from Nelson & Martin, 1953). Home range is for non-egg laying female (from Dwyer et al., 1979); also used in CH2M Hill 2003.

[b] Nagy, 2001.

[c] Beyer et. al., 1994; also used in CH2M Hill 2003.

[d] Calculated by multiplying the fraction of sediment ingested by the ingestion rate of food.

[e] Conservatively assumed to equal 1.

[f] Wilson, W.H., 1994. Dietary composition identified as invertebrates in all studies reported.
Body weight is average of California birds from March to mid-April.

[g] Beyer et. al., 1994.

[h] Dietary composition is assumed to be amphibians, given the paucity of fish at the Site.

[i] US EPA, 1993. Body weight is average female body weight (less than male; from Hartman, 1961).

[j] Beyer, et al., 1994. No heron sediment ingestion information available. Used mid-point of range (<2.0 to 3.3) of other non-probing aquatic birds (ducks).

[k] US EPA, 1993. Dietary composition is summer diet from New York study (Hamilton, 1951). Total of 1.007 normalized to 1.0.
Body weight is mean of adult female body weights (less than male).
Mean home range of adult female (smaller than male) in Georgia coastal study from US EPA, 1993.

Table 4.
Receptor-Specific Exposure Parameters
SLO Tank Farm, San Luis Obispo, CA

Parameter	Symbol	(units)	Song Sparrow	California Vole	Western Meadowlark	Loggerhead Shrike	Ornate Shrew	American Kestrel	Northern Harrier	Coyote
Diet										
Proportion of Diet - Invertebrates	Pinv	unitless	0.11 [a]	0	0.63 [h]	0.88 [j]	1 [l]	0.26 [o]	0	0.1 [t]
Proportion of Diet - Plants	Pveg	unitless	0.89 [a]	1 [f]	0.37 [h]		0		0	0.034 [t]
Proportion of Diet - Vertebrates	Pvert	unitless	0	0		0.12 [j]	0	0.74 [o]	1 [r]	0.87 [t]
Ingestion Rate of Food	IR	(kg/day DW)	0.0054 [b]	0.0053 [b]	0.014 [b]	0.0088 [b]	0.0010 [b]	0.019 [b]	0.043 [b]	0.33 [b]
Body Weight	bw	(kg)	0.023 [a]	0.036 [f]	0.091 [h]	0.048 [j]	0.0048 [m]	0.11 [p]	0.37 [r]	10 [t]
Media Uptake										
Fraction of Soil Ingested (% diet)	sfr	%	9.3 [c]	2.4 [g]	10 [i]	0 [k]	3.0 [n]	0 [q]	0 [s]	2.8 [u]
Incidental Soil Ingestion Rate	IRs	(kg/day)	0.00050 [d]	0.00013 [d]	0.0014 [d]	0 [d]	0.00003 [d]	0 [d]	0 [d]	0.0093 [d]
Site Usage										
Home Range	hr	(ha)		0.01 [f]					260 [r]	1570 [t]
Site Use Factor	SUF	(unitless)	1 [e]	1 [e]	1 [e]	1 [e]	1 [e]	1 [e]	1 [e]	1 [e]

Notes: kg/day = kilograms per day. kg = kilograms. ha = hectares.

[a] Arcese et al., 2002. Highest estimated seasonal vegetation ingestion rate based on intake in non-breeding season (average of Fall and Winter) from study by Martin et al., 1951.
Body weight is for female control group (less than males) in Mandarte Island study (Arcese, 1989).
[b] Nagy, 2001.
[c] Beyer et. al., 1994. Wild turkey percentage soil in diet used as a surrogate.
[d] Calculated by multiplying the fraction of soil ingested by the ingestion rate of food.
[e] Conservatively assumed to equal 1.
[f] Cal Ecotox (2003). Dietary composition entirely plants in both studies listed. Body weight is mid-point of range for non-breeding females in Contra Costa, CA.
Home range is midpoint of range for adult female (smaller than male).
[g] Beyer et. al., 1994.
[h] Lanyon, W.E., 1994. Dietary composition is annual diet of adults (Bryant, 1914 as cited in Lanyon, 1994). Body weight is average of female means (less than male).
[i] Beyer et. al., 1994. American woodcock percentage soil in diet used as a surrogate.
[j] Yosef, 1996. Dietary composition from study of western US birds (Beal & McAtee, 1912 in Yosef, 1996), with highest estimated insect uptake (total 97%; allocated 3% proportionally).
Body weight is mean of 2 studies reported.
[k] No soil ingestion rate available. Assumed to be zero based on prey type and feeding strategy.
[l] Zeiner et al., 1990a.
[m] Cal Ecotox, 2003. Body weight is mid-point of range reported for adult females in CA study.
[n] US EPA, 2002. 90th percentile value for short-tailed shrew used as a surrogate.
[o] US EPA, 1993. Dietary composition from study of California pasture area (Callopy & Koplin, 1983), with highest estimated vertebrate ingestion (total 96.3%; allocated 3% proportionally).
[p] Smallwood and Bird, 2002. Body weight is average of males (less than female).
[q] No soil ingestion information found. Assumed to be zero based on feeding strategy.
[r] MacWhitter and Bildstein, 1996. Diet comprised of mammals, birds, reptiles and frogs; same proportion used by CH2M Hill, 2003. Body weight is avg male (less than female) reported from Bildstein, 1988.
Home range is median of 8 studies, also used by CH2M Hill, 2003.
[s] No soil ingestion information found. Assumed to be zero based on feeding strategy. Used in CH2M Hill, 2003.
[t] Cal Ecotox. Dietary composition from Coastal CA study - based on % volume of stomach contents (Ferrel et al., 1953). Miscellaneous category assumed to be invertebrates.
Body weight is average of three mean values reported for California adult females.
Home range is average overall annual home range for adults from an AZ study (converted from 15.7 km^2 to ha).
[u] Beyer et. al., 1994. Red fox percentage soil in diet used as a surrogate. Used byCH2M Hill, 2003.

Appendix G
Screening Benchmark and Bioaccumulation Factor Technical Memorandum

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Screening Benchmark and Bioaccumulation Factor Technical Memorandum

San Luis Obispo Tank Farm
San Luis Obispo County, California

This memo provides the underlying rationale for proposed screening benchmarks for the constituents of potential ecological concern (COPECs) identified for the predictive Ecological Risk Assessment (pERA) for the San Luis Obispo Tank Farm (SLO TF). These include arsenic (As), lead (Pb), the 17 individual priority pollutant polynuclear aromatic hydrocarbons (PAHs), sum PAH and total petroleum hydrocarbons (TPH). Both direct and food chain exposures were considered. Direct or contact toxicity benchmarks are presented in Tables 1 and 2 and food chain toxicity reference values (TRVs) for avian and mammalian receptors are presented in Table 3. To model food chain exposures, receptor-specific exposure parameters and media-specific bioaccumulation factors (BAFs) are necessary. This memo will also include proposed BAFs for the food chain models (Table 5) and exposure parameters for selected receptors of concern will be addressed in a separate memo.

In general, benchmarks were selected to be conservative estimators of potential toxic effects. In other words, benchmarks were selected to minimize the possibility of reaching a finding of no risk when risk actually exists. The low benchmarks represent a level below which there is high confidence of no risk. Concentrations that fall between the low and high benchmarks represent a level above which there is a possibility of some level of risk. Concentrations that exceed the high benchmark indicate that risk is more probable and further evaluation is needed.

When applicable, benchmarks from the Guadalupe Oil Field (GOF) Ecological Risk Assessment (ERA) (CH2MHill, 2003) were utilized. The GOF site is located on the central coast of California and is a petroleum contaminated site like the SLO Tank Farm; however, the TPH source material and the residual TPH composition are different at the GOF. GOF ERA benchmarks that were selected for use at SLO Tank Farm were developed as a part of a cooperative effort with the regulators and are generally thought to be appropriately conservative for use at SLO Tank Farm. GOF benchmarks that were not considered applicable to SLO Tank Farm included TPH benchmarks based on diesel or jet fuel, or GOF-specific, bioassay-based benchmarks. When GOF benchmarks were not available, or were not applicable, other benchmarks were developed from the available literature.

Sections 1 and 2 of this memo summarize the proposed benchmarks and Section 3 summarizes the bioaccumulation factors (i.e., available literature based values and associated references). Section 4, provides the rationale for the development of TPH contact toxicity benchmarks for soil invertebrates and plants. Section 5 provides an uncertainty analysis and Section 6 provides conclusions for the benchmarks and BAFs that will be used in the pERA.

1.0 Contact Toxicity

Contact toxicity benchmarks for soil invertebrates, terrestrial plants, aquatic life, and sediment invertebrates are presented in this section. As discussed previously, the benchmarks used for the GOF ERA were selected when available. When these values were not available or were not applicable, other benchmarks were developed as described below.

1.1 Terrestrial Invertebrates and Plants

This section provides the rationale for selection of direct toxicity benchmarks for soil invertebrates and plants for metals and PAHs. The derivation of benchmarks for TPH will be presented separately in Section 4. When GOF ERA benchmarks were not available or applicable, values recommended by the Oakridge National Laboratory (ORNL) in the documents entitled *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision* (Efroymson et al, 1997a) and *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision* (Efroymson et al, 1997b) were utilized for invertebrates and plants respectively. Benchmarks recommended by ORNL were developed by rank-ordering lowest observed effect concentration (LOEC) values and choosing a number that approximated the 10th percentile. These recommended values were utilized as the "low" benchmarks. "High" benchmarks were developed for the SLO Tank Farm, using the ORNL data set, and choosing a number that approximated the 50th percentile, as the data allowed. This approach is consistent with the approach used by Long and Morgan (1990) to develop the sediment benchmarks used by NOAA.[1] Table 1 summarizes the benchmarks selected and their respective sources.

1.1.1 Metals

The soil invertebrate and plant benchmarks selected for the two inorganic COPECs (As and Pb) are based the ORNL documents described above (Efroymson et al, 1997 a and b). In these documents, soil benchmarks are based on data provided by toxicity studies in the field or, more commonly, in laboratory settings. Many of these soil toxicity tests are conducted with soluble metal salts which are likely to be more bioavailable than mixtures of forms found in the field at contaminated sites such as SLO Tank Farm. Thus, these benchmarks would likely over rather than under estimate potential toxicity.

1.1.2 PAHs

For most individual PAHs, the low and high benchmarks used in the GOF ERA were used. For terrestrial invertebrates, these values are based on studies conducted by Sverdrup et al (2001 and 2002). For plants, two individual PAH benchmarks from the GOF ERA were applicable (benzo(a)pyrene and naphthalene) and these were based on the Canadian Council Ministries of the Environment (CCME) soil screening documents (CCME 1999 a and b). A third PAH plant benchmark, for acenaphthene, was found in Efroymson et al, 1997a. While the GOF ERA provides a value for acenaphthene that is derived from Efroymson et al, 1997, this value was not used. To be consistent with the approach recommended by the authors and used to develop other benchmarks as discussed above, the benchmark was taken from the original source using the 10th percentile value. The ORNL data set (Efroymson et al, 1997a) was not adequate to develop a high benchmark for acenaphthene using the 50th percentile approach.

[1] The approach used herein is more conservative than the Long and Morgan approach because only low effects data were considered in the dataset whereas, Long and Morgan included all effects data including LC data.

Because phytotoxicity benchmarks were available for only three of the individual PAHs, it was necessary to assign surrogate screening criteria to other detected PAHs. Surrogate benchmarks for specific PAHs were identified by dividing the PAHs into low and high molecular weight compounds. The low and high phytotoxicity screening values for naphthalene are used as a surrogate for all low molecular weight compounds (shown in italics in Table 1) because values for naphthalene were the more conservative of the available values. The low and high values for benzo(a)pyrene are used as surrogate values for high molecular weight compounds because this is the only high molecular weight compound for which screening values were available. It was not necessary to assign surrogate invertebrate benchmarks because screening criteria were available for most PAHs.

1.2 Sediment Invertebrates

This section provides the rationale for selection of direct toxicity benchmarks for sediment invertebrates for metals, PAHs and TPH.

1.2.1 Metals and PAHs

For sediment invertebrates, benchmarks for all COPECs except lead and TPH (i.e., arsenic and PAHs) were available from the GOF ERA. The Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) from MacDonald et al (2000) were used for the low and high lead values, and were also the primary source for the majority of the benchmarks used in the GOF ERA. These values are based on a large data set, are widely used as preliminary screening values in freshwater sediments and are generally thought to provide an appropriately conservative screen. Other sources of the low and high benchmarks used in the GOF ERA and in this assessment include values developed by ORNL for screening potential contaminants of concern for effects on sediment-associated biota (Jones et al, 1997) and Upper Effect Threshold (UET) values provided in the NOAA screening quick reference tables (Buchman, 1999). Table 1 summarizes the benchmarks selected and their respective sources.

1.2.2 TPH

A sediment benchmark for TPH is not currently available. A search was conducted of scientific literature databases such as Toxline and Medline. In addition, a bibliography of petroleum-related literature citations from the U.S. Geological Service (USGS) was reviewed. Adequate data were not available to develop a TPH sediment benchmark for the site. The petroleum constituents at the site will be addressed using the soil invertebrate screening values and by evaluating individual and total PAHs in sediment.

1.3 Aquatic Life

As with the plants and invertebrates, benchmarks used in the GOF ERA were used when available for surface water screening. Low benchmarks are chronic freshwater federal Ambient Water Quality Criteria (AWQC) when available. Secondary chronic values (SCVs) developed by Suter and Tsao (1996) were used as the low benchmark when AWQC were not available. Based on recent surface water sampling data, only barium exceeded the low benchmark, and required the development of a high benchmark. Consistent with the GOF ERA, the Suter and

Tsao (1996) secondary acute value (SAV) was used as the high benchmark. Table 2 summarizes the water screening criteria[2].

2.0 Food Chain Benchmarks

Proposed toxicity reference values (TRVs) for avian and mammalian receptors are presented in Table 3 and discussed in the following sections.

2.1 Avian and Mammalian Food Chain Benchmarks

2.1.1 Metals

Because of concerns regarding the protectiveness of the arsenic and lead TRVs used in the GOF ERA, the TRVs used in that assessment were not selected for use at SLO Tank Farm. Instead, low TRVs (i.e., based on no observed adverse effect levels) and high TRVs (i.e., based on lowest observed effect levels) for both avian and mammalian receptors developed by the US EPA's Region 9 Biological Technical Assistance Group (BTAG) were used. The BTAG values were developed by considering the available literature and selecting a value that is likely to be protective of a variety of avian and mammalian species.

2.1.2 PAHs

An avian TRV for naphthalene was the only compound-specific avian TRV for individual PAHs used in the GOF ERA. This value will be used in the pERA. The avian TRV identified for the majority of the other individual PAHs in the GOF ERA was based on a study conducted with hydrocarbon mixtures and mallard ducks (Patton and Dieter 1980). As in the GOF ERA, this benchmark will be applied to all individual PAHs in the pERA. An uncertainty factor of 10 will be applied to this value for screening threatened or endangered birds if they are identified at the Site.

Mammalian TRVs were identified in the GOF ERA for several of the individual PAHs and will also be used in the pERA. TRVs were not available for the majority of the high molecular weight PAHs. The TRV for benzo(a)pyrene is used as a surrogate for these compounds as shown in Table 3. Consistent with the GOF ERA, the TRV identified for fluorene is used as a surrogate for phenanthrene.

2.1.3 TPH

Because of the variable composition of TPH, it is not possible to track this compound through the food chain. However, it is possible to evaluate the potential risk from incidental ingestion of TPH adhered to soil to the identified receptors.

The avian TPH TRVs used in the GOF ERA were based No.2 fuel oil toxicity to mallards. Because No. 2 fuel oil may not be representative of the weathered crude oil found at the Site, this study was not used as the basis for the avian TPH TRV for the pERA. The most appropriate study identified from the available literature for deriving an avian TPH TRV evaluated the

[2] None of the detected metals are hardness dependent, so benchmarks did not require adjustment.

effects of weathered EXXON Valdez crude oil on mallards (Stubblefield et al, 1995). A value of 218 mg/kg/day (2000 mg/kg in diet) was selected as the low avian TRV. This value is based on the no observed adverse effect level (NOAEL) for endpoints including body weight, food consumption, egg production, eggs set, number of fertile eggs, number of viable eggs, hatch success, chick survival, egg shell thickness, organ weights, and blood chemistry. The no effect dietary concentration of 2000 mg/kg diet was converted to a daily dose by dividing the average daily ingestion rate (0.136 kg/day) by the average body weight (1.25 kg) and multiplying by the dietary concentration of 2000 mg/kg diet. The high avian TRV was selected based on the high dose from this study of 20,000 mg/kg in diet. At this dose, there were no effects on any of the reproductive parameters measured, however, shell thickness was slightly reduced making this a lowest observed adverse effect level (LOAEL). Converted to a body weight normalized dose, the TRV is 2180 mg/kg/day.

The mammalian TRVs used for the GOF ERA were based on toxicity to rats dosed with JP-8. Because JP-8 may not be representative of the weathered crude found at SLO Tank Farm, this study was not used as the basis for the mammalian TRV for the pERA. Instead a value of 197 mg/kg/day was selected as the low mammalian TPH TRV. This value is based on a study conducted by administering a dietary dose of weathered Prudhoe Bay crude oil to farm raised mink over a period of 4 months (Beckett et al, 2002). The selected value is the NOAEL for body weight, organ weight and histopathology. Because this is not a reproductive study, which is typically preferred in TRV development, other studies conducted with mammalian species and crude oils were reviewed to evaluate potential reproductive effects. Table 4 summarizes the studies reviewed and the endpoints measured. As is shown in Table 4, the selected NOAEL is one of the most conservative values and represents a biological effect in a sensitive species (i.e., mink). The only lower value found was for hematological endpoints which the authors point out were only slightly different from reference values. Thus, the hematological endpoint was not deemed appropriate for TRV development.

The high mammalian TPH TRV of 890 mg/kg/day was selected from a reproductive study conducted by Kahn et al (1987) with rats and fresh Prudhoe Bay crude oil. In this study pregnant rats were fed liquid oil by gavage on days 6 – 17 of gestation. Effects were observed on number of resorptions, live fetuses, fetal weight and fetal crown-rump length in the lowest dose tested (1 ml/kg body weight). Although this value represents an unbounded LOAEL, when considered in the context of the other LOAEL and NOAEL values presented in Table 4, represents a reasonable estimate of a low effect level. This dose was converted to a daily dose using the specific gravity of Prudhoe Bay crude of 0.89 and converting milliliters to grams (1 ml = 890 g).

Table 3 summarizes the TRVs selected for avian and mammalian receptors.

3.0 Bioaccumulation Factors

In a forward risk assessment, the dose is modeled and compared to a TRV for the specific receptor and a hazard quotient (HQ) is calculated. To model the dose it is necessary to calculate the contaminant concentration in prey using specific biota-soil or biota-sediment accumulation factors (BAFs) for the food items of the receptor (i.e., invertebrates and/or plants). BAF selection for the food chain assessment is discussed in the following sections.

3.1 Plant and Soil Invertebrate BAFs

For the purposes of this memo, the most appropriate and conservative BAFs found in the available literature were selected for each prey item and are presented in Table 5. BAFs developed by ORNL (based on the 90th percentile of a large data set) for both plants and soil invertebrates were used preferentially over values from individual studies. Because BAFs can be highly variable, using a larger data set to more comprehensively capture this variability is appropriate for a screening level assessment. ORNL BAFs were available for both plants and soil invertebrates for arsenic and lead but were not available for PAHs. At the recommendation of Regina Donohoe of California Department of Fish and Game (CDFG), the USEPA's Kow-based model (USEPA 2000) was reviewed for its potential use for deriving BAFs for specific PAHs. The model takes the form:

<u>Invertebrates (earthworms)</u>: $BAF = 10^{(\log Kow - 0.6)} / foc \times 10^{(0.983 \log Kow + .00028)}$

<u>Plants</u>: $BAF = 10^{(1.31 - 0.385 \times \log Kow)}$

Where: K_{ow} = compound-specific octonol-water partitioning coefficient;
F_{oc} = fraction organic carbon (assumed to be 1%)

This model is proposed in the draft EPA Ecological Soil Screening Level Guidance document (USEPA, 2000a). The model for plants was found to be consistent with the general ranges of observed plant PAH uptake in the available literature (Kipopoulou et al 1999, Wild et al 1992 as cited in CH2MHill 2001) and will be used in the pERA. The primary source of the Kow values was the Agency for Toxic Substances and Disease Registry (ASTDR) toxicological profile for polycyclic aromatic hydrocarbons (1995) (http://www.atsdr.cdc.gov/toxprofiles/tp69-c3.pdf). The Kow values selected for each PAH are shown along with the modeled BAFs in Table 5.

Unlike the plant uptake model, the soil invertebrate model from the EPA's Eco SSL document, predicts uptake values that are orders of magnitude greater than empirical observations found in the literature (Van Brummelen et al, 1996; Ma et al, 1994; 1997; Beyer and Stafford, 1993). BBL evaluated other studies containing empirical data and found that one study conducted by Van Brummelen et al (1996) was specifically designed to evaluate the uptake of PAHs in soil invertebrates. This study was conducted using field soils with 4 different invertebrate species and measured 8 different PAHs and sum PAH. The data for all PAHs and all species in humus were converted to dry weight (values presented in study are based on wet weight tissue concentrations). The variability among the 8 PAHs and sum PAH was small (90th percentiles for BAFs ranged from 0.06 to 0.18). Thus, to be conservative and to address all 17 of the PAHs being evaluated in the pERA, all BAFs from the study were rank ordered and the overall 90th percentile value of 0.16 was selected as the BAF for all PAHs for terrestrial invertebrates in the pERA. The underlying data from the Van Brummelen (1996) study are presented in Table 6.

3.2 Sediment Invertebrate BAFs

BAFs for sediment invertebrates were derived by reviewing studies presenting potentially relevant data for sediment PAH BAFs, primarily found on the USEPA's website for bioaccumulation testing and interpretation (http://www.epa.gov/waterscience/cs/biotesting). Upon review, two of the papers (Ingersoll et al., 2003 and Schuler et al., 2003) were selected to

support the development of a PAH BAF estimates. These papers were selected because they are current, they both specifically address PAH uptake and present bioaccumulation factors (BAFs) or BSAFs (i.e., organic carbon and lipid normalized BAFs), and they address species that are relevant for the San Luis Obispo Tank Farm (i.e., *Lumbriculus variegatus*, *Hyallela azteca*, and *Chironomus tentans*). Ingersoll et al. (2003) evaluated individual PAHs and total PAH, and observed that different patterns of accumulation occur for PAHs with higher and lower Kow values, and reported BSAF values for both groups of compounds. Figure 1 presents the minimum (MIN), steady state (SS), and maximum (MAX) BSAFs for the two Kow-based PAH categories (H-Kow and L-Kow). Conversions were conducted to translate the reported lipid and TOC normalized BSAF values to unitless dry weight BAFs that can be used in the food chain models. An assumption of 1% organic carbon for the Site sediments and 2.3 % lipid content of *Lumbriculous* (mean of study organisms) was used to conduct this conversion.

Converted unitless BAFs for individual PAH compounds range from 0.9 to 4.6 for high-Kow PAHs, and from 1.6 to 6.9 for low-Kow PAHs. The organic carbon adjusted BAFs for steady state for both low and high Kow PAHs is 2.3. This value (2.3) is considered to be conservative as Ingersoll et al (2003) provides a comparison of BSAF values presented in his study to other values developed by Van Hoof et al. (2002) for the same species and the same river system, and observes that the vales presented in Van Hoof et al (2002) are 9% to 40% lower. Ingersoll et al (2003) explains the differences as likely being a result of more accurate lipid measures obtained in the Van Hoof et al (2002) study. In addition, Ingersoll notes that Brunson et al (1998) reported comparable BSAFs for the same species in sediments containing much lower concentrations of PAHs, corroborating that the observed BSAFs are likely representative of a range of contaminant concentrations.

The appropriateness of the 2.3 value is also supported by data reported in Schuler et al. (2003). Schuler et al (2003) presents BAFs for *Lumbriculus variegates*, and additionally presents BAFs for *Hyallela azteca*, and *Chironomus tentans* for PAHs (i.e., benzo(a)pyrene). The BAFs presented by Schuler are presented on a dry sediment/ wet tissue basis. In order to evaluate the consistency of these values with the proposed value of 2.3, it was necessary to convert the dry weight/wet weight BAFs to dry weight/dry weight values. To convert these values, a percent-moisture content of 75% was used for all three aquatic species. This is an estimated value based on percent moisture data presented in *Estimating Exposure of Terrestrial Wildlife to Contaminants* (ORNL, 1994) for crabs (74% moisture), shrimp (78% moisture) and amphipods (71% to 80% moisture). As displayed on Figure 1, converted BAFs ranged from 0.65 for *Hyallela azteca*, to 4.29 for *Lumbriculus variegates*, with a middle value of 1.91 for *Chironomus tentans*. The average of these values (to represent a mixed diet of a potential wildlife receptor) is 2.28, which approximates the 2.3 steady state value presented by Ingersoll et al (2003).

The majority of the identified sediment invertebrates at the Site are considered “facultative”, meaning that they live in contact with the sediment during at least one life stage but do not live exclusively in the sediments. Thus, the value of 2.3 is considered protective of the potential uptake scenarios at the Site.

As discussed previously, TPH cannot be tracked through the food chain, therefore BAFs were not developed for this constituent. Table 5 summarizes the BAFs used in this screen and their respective sources.

4.0 TPH Benchmarks for Plants and Soil Invertebrates

Proposed benchmarks and associated rationale are presented in this section. The toxicity of petroleum hydrocarbon mixtures is highly variable. The available literature supports the fact that products containing the lighter carbon ranges (i.e., gasoline) are generally more toxic than those containing the heavier carbon ranges (i.e., crude oil) due to reduced bioavailability of the more prevalent larger carbon compounds. Thus, a TPH benchmark developed for gasoline or diesel fuel may not be applicable to a crude oil site. In addition, weathering can affect the toxicity of petroleum products as lighter more toxic components are more rapidly lost or degraded.

To develop an appropriate TPH benchmark for the SLO Tank Farm site, a thorough literature review was conducted to locate toxicity studies with petroleum mixtures that may be representative of the mixture found at the SLO Tank Farm Site. This review included any studies conducted with fresh or weathered crude oil and terrestrial plants or invertebrates. Three primary studies evaluating the toxicity of hydrocarbon mixtures to soil invertebrates and plants have been identified as potentially useful in developing TPH benchmarks for SLO Tank Farm. These studies are:

1) CCME: Study conducted by Canadian Council of Ministers of the Environment evaluating the toxicity of carbon fractions and whole Federated crude oil to terrestrial plants and invertebrates (CCME, 2000).
2) Saterbak/Wong: Study evaluated the toxicity of 6 different soils contaminated with different weathered crude oils (Saterbak et al, 1999) and (Wong et al, 1999).
3) Salanitro/Dorn: Study evaluated the toxicity of 2 different soils contaminated with 3 different artificially weathered crude oils. (Salanitro et al, 1997) (Dorn et al 1998), and (Dorn and Salanitro, 2000).

Each of these studies is briefly summarized below and the relevant information that they provide to support TPH benchmarks for plants and invertebrates is summarized in Table 7.

4.1 CCME

The CCME (2000) study evaluates fraction based terrestrial plant and invertebrate toxicity of whole fresh Federated crude oil to differentiate the variable toxicity of hydrocarbon mixtures. Four carbon fraction ranges were selected to generally represent gasoline, diesel, lubricants and tars, Fraction 1– Fraction 4 (F1 – F4) respectively. Because studies with the F4 fraction were not completed at the time of this document publication, whole Federated crude was used in the CCME document as a conservative surrogate for this fraction. Thus the F4 benchmark developed in the CCME document is in fact a benchmark for whole Federated crude oil. While the same fractional breakdowns are not available for both Federated Crude and Site data, the fractional compositions can be compared as follows:

Federated Fresh Crude	Site Weathered Crude	Federated Fresh Crude	Site Weathered Crude	Federated Fresh Crude	Site Weathered Crude
C1 – C10	C4 – C10	C11 – C22	C10 – C25	C23- > C35	C25 – C40
26%	< 1%	37.3%	39%	*36.7%	61%

* Value estimated based on data presented in Appendix G of CCME 2000 and on Site data available through June 2003.

This evaluation focused on the F4 (i.e., whole crude oil) benchmark as a conservative representative of potential toxicity at the SLO Tank Farm site. The CCME document presents results of a number of bioassays conducted using various field and artificial soil types, plant and invertebrate species and test durations. Measured endpoints include 20% and 50% effects concentrations (EC20 and EC50) and 50% lethal effect concentrations (LC50). EC values represent non-lethal endpoints and are concentrations at which either a 20 or 50% effect was measured in the test endpoint compared to controls (e.g., a 20 % reduction in root length in the test species compared to controls) or where 20 or 50% of the organisms tested were significantly affected (e.g., 20% of the plants tested had a significant reduction in root length compared to controls). LC50s are values at which 50% of the test organisms are not expected to survive. The variability of the study results are demonstrated by the results outlined below:

- Plant: mean EC20 29,536 ppm; range 277 - 131,334 ppm ; 10th percentile 782 ppm [n=54],
- Plant: mean EC50 55,252 ppm; range 1054 - 302,221 ppm; 10th percentile 4,598 ppm [n=54],
- Invertebrate: mean EC20 998 ppm; range 842 – 1183 ppm; 10th percentile 842 ppm [n=3],
- Invertebrate: mean EC50 3002 ppm; range 1633 - 4977 ppm; 10th percentile 1633 ppm [n=5],
- Invertebrate: mean LC50 5201 ppm; range 3984 - 7588 ppm; 10th percentile 3984 ppm [n=9].

All of the results are considered by the authors and a value was selected by taking the 25th percentile of all (plant and invertebrate) of the EC and LC values (4800 ppm) and applying a correction factor of 0.58 to account for potential hydrocarbon losses during the experiment. This correction factor was applied to the nominal F4 concentration based on observations made by Stephenson et al (2000) where hydrocarbon losses were measured at time zero of a number of soil based bioassays. For more details of the derivation of this value, see Section 4.2.3 of the CCME 2000 document. The resulting soil quality benchmark for whole fresh crude oil protective of plants and invertebrates selected by the CCME is 2800 ppm.

To put this fresh crude value in context, work conducted using weathered Federated crude oil by Visser et al (in progress) is also presented in the CCME document to address the differences in toxicity that might exist between fresh and weathered products. This work is not complete, but results of the preliminary tests, a 14 day survival assay for earthworms and a 4-5 day germination and root elongation test for lettuce and barley, indicate that the NOEC for artificially weathered Federated crude in loam for both earthworms and the two plant species is 29,603 ppm. When compared to the 14 day earthworm LC50 values for fresh crude, which ranged from 3984 to 5729 ppm, it is apparent that the weathering process significantly reduced the potential toxicity of Federated crude oil.

4.2 Saterbak/Wong

The Saterbak/Wong study is the basis for the benchmark value of 1008 ppm for soil invertebrates developed by CH2MHill for the GOF ERA. The study uses 8 different soil types containing varying ages of spilled crude oil. The study measures 3 different lethality endpoints and two reproductive endpoints in earthworms. CH2MHill fit the soil concentration data to the effects data using a model described in the "TPH Ecotoxicity and Bioaccumulation Values for GOF ERA" document (CH2MHill, 2001) to develop EC50s and LC50s. The 1008 ppm is based on

the reproductive EC50. It is important to note that the TPH concentrations used for the model fit are only measures of C6 - C25. Given that the majority of the soils used in the study are contaminated with weathered crude, this likely underestimates the actual total. Based on the composition of the weathered crude at SLO Tank Farm, one half to two thirds of the TPH found is in the fraction from C25 – C 40 making the 1008 benchmark value 2+ times lower than if the full carbon range had been measured.

Furthermore, the authors of the study (Wong et al, 1999) found no significant correlation between the reproductive endpoints and TPH concentrations. The authors state that "Earthworm reproduction endpoints were most highly correlated with soil texture and metal constituents." Because only 1 of the 8 soils used in the bioassays had similar composition to the SLO Tank Farm Site (i.e., a silty clay), it is difficult to determine the relevance of this study to SLO Tank Farm.

The final conclusions of the authors are that TPH concentrations were correlated with the 14-day test of earthworm avoidance and survival and that the NOEC was < 4000 ppm and the LOEC was between 4000 and 10,000 ppm. For plants, 14-day seed germination for mustard, wheat, and corn was correlated with TPH concentrations and the LOECs were > 2000 ppm, >10,000 and 34,000 respectively. Again, these values are based on a measure of only a portion of the TPH present and may underestimate the actual TPH present in the test soils.

4.3 Salanitro/Dorn

Salanitro et al, 1997 and Dorn and Salanitro 2000 evaluated the toxicity of 2 different soils (high and low organic carbon content) contaminated with 3 different artificially weathered crude oils (light, medium and heavy) before, during and after bioremediation. For the purposes of this evaluation only the soil most similar to the SLO Tank Farm Site (Norwood soil, a silty loam with 0.3% organic carbon), and the oil product most similar to GOF sources (heavy or medium artificially weathered crudes) were considered. An earthworm 14 day survival bioassay, a Microtox assay, a 21 day seed germination (corn, wheat and oat) bioassay and a plant growth bioassay were conducted both pre and post bio-remediation (i.e., land farming). The most comparable TPH measurements taken were the carbon fraction analyses using methylene chloride extraction and simulated boiling point gas chromatography on untreated and bio-remediated soils at the end of the 11 month test period. These data are presented in Table 2 in Salanitro et al, (1997) as carbon fraction data and were summed to derive the total TPH values. This measurement accounts for the complete carbon range in the soil and accounts for all hydrocarbon losses during the experiment. The results indicate that residual TPH concentrations of 8260 ppm in the heavy oil treated soil and 7543 ppm in the medium oil treated soil do not affect any of the earthworm or plant endpoints measured (i.e., NOECs).

4.4 Dorn

Using the same oil products and soils as described in the two previous studies, Dorn et al (1998) evaluated the acute toxicity of fresh heavy, medium and light crude oils to earthworms and five plant species. This study provided LC and EC 50s as percent of the nominal oil concentrations in soil. The study found that 14 day survival LC50 for earthworms in the Norwood (low organic carbon) soil spiked with medium crude ranged from 0.13 to 0.19% (1300 to 1900 mg/kg) and for heavy crude the range was 0.53 to 0.62% (5300 to 6200 mg/kg). The earthworms appeared to be

more sensitive to the contaminated soil than the plant species tested. Plant inhibition concentration for 25% of the test organisms (IC 25s) for germination in the Norwood soil spiked with medium crude ranged from 4 to 8.35 % (40,000 to 83,500 mg/kg) for five plants species tested and the heavy crude IC25 was 1.15% (11,500 mg/kg) for lettuce. While this study does not have a direct input to the development of the TPH benchmark, it does support the findings of the two companion studies and the LC and IC concentrations are generally within the ranges of those reported by CCME for earthworms and plants.

4.5 Recommendation

Based on review of the studies summarized above and consultation with Regina Donohoe, low screening benchmarks of 782 ppm for terrestrial plants and 842 ppm for terrestrial invertebrates are proposed. These values are the 10th percentile of the observed EC 20 values presented in the CCME document for plants and invertebrates respectively. The proposed high benchmarks are 4598 ppm for plants and 1163 for terrestrial invertebrates. These values are the 10th percentile of the EC50 values presented in the CCME document. This approach is consistent with the approach used by Long and Morgan (1990) to develop sediment effect-range low and effect-range median values and by Efroymson et al 1997 to develop plant and invertebrate benchmarks for COPEC screening. Specific rationale for the selection of these values is provided below.

Plants: The CCME study was selected as the basis for the benchmarks because it contains a large data set of non-lethal and sensitive endpoints (i.e., root and shoot length and weight) and study durations ranging from 6 to 20 days. While the three other studies considered indicated that plant toxicity threshold in soils containing weathered petroleum mixtures may be considerably higher than 782 ppm, these studies were not selected for the following reasons. The LOEC values for germination observed by Saterbak/Wong ranged from 2000 ppm to 34,000 ppm, but were based on an incomplete measure of TPH and were observed in soil types that are not similar to the SLO Tank Farm. The Salanitro/Dorn study found post-remediation NOECs for germination of 7543 ppm and 8206 ppm for medium and high weight weathered crudes respectively. While these values are based on adequately measured concentrations in a soil type similar to the SLO Tank Farm soils, this study was not selected because it represents only 1 test situation and may not capture the variability associated with the toxicity of hydrocarbon mixtures. By way of comparison, the most conservative generic Tier 1 TPH benchmark values promulgated by the CCME as the Canada-wide petroleum hydrocarbon in soil remedial (or clean-up) standard are 2,800 to 5,600 mg/kg dry wt. (assuming residential land use and a coarse soil and fine soil, respectively). These studies along with the Canada-wide standards provide context for the selected value and demonstrate that the proposed values of 782 ppm and 4598 ppm are conservative estimates of a toxicity thresholds for plants. This context may be useful in interpreting the results of the pERA.

Invertebrates: As with the plant benchmark, the CCME study was selected as the basis for the terrestrial invertebrate benchmark because it is based on multiple observations with chronic study durations of 61 days for the non-lethal endpoints. While the two other studies considered demonstrated higher possible benchmark concentrations (i.e., NOECs of 4000, 7543 and 8206 ppm), these studies were not selected as the basis for the TPH benchmark for the reasons discussed above for plants. While both of these studies considered only survival and avoidance endpoints in 14 day test durations (i.e., sub-chronic tests), they do provide context for the

proposed benchmark and demonstrate that the proposed values of 842 ppm and 1163 ppm are likely conservative thresholds for terrestrial invertebrates. This conservatism is also highlighted when these values are compared with the generic Tier 1 TPH benchmark values promulgated by the CCME (2,800 to 5,600 mg/kg dry wt.). As with the plant benchmarks, the context provided by the available literature and the Canada-wide standards may be useful in interpreting the results of the pERA.

5.0 Uncertainty Analysis

Many of the benchmarks and BAFs used for this initial screening effort have significant associated uncertainty because they are not site-specific. However, they are generally considered to be conservatively protective such that the possibility of reaching a finding of no risk when risk actually exists at the site is minimized. Specific uncertainties are discussed below.

5.1 Non-TPH Benchmarks

The majority of the contact toxicity benchmarks for metals in soils are based on the compilation of data presented in the ORNL screening documents for plants and invertebrates. These values are not site-specific and are based on percentiles of effects over a range of studies. While these values are somewhat uncertain, the selection of a benchmark based on a larger data set is more likely to capture the variability of responses and is therefore conservative for a wide range of site circumstances.

The contact toxicity benchmarks for sediment metals and PAHs are generally consensus-based benchmarks (i.e., TECs and UETs) that are derived by assuming a cause and effect relationship between observed toxicity in a given study and the concentration of a particular constituent. In many cases, the studies use field collected sediments that contain a number of potential toxicants and there may or may not be a causative relationship. While the degree of the uncertainty associated with these values is unknown, they are generally considered conservative values appropriate for screening level evaluations.

5.2 TPH Benchmarks

There are a number of uncertainties associated with the development of the TPH contact-toxicity benchmarks for terrestrial plants and invertebrates. The primary uncertainty is the paucity of available data in the literature to address the potential toxicity of weathered crude in soil similar to that of SLO Tank Farm. The largest uncertainty associated specifically with the proposed benchmark is the fact that it is based on fresh crude rather than weathered crude. The toxicity of TPH and in particular of weathered TPH is highly variable and depends largely on the specific composition of the TPH mixture. Because weathered products typically contain a higher percentage of the larger less bioavailable carbon compounds, it would follow that the associated toxicity would be less than that of a fresher crude or a mixture containing more of the lighter carbon compounds (i.e., diesel). However, while preliminary studies conducted on behalf of CCME with weathered crude indicate that the weathered product is much less toxic than the fresh product, only acute exposures have been tested to date (Visser et al., cited in CCME 2000). In addition, Appendix G of the CCME document provides a compilation of available invertebrate and plant toxicity data comparing weathered and fresh products. The evaluation of these data indicate that the toxic responses are variable and that the general assertion that weathered crude

is less toxic (chronically) than fresh crude is not always accurate, particularly for sensitive species.

5.3 BAFs

The BAFs selected for use in the pERA food web assessment are uncertain, largely because site-specific parameters such as soil organic carbon, pH, grain size and temperature can all affect uptake. Thus, deriving a BAF that is applicable to the Site based on non-site specific studies adds uncertainty to the evaluation. Every effort was made to select conservative BAFs that would over rather than under estimate uptake. The BAFs selected from the ORNL documents (for As and Pb for plants, soil and sediment invertebrates) are considered highly protective since they are based on the 90th percentile of a large data set encompassing a wide range of variability. Likewise, the values selected from the literature for PAHs in soil invertebrates are based on the 90th percentile of data from 4 different species and 8 different PAHs. While this dataset is likely to capture much of the variability in estimating uptake, these BAFs are not organic carbon normalized and the uptake of organic constituents can be heavily influenced by the amount of organic carbon in the soil. The effect this may have on the estimated BAFs is unknown.

The sediment invertebrate PAH BAFs are based on a review of a number of different studies in the literature that all support BAFs within the range of the selected value. The selected BAF value is normalized to organic carbon, however no measured organic carbon data for the site is available. Thus, the value is based on an assumption of 1% organic carbon in the soil. While this is a common assumption in the absence of site-specific data, the potential over or under estimation of uptake from this assumption is unknown.

6.0 Conclusions

The objectives of this memo were to provide the underlying rationale for the selection of low and high benchmarks and bioaccumulation factors to be used in the pERA. Readily available values from the GOF ERA and from commonly used literature sources were used when applicable. Because of the composition of the TPH at SLO Tank Farm, many of the available screening values for TPH were not applicable to the Site and it was necessary to develop TPH benchmarks more specific to the weathered crude oil found at SLO Tank Farm. The literature reviewed and the rationale for the TPH benchmarks are summarized in this document. The values presented in Tables 1,2 and 3 summarize the selected benchmarks for plants, terrestrial, and benthic invertebrates, aquatic invertebrates and avian and mammalian wildlife receptors respectively. Table 5 summarizes the BAFs selected for plants, terrestrial and benthic invertebrates, and prey.

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Table 1: Contact Toxicity Benchmark Summary

Analyte	Terrestrial Plant Benchmark (mg/kg- DW)			Terrestrial Invertebrate Benchmark (mg/kg- DW)			Sediment Invertebrate Benchmark (mg/kg- DW)		
Metals	Low	High	Ref	Low	High	Ref	Low	High	Ref
Arsenic	10	90	1a	60	N/A	1b	**9.79**	**33.0**	**6**
Lead	50	500	1a	500	1629	1b	35.8	128	6
Organics									
Acenaphthene	20	61*	1a/2	**31**	**107**	**5**	**0.29**	**1.3**	**7a, 8a**
Acenaphthylene	3*	61*	2	**23**	**145**	**5**	**0.16**	**N/A**	**7a**
Anthracene	3*	61*	2	**5**	**67**	**5**	**0.057**	**0.845**	**6**
Benzo(a)anthracene	1.2*	3.3*	3	**>980**		**5**	**0.108**	**1.05**	**6**
Benzo(a)pyrene	**1.2**	**3.3**	**3**	**>840**		**5**	**0.15**	**1.45**	**6**
Benzo(b)fluoranthene	1.2*	3.3*	3	**>360**		**5**	**0.0272**	**4.0**	**8b, 8c**
Benzo(k)fluoranthene	1.2*	3.3*	3	**>560**		**5**	**0.0272**	**4.0**	**7b, 8c**
Benzo(ghi)perylene	1.2*	3.3*	3	N/A			**0.17**	**3.2**	**8d**
Chrysene	1.2*	3.3*	3	**>1030**		**5**	**0.166**	**1.29**	**6**
Dibenzo(a,h)anthracene	1.2*	3.3*	3	**>780**		**5**	**0.033**	**N/A**	**6**
Fluoranthene	1.2*	3.3*	3	**47**	**51**	**4**	**0.423**	**2.23**	**6**
Fluorene	3*	61*	2	**7.7**	**39**	**5**	**0.077**	**0.536**	**6**
Indeno(1,2,3-cd)pyrene	1.2*	3.3*	3	**>910**		**5**	N/A		
Naphthalene	**3**	**61**	**2**	**20**	**167**	**5**	**0.176**	**0.561**	**6**
Perylene	1.2*	3.3*	3	**>560**		**5**	N/A		
Phenanthrene	3*	61*	2	**21**	**30**	**4**	**0.204**	**1.17**	**6**
Pyrene	1.2*	3.3*	3	**13**	**16**	**4**	**0.195**	**1.52**	**6**
Total PAHs	N/A	N/A		N/A	N/A		**1.61**	**22.8**	**6**
TPH	782	4598	9	842	1163	9	842	1163	9

DW = dry weight
Italics are low molecular weight compounds (i.e., 2 or 3 carbon rings). All other individual PAHs are high molecular weight (i.e.,4 or more carbon rings)
* indicates benchmark is a surrogate. Naphthalene used for low and Benzo(a)pyrene used for high molecular weight PAHs.

References:

1a = Efroymson et al., 1997a: Low is 10th percentile of LOEC values; High is 50th percentile of LOEC values

1b = Efroymson et al., 1997b: Low is lowest LOEC values; High is second lowest LOEC value.

2 = CCME, 1999a: Low is LC25 for lettuce seed emergence; High is LC25 for radish seed emergence

3 = CCME, 1999b: Low is NOEC for rye, wheat and corn; High is NOEC for rye

4 = Sverdrup et al., 2001: Low is reproduction NOEC for Collembola; High is reproduction EC 50 for Collembola

5 = Sverdrup et al., 2002: Low is reproduction EC 10 for Collembola; High is LC 50 for Collembola.

6 = MacDonald et al, 2000: Low is Threshold Effect Concentration; High is Probable Effect Concentration.

7a = Buchman 1999 (Upper Effect Thresholds) 7b Buchman 1999 (Lowest ARCs *H. azteca* Threshold Effect Level)

8a = Jones et al., 1997 (EqP NAWQC) 8c = Jones et al., 1997 (Great Lakes NEC)

8b = Jones et al., 1997 (Great Lakes TEC) 8d = Jones et al., 1997 (Ontario MOE - Low is "Low"; High is "Severe")

9 = Benchmark proposed in Section 4 of this document **Bold Values used in GOF ERA**

Table 2: Summary of Surface Water Benchmarks

Detected Analytes	Low Benchmark (mg/l)	High Benchmark (mg/l)		
Metals				Ref
Arsenic	**0.15**			**1**
Barium	**0.004**	0.110		**2**
Nickel	0.052			1
Thallium	0.012			2
Vanadium	**0.02**			**2**
Zinc	**0.12**			**1**
Organics				
Toluene	**0.0098**			**2**

1= USEPA 2002 (National Recommended Water Quality Criteria - chronic freshwater value).

2 = Suter and Tsao 1996: Low is secondary chronic value (SCV); High is secondary acute value (SAC).

Bold Values used in GOF ERA.

Table 3: Summary of Wildlife Toxicity Reference Values

Analyte	Avian TRVs (mg/kg/day)			Mammalian TRVs (mg/kg/day)		
Metals	Low	High	Ref	Low	High	Ref
Arsenic	5.5	22.01	1	0.32	4.7	1
Lead	0.014	8.75	1	1.0	240.64	8, 1
Organics						
Acenaphthene	**32.5**	**325**	**3**	**175**	**350**	**9**
Acenaphthylene	**32.5**	**325**	**3**	**175**	**350**	**9**
Anthracene	**32.5**	**325**	**3**	**1000**	**NA**	**9**
Benzo(a)anthracene	**32.5**	**325**	**3**	**1**[3]	**10**[3]	**5**
Benzo(a)pyrene	**32.5**	**325**	**3**	**1**	**10**	**5**
Benzo(b)fluoranthene	**32.5**	**325**	**3**	**1**[3]	**10**[3]	**5**
Benzo(k)fluoranthene	**32.5**	**325**	**3**	**1**[3]	**10**[3]	**5**
Benzo(ghi)perylene	**32.5**	**325**	**3**	**1**[3]	**10**[3]	**5**
Chrysene	**32.5**	**325**	**3**	**1**[3]	**10**[3]	**5**
Dibenzo(a,h)anthracene	**32.5**	**325**	**3**	**1**[3]	**10**[3]	**5**
Fluoranthene	**32.5**	**325**	**3**	**125**	**250**	**9**
Fluorene	**32.5**	**325**	**3**	**125**	**250**	**9**
Indeno(1,2,3-cd)pyrene	**32.5**	**325**	**3**	**1**[3]	**10**[3]	**5**
Naphthalene	**26.9**	**269**	**2**	**50**	**150**	**4**
Perylene	**32.5**	**325**	**3**	**1**[3]	**10**[3]	**5**
Phenanthrene	**32.5**	**325**	**3**	**125**[3]	**250**[3]	**9**
Pyrene	**32.5**	**325**	**3**	**75**	**125**	**9**
Total PAH	NA	NA		NA	NA	
TPH[4]	218	2180	6	197	890	7a,b

1 = EFA West 1998 (Navy/BTAG Wildlife TRVs)[1]
2 = Wildlife International, 1985 – based on mortality endpoint
3 = Patton and Dieter, 1980[2] – based on growth and body weight endpoints
4 = Navarro et al., 1991 – based on reproductive endpoints
5 = Mackenzie and Angevine, 1981 – based on reproductive endpoints
6 = Stubblefield et al, 1995 – based on reproductive endpoint
7a = Beckett et al, 2002; 7b = Kahn et al, 1987 – based on reproductive endpoints
8 = HERD Econote 5 – based on a renal effects[1]
9 = USEPA 2001 – hepatotoxicity and nephropathy endpoints

Bold values used in GOF ERA

[1] BTAG and HERD TRVs are developed by considering the weight of evidence of all studies reviewed. While the low and high values selected are taken from single studies, they are developed to be protective of the range of endpoints considered.
[2] An uncertainty factor of 10 will be applied to benchmarks based on this study for special status species if identified.
[3] Value is based on toxicity study conducted with a surrogate compound.
[4] TPH benchmark is for incidental soil or sediment ingestion only.

Table 4: Toxicity of Crude Oils to Mammalian Receptors

Petroleum Product	Test Species	Dose Route	Study type/ duration	Endpoint	NOAEL	LOAEL	Comments	Reference
Crude oil from mixed locations	mouse	gavage	single dose - 14 day observation	mortality	na	>10,000[1]		Smith et al 1981
Weathered North Slope Crude	ferret	gavage	daily dose 5 days	mortality and histopathology	>5000	na	No evidence of toxicity	Stubblefield et al 1995
Prudhoe Bay crude	mouse	gavage	daily dose 5 days	body &organ wts; blood chemistry	1780	3560	Statistically significant diff. weight observed at 4 ml dose but not at 2 ml dose.[2]	Leighton 1990
Prudhoe Bay crude	mouse	gavage	daily dose 5 days	hematological changes	na	8900	No statistically significant diff. in packed cell volume and mean corpuscular hemoglobin concentration in 1 experiment, but slight differences observed in 2 others. Slight differences in body and organ weights were also observed at this dose.[2]	Leighton 1990
Prudhoe Bay crude	Sprague Dawley Rats	gavage	1 dose on various days of gestation	maternal body weight gain	na	4450	A small effect on weight gain in the day 6 treatment group (no changes in other day treatments) [2]	Kahn et al 1987
Prudhoe Bay crude	Sprague Dawley Rats	gavage	daily dose on days 6-17 of gestation	maternal body weight changes	na	890	Unbounded LOAEL (lowest dose tested) - effects observed from days 6 - 18.[2]	Kahn et al 1987
Prudhoe Bay crude	Sprague Dawley Rats	gavage	1 dose on various dose days during gestation	No. pregnant females, implants, resorptions, live fetuses, & fetal weight and fetal crown-rump length.	na	4450	Effects observed on resorptions, live fetuses and fetal weight in the 3,6 and 11 day treatment groups). No effects observed in day 15 and 17 treatment groups.[2]	Kahn et al 1987
Prudhoe Bay crude	Sprague Dawley Rats	gavage	daily dose on days 6-17 of gestation	No. pregnant females, implants, resorptions, live & fetuses, fetal weight and fetal crown-rump length.	na	*890*	Effects observed on resorptions, live fetuses, fetal weight and fetal crown-rump length in the lowest dose tested.[2]	Kahn et al 1987
Weathered Prudhoe Bay crude	Mink	dietary ingestion	4 month exposure	body weight and organ weight and histopathology	*197*	na	Unbounded NOAEL for each endpoint - authors also noted no clinical signs of toxicity[3].	Beckett et al 2002
Weathered Prudhoe Bay crude	Mink	dietary ingestion	4 month exposure	hematological changes	na	22	Unbounded LOAEL for blood parameters that do not necessarily indicate toxicity or impairment. Authors diagnosed "non-specific anemia". Also stated "several serum chemistry values reported fell just outside reported reference ranges for healthy mink." [3]	Beckett et al 2002

Proposed low TRV of 197 mg/kg/day and high TRV of 890 mg/kg/day.

Values are mg/kg/day

[1] Value is LD 50

[2] ml/kg converted to mg/kg assuming 890 mg/ml (specific gravity of Prudhoe Bay Crude is 0.89)

[3] Based on an assumed body weight of 1 kg and measured mean ingestion rates of 0.218 and 0.197 for the 100 and 1000 ppm dose groups respectively

Table 5. Biota-Soil/Sediment Accumulation Factors (BAFs)

Biota-Soil and Biota-Sediment Accumulation Factors												
	Soil		**Sediment**		**Soil**		**Log K_{ow}**		**Soil**		**Sediment**	
	Invertebrates				**Plants***				**Prey**			
Metals												
Arsenic	0.52	1	0.69	3	1.1	4	NA		0.015	6a	0.015	6a
Lead	1.5	1	0.61	3	0.47	4	NA		0.29	6a	0.34	6b
Organics												
Acenaphthene	0.16	2	2.30	5	0.60	7	4.0	8	2.2	6c	2.2	6c
Acenaphthylene	0.16	2	2.30	5	0.55	7	4.1	8	2.2	6c	2.2	6c
Anthracene	0.16	2	2.30	5	0.40	7	4.5	8	2.2	6c	2.2	6c
Benzo(a)anthracene	0.16	2	2.30	5	0.14	7	5.6	8	2.2	6c	2.2	6c
Benzo(a)pyrene	0.16	2	2.30	5	0.05	7	6.7	8	2.2	6c	2.2	6c
Benzo(b)fluoranthene	0.16	2	2.30	5	0.10	7	6.0	8	2.2	6c	2.2	6c
Benzo(g,h,i)perylene	0.16	2	2.30	5	0.06	7	6.5	8	2.2	6c	2.2	6c
Benzo(k)fluoranthene	0.16	2	2.30	5	0.09	7	6.1	8	2.2	6c	2.2	6c
Chrysene	0.16	2	2.30	5	0.21	7	5.2	8	2.2	6c	2.2	6c
Dibenzo(a,h)anthracene	0.16	2	2.30	5	0.05	7	6.8	8	2.2	6c	2.2	6c
Fluoranthene	0.16	2	2.30	5	0.27	7	4.9	8	2.2	6c	2.2	6c
Fluorene	0.16	2	2.30	5	0.50	7	4.2	8	2.2	6c	2.2	6c
Indeno(1,2,3-cd)pyrene	0.16	2	2.30	5	0.06	7	6.6	8	2.2	6c	2.2	6c
Naphthalene	0.16	2	2.30	5	1.10	7	3.3	8	2.2	6c	2.2	6c
Perylene	0.16	2	2.30	5	0.08	7	6.3	9	2.2	6c	2.2	6c
Phenanthrene	0.16	2	2.30	5	0.40	7	4.5	8	2.2	6c	2.2	6c
Pyrene	0.16	2	2.30	5	0.27	7	4.9	8	2.2	6c	2.2	6c

* Uptake by terrestrial plants are expected to be adequate surrogates for potential aquatic plant uptake.

1 = Sample et al, 1998a. 90th percentile values.

2 = VanBrummelen et al 1996. 90th percentile value of 4 species and 9 PAHs converted to dry weight.

3 = Bechtel Jacobs Company LLC. 1998b. 90th percentile values.

4 = Bechtel Jacobs Company LLC. 1998a. 90th percentile values.

5 = Ingersoll et al 2003. Steady state values converted to dry wt/dry wt.

6a = Sample 1998b. 90th percentile values for general mammals.

6b = Sample 1998b. 90th percentile values for insectivores.

6c = Sample 1998b. 90th percentile value for general mammals - TCDD used as surrogate for PAHs.

7 = USEPA Ecological Soil Screening Level Guidance Document 2000. Model in Appendix 4-1.

8 = ATSDR (1995) Toxicological profiles for polycyclic aromatic hydrocarbons.
# Total PAH Kow is average of 17 PAHs.

9 = Syracuse Research Corporation Phys prop database - http://esc.sy.rres.com

Table 6. Summary of Data Used to Derive PAH Soil to Invertebrate Bioaccumulation Factors

Soil to Invertebrate Bioaccumulation Factor Summary								
	Porcelio Scaber	*Oniscus asellus*	*Philoscia muscorum*	*Lumbricus rubellas*	Min	Max	Mean	90th Percentile
PAH BAFs								
Benzo (a) anthracene	0.030	0.035	--	0.162	0.030	0.162	0.076	0.14
Benzo (a) pyrene	0.017	0.033	0.014	0.125	0.014	0.125	0.047	0.10
Benzo (b) fluoranthene	0.011	0.013	0.007	0.074	0.007	0.074	0.027	0.06
Benzo (k) fluorene	0.025	0.027	0.015	0.131	0.015	0.131	0.050	0.10
Chrysene	0.051	0.032	0.034	0.236	0.032	0.236	0.088	0.18
Fluoranthene	0.052	0.072	0.125	0.159	0.052	0.159	0.102	0.15
Phenanthrene	0.099	0.058	0.205	0.105	0.058	0.205	0.117	0.17
Pyrene	0.068	0.050	0.123	0.178	0.050	0.178	0.105	0.16
Total PAH	0.051	0.031	0.069	0.153	0.031	0.153	0.076	0.13
All Data								0.16

* all data from Van Brummelen et al 1996.
BAFs are for uptake from humus to the specified invertebrate on a dry weight basis.

Soil Invertebrate Fraction Dry Weight				
Sample Site	*Porcelio Scaber*	*Oniscus asellus*	*Philoscia muscorum*	*Lumbricus rubellas*
	dry weight as % ww			
1	0.346	0.325	0.317	0.18
2	0.317	0.33	0.324	0.186
3	0.318	0.299	0.311	0.17
4	0.315	0.298	0.313	0.165
5	0.347	0.315	0.31	0.175
6	0.333	0.299	0.318	0.163
7	0.332	0.276	0.309	0.167
8	0.319	0.27	0.3	0.166
9	0.321		0.299	0.161
10	0.336		0.298	0.161
Mean fraction dry weight	0.3284	0.3015	0.3099	0.1694

Table 7. Plant and Soil Invertebrate TPH Toxicity - Literature Summary

Study	CCME (2000)[1]	Saterbak(1999)/ Wong(1999)[2]	Salanitro(1997)/ Dorn (2000)[3]	Dorn (1998)[3]
Soil Type	Field and artificial	Primarily sandy loams	Silty loam	Silty Loam
Petroleum Product Type	Fresh Federated Crude Oil	8 different weathered crude oils from historical releases	Artificially weathered crude oils (medium [API gr 30]and heavy [API gr 14])	Fresh crude oils (medium [API gr 30]and heavy [API gr 14])
Plants				
Endpoints Measured	Root and shoot weight and length and whole plant weight 6-20 days	Germination and growth – 14 day	Germination and growth – 21 day	Germination and growth- 14 day
Test Species	Alfalfa, barley, kandy korn, and northern wheatgrass	Corn, lettuce, mustard, wheat	Corn, wheat and oat	Corn, wheat, oat, lettuce and rye
Effect Level – 1	EC 20 Range = 277 – 131,344 ppm (10th percentile – 782 ppm)	Germination LOEC- mustard >2000 wheat >10,000 ppm	Germination NOEC 16,552 ppm – heavy crude	Germination IC 25 1.15% - heavy crude
Effect Level – 2	EC 50 Range = 1054 – 302,221 ppm (10th percentile = 4598 ppm)		Growth NOEC - 7543 ppm – medium crude	Germination IC 25 4 – 8.35% - medium crude
Recommended Low Screening Value	CCME recommended – 2800 ppm * Recommended for SLO Tank Farm pERA – 782 ppm	Lowest LOEC - 2000 ppm	Lowest NOEC - 7543 ppm	NA
Invertebrates				
Endpoints Considered	Body weight – 61 day fecundity – 36 day; Survival – 7-14 days	Survival – 14 and 28 day Reproductive success - 28 day	Survival – 14 day	Survival – 14 day
Test Species	Springtail and earthworm	Earthworm	Earthworm	Earthworm
Effect Level - 1	EC 20 Range = 842-1183 ppm; (10th percentile = 842 ppm)	14 day - Survival and avoidance NOEC <4000 ppm[4]	NOEC 8206 ppm – heavy crude	LC50 0.53 – 0.62 – heavy crude
Effect Level – 2	EC 50 Range = 1633-4977 ppm; (10th percentile = 1633 ppm)	14 day - Survival and avoidance LOEC > 4000 <10,000 ppm[4]	NOEC 7543 ppm – medium crude	LC50 0.13 – 0.19% - medium crude
Recommended Value	CCME recommended – 2800 ppm * Recommended for SLO Tank Farm pERA – 842 ppm	CH2MHill recommended for GOF 1008 ppm[5]	Lowest NOEC - 7543 ppm	NA

[1] Document summarizes a number of individual bioassays conducted using whole and fractionated fresh crude oil.

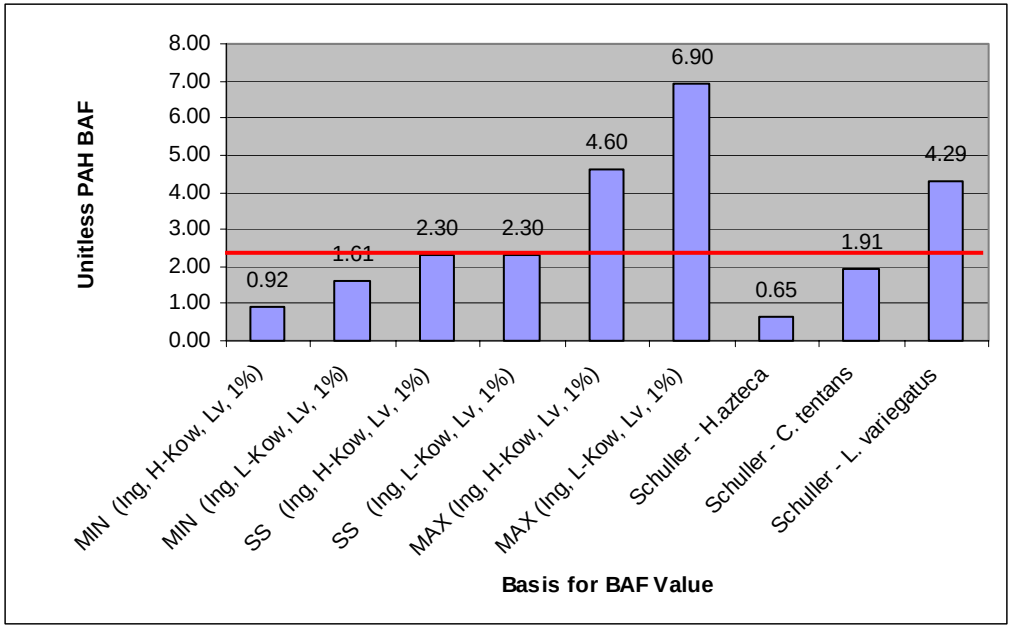
[2] TPH concentrations reflect only the C6 to C25 range of TPH.

[3] Based on Norwood soil (silty loam with low organic carbon content) and the medium and heavy oil treatments.

[4] 14-day survival was the only endpoint measured that showed a concentration-response curve as a function of the TPH measurement (i.e., C6-C25).

[5] Value is an EC50 calculated by CH2MHill using a regression equation of reproductive endpoint data. Authors of study (Wong et al) found no significant correlation between TPH-GC and reproductive endpoints.

Figure 1. Summary of PAH Sediment Invertebrate Uptake Data



SS = steady state
2.3 selected as BAF based on the steady state value for Lumbriculus presented in Ingersoll et al 2003.
BAF values converted to dry wt/dry wt assuming 1% organic carbon in sediment and 2.3% lipid in the test organism.

Note: Average of three species in Schuller 2003 study = 2.28. (Representing a possible mixed diet of wildlife receptor)

Appendix H

Characterization of TPH and PAHs in Soils, Sediment, and Surface Tars from Unocal's Former San Luis Obispo Tank Farm

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MEMORANDUM

TO: SAN LUIS OBISPO TANK FARM, SURFACE EVALUATION, REMEDIATION AND RESTORATION TEAM (SERRT)

FROM: ROBERT HADDAD (AGSI) AND BECKY COUNTWAY (BBL)

SUBJECT: CHARACTERIZATION OF TPH AND PAHS IN SOILS AND SEDIMENT, AND SURFACE TARS FROM UNOCAL'S FORMER SAN LUIS OBISPO TANK FARM, VER 2.0

DATE: OCTOBER 24, 2003

CC:

1. INTRODUCTION

The objectives of this technical memorandum are three-fold:

- To describe the overall carbon-range distribution (i.e., EC4-EC10, EC10-EC25, and EC25-EC40 ranges[1]) of residual Total Petroleum Hydrocarbon (TPH) present in the surface soils (0 to 10 ft. bgs[2] and 0-5 ft. bgs) and surface tars (0-3 ft. bgs) at the SLO Tank Farm site (the Site);

- To characterize the hydrocarbons found in a subset of soils and tars from the Site in terms of broad organic families or fractions that are operationally defined based on like chemistry (i.e., aliphatics, aromatics, NSO/asphaltenes) and for the aliphatic and aromatic fractions to further define them in terms of discrete carbon ranges (e.g., EC10-12, EC12-16, EC16-C21, and EC21-C40); and

- To determine whether TPH concentrations can be used to estimate individual and sum PAH concentrations for application in the predictive ecological risk assessment (pERA), as warranted.

The purpose of the first objective is to develop a solid understanding of the nature of the TPH measured in surface soils and surface tars from the San Luis Obispo Tank Farm (the Site). Based on historical Site information, a large volume (approx. 6 million barrels) of crude oil was released to Site environmental media as a result of a 1926 lightening strike and associated fire (England & Associates, 1999[3]). While much of the crude oil is believed to have been consumed by the fire,

[1] EC refers to the Equivalent Carbon notation as defined by the TPH Criteria Working Group (TPHCWG, Gustafson *et al*., 1997)
[2] bgs = below ground surface
[3] England & Associates, 1999. Additional Site Characterization, Unocal San Luis Obispo Tank Farm, 276 Tank Farm Road, San Luis Obispo, California: Report Dated April 5, 1999

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past site characterization has demonstrated that a substantial amount of the crude oil was released into the soils at the Site and is present as soil associated TPH and tar material. As well, England & Associates (1999) have described other sources of potential hydrocarbon releases to surface soils at the Site. These are primarily associated with lighter petroleum products (gasoline, naphtha, etc.) used at a fire-fighting training facility located immediately east of the current office/operations area. In terms of magnitude, it is believed that the petroleum release associated with the 1926 catastrophe far exceeds the petroleum released to the environment resulting from operational activities (including the fire-fighting training facility).

The fate and transport of hydrocarbons are, in general, related to their chemistry and molecular weight. Thus an understanding of the carbon range distribution of the TPH provides insight into the potential for hydrocarbon migration in the environment, the degree to which the existing petroleum has been environmentally weathered, and the bioavailability of this material (assuming exposure).

The second objective seeks to characterize the existing Site media hydrocarbon distribution in terms of compound classes that are operationally-defined based their chemical nature. There are two reasons for such an approach. The first is to assess the degree to which the existing hydrocarbon mixture is likely to be composed of the large and relatively non-mobile NSO/asphaltene components of petroleum. The second is to quantify the more readily available aliphatic and aromatic fractions for purposes of exposure assessment in the human health risk assessment.

With respect to the third objective, there is a limited amount of usable soil/tar PAH data relative to the larger amount of TPH data at the Site. If correlations between TPH and individual and sum PAHs are significant and account for the majority of the variability in the data, the resulting regression equations could be used estimate concentrations of PAHs based on TPH concentrations. This would allow for a more widely based assessment of the ecological risks associated with exposure and uptake of PAHs from the soils at the Site.

All data included in these three assessments were derived from Blasland, Bouck & Lee, Inc.'s (BBL) SLO Tank Farm secondary database, the derivation of which is detailed in the Draft Data Verification and Analysis Technical Memorandum, Version 1.1 (July 9, 2003). Briefly, this secondary database is derived from the primary database developed and maintained by England GeoSystem Inc., and includes all validated on-site data relevant to the human health and ecological risk assessments. Where appropriate, non-detected results were utilized based on half of the detection limit.[4]

[4] Non-detects were not included in distribution tests, but were included at half the detection limit for all sums and calculations of percentages.

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1.1 OVERALL TPH SURFACE SOIL AND SURFACE TAR CARBON RANGE DISTRIBUTIONS

1.1.1 Data included in assessment

The human health and ecological risk assessments focus on different depth strata and media. Thus, for the objectives described above, overall TPH carbon range distributions were assessed for three subsets of data from the secondary database:

- Data analyzed for the HHRA - all-onsite soils and sediment from depths less than or equal to 10 feet;
- Data analyzed for the pERA - all-onsite soils and sediment from depths less than or equal to 5 feet; and
- The surface tar assessment - all samples where the matrix was identified by England GeoSystem as “other solid waste”.

Note also that the data for all soil samples obtained from the BBL 2° database have been corrected for soil moisture (Draft Data Verification and Analysis Technical Memorandum, Version 1.1, July 9, 2003) and are presented on a dry weight basis while the tar samples are presented on a wet weight basis. If a particular carbon range was not detected in a sample, TPH sums and % compositions were calculated using ½ the detection limit.

1.1.2 Soils and Sediments in the EC4-EC40 Ranges

Historical results from the Site characterization indicated that there were rarely detectable amounts of EC4-EC10 hydrocarbons in the soils and tar media in samples from the Site. For this reason, while the overall TPH database contains over 300 sample results in which TPH was characterized in the EC10-EC40 range, only a small percentage of these samples were also measured for the EC4-EC10 range TPH. In order to completely evaluate the TPH distribution in these soils and tars, the first step was to assess the degree to which TPH in EC4-EC10 range was or was not significant. The working hypothesis is that the EC4-EC10 TPH fraction accounts for a minor percentage of the total EC4-EC40 TPH concentration such that a TPH distribution based solely on TPH measured in the EC10-EC40 carbon range will provide an adequate analysis of the TPH distribution in the soils, sediments and surface tars at the Site. The following analyses consider only samples where EC4 through EC40 were measured concurrently (i.e., EC4-EC10 and EC10-EC40, or EC4-EC10, EC10-EC25, and EC25-EC40).

HHRA Soils and Sediments: Of the 79 soil/sediment samples analyzed over the 0-10 ft. bgs interval, 73% (58/79 samples) had detectable TPH concentrations in the EC4-EC40 range (detection limits $\leq$ 12.5 mg/kg for EC4-EC10 and for EC10-EC40 ranges). Of the 58 samples with detectable TPH, 41% (24/58 samples) had TPH detections in the EC4-EC10 range (detection limits = 12.5 mg/kg), 92% (44/48 samples) had TPH detections in the EC10-EC25 range (detection limits = 12.5 mg/kg), 100% (48/48) had TPH detections in the EC25-EC40 range, and 100% (10/10 samples) had TPH detections in the EC10-EC40 range.

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pERA Soils and Sediments: Of the 50 soil/sediment samples analyzed in over the 0-5 ft. bgs depth interval, 72% (36/50 samples) had detectable TPH concentrations in the EC4-EC40 range (detection limits ≤ 12.5 mg/kg for EC4-EC10 and for EC10-EC40 ranges). Of the 36 samples with detectable TPH, 19% (7/36 samples) had TPH detections in the EC4-EC10 range (detection limits = 12.5 mg/kg), 89% (32/36 samples) had TPH detections in the EC10-EC25 range (detection limits = 12.5 mg/kg), and 100% (36/36) had TPH detections in the EC25-EC40 range. In the 36 samples where TPH was detected, there were no samples with detectable C10-C40 TPH concentrations (detection limits ≤ 12.5 mg/kg).

Surface Tars: Of the 20 surface tar samples analyzed over the 0-3 ft. bgs interval, 100% had detectable TPH concentrations in the EC4-EC40 range. Of these 20 samples, 50% (10/20 samples) had EC4-EC10 detections (detection limits were ≤10 mg/kg for 8 samples and ≤100 mg/kg for 2 samples), 93% (13/14 samples) had EC10-EC25 TPH detections (detection limit = 30 mg/kg), 100% (14/14) had EC25-EC40 TPH detections, and 100% (6/6 samples) had EC10-EC40 detections.

The results presented above can be summarized as follows[5]:

- For soil and sediment samples in the ≤ 10 ft. bgs range, TPH measured in the EC4-EC10 carbon range fraction accounts for 4.7±6.8% of the total EC4-EC40 TPH concentration. In terms of the median and geomean values, the EC4-EC10 range accounts for 1.3 % and 1.2%, respectively of the total EC4-EC40 TPH concentration.
- For soil and sediment samples in the ≤ 5 ft. bgs range, TPH measured in the EC4-EC10 carbon range fraction accounts for 4.1±6.6% of the total EC4-EC40 TPH concentration. In terms of the median and geomean values, the EC4-EC10 range accounts for 0.7% and 0.8%, respectively of the total EC4-EC40 TPH concentration.
- For surface tar samples, TPH measured in the EC4-EC10 carbon range fraction accounts for 0.3±1.0% of the total EC4-EC40 TPH concentration. In terms of the median and geomean values, the EC4-EC10 range accounts for 0.01 % and 0.02%, respectively of the total EC4-EC40 TPH concentration.

Based on these results, the hypothesis that the EC4-EC10 TPH concentration accounts for a minor percentage of the EC4-EC40 TPH concentration such that TPH distribution in soils, sediments, and surface tars at the Site is adequately represented by analysis of TPH in the EC10-EC40 range appears sound.

1.1.3 Soils and sediments in the EC10-EC40 Range

Because significantly more data are available for the EC10-EC40 than the EC4-EC40 carbon ranges, and as discussed above, the EC4-EC10 range comprises only a small fraction of total residual TPH at the Site, subsequent analyses of the TPH composition at the Site are made for

[5] All percentages were calculated using samples in which there was a detection in at least one of the three carbon range fractions. Non-detects were assumed to have a concentration that is ½ times the detection limit for the sample.

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only the EC10-EC25 and EC25-EC40 carbon ranges. The following analyses consider only samples where EC10-EC25 and EC25-EC40 were measured concurrently.

HHRA Soils and Sediments: Of the 294 soil/sediment samples where EC10-EC25 and EC25-EC40 were analyzed over the 0-10 ft. bgs interval, 58% (171/294 samples) had detectable TPH concentrations within the overall EC10-EC40 range (detection limits ≤ 12.5 mg/kg for each of the EC10-EC40 ranges). Of the 171 samples with detectable TPH, 92% (158/171 samples) had TPH detections in the EC10-EC25 range (detection limits ≤ 12.5 mg/kg) and 99% (170/171) had TPH detections in the EC25-EC40 range (detection limits ≤ 12.5 mg/kg). Within the HHRA dataset, the TPH concentration within the EC10-EC25 range accounted for 43±20% of the EC10-EC40 TPH concentration. The higher molecular weight EC25-EC40 TPH fraction accounted for the remaining 57±20% of the EC10-EC40 TPH concentration.

pERA Soils and Sediments: Of the 232 soil/sediment samples analyzed in over the 0-5 ft. bgs depth interval, 62% (143/232 samples) had detectable TPH concentrations within the overall EC10-EC40 range (detection limits ≤ 12.5 mg/kg for the two EC10-EC40 ranges). Of the 143 samples with TPH detections, 91% (130/143 samples) had TPH detections in the EC10-EC25 range (detection limits ≤ 12.5 mg/kg) and 99% (142/143) had TPH detections in the EC25-EC40 range (detection limits ≤ 12.5 mg/kg). Within the pERA dataset, the TPH concentration within the EC10-EC25 range accounted for 38±18% of the EC10-EC40 TPH concentration. The higher molecular weight EC25-EC40 TPH fraction accounted for the remaining 62±18% of the EC10-EC40 TPH concentration.

Surface Tars: Of the 32 surface tar samples analyzed over the 0-3 ft. bgs interval, 100% had detectable TPH concentrations within the overall EC10-EC40 range. Of these 32 samples, 94% (30/32samples) had EC10-EC25 TPH detections (detection limits ≤ 30 mg/kg) and 100% (32/32) had EC25-EC40 TPH detections. Within the surface tar dataset, the TPH concentration within the EC10-EC25 range accounted for 30±13% of the EC10-EC40 TPH concentration. The higher molecular weight EC25-EC40 TPH fraction accounted for the remaining 70±13% of the EC10-EC40 TPH concentration.

The results from the above analysis are summarized in Table 1-1 as follows[6]:

[6] All percentages were calculated using samples in which there was a detection in at least one of the two carbon range fractions. Within this data set, non-detects were assumed to have a concentration that is ½ times the detection limit for the sample.

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Table 1-1. Percentages of EC fractions in HHRA, pERA, and surface tars data sets.

	HHRA (0≤10 ft. bgs)	pERA (0≤5 ft. bgs)	Surface Tars
% EC10-EC25 Range			
Average Value	43%	38%	30%
1 standard deviation	20%	18%	13%
Median Value	37%	33%	32%
Geomean Value	38%	34%	27%
% EC25-EC40 Range			
Average Value	57%	62%	70%
1 standard deviation	20%	18%	13%
Median Value	63%	67%	68%
Geomean Value	53%	58%	69%

These results indicate that the distribution of TPH in the surface soils/sediments and surface tars from the site can be best described as dominated by high molecular weight hydrocarbons (i.e., in the EC25-EC40 range). This finding is consistent with expectations based on our understanding of the Site and Site history. First, the vast majority of the hydrocarbons found on site are believed to have been derived from the 1926 fire. This disaster resulted in the release of crude oil (much of which was likely subjected to elevated temperatures due to the associated fire) into the environment. Second, it is likely that the bulk of the crude oil released at this time was from San Joaquin oil fields (this tank farm was being used as a storage facility for transshipment of oil by tanker from the Avila facility). As these oil fields are known for their heavy crude oils (i.e., crude oil that is relatively viscous and characterized by high molecular weight organics), the distributions found in the soils/sediments and tars at the Site are consistent with the assumption of release of this oil into the environment. Finally, the oil released during the 1926 disaster has been exposed to environmental weathering processes for over 75 years, which preferentially removes lower molecular weight hydrocarbons. This consideration alone would be consistent with the TPH distributions presented in Table 1-1.

These results do not rule out more recent releases of lighter hydrocarbons (e.g., possible releases during the >60 years between the fire and the decommissioning of the SLO Tank Farm). However, from an empirical perspective, there is no evidence to conclude that more recent petroleum releases have occurred. Overall, the Site data presented above suggest that the distribution of the organic matter comprising the TPH measurements in the soils/sediments and surface tars from the Site is dominated by higher molecular weight compounds.

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2. CHARACTERIZATION OF ORGANIC FRACTION DATA

2.1 DATA INCLUDED IN ASSESSMENT

This assessment focuses on surface tars and on soil and sediment pertinent to the HHRA, and is based on data collected during the June 2003 sampling event[7]. Two different types of data are discussed. The first data type is derived from the gas chromatographic quantifications of the aliphatic and aromatic organic fractions (see Haddad, 2000; and Haddad and Countway, 2001[8]) and includes results from the analysis of soils (borings 68 through 73) and surface tars (ST-18 through ST-29). In addition to total chromatographic concentrations of the aliphatic and aromatic organic fractions, the data are also presented and analyzed in terms of their carbon range distribution. For example, chromatographic concentration data are presented for the total aliphatic material in the EC10-EC40 range and for the aliphatic material quantified in the EC10-EC12, EC12-EC16, EC16-EC21, and EC21-EC40 carbon ranges. Similar data are presented for the aromatic organic fraction. The carbon range distribution was determined only for samples where at least one of the aliphatic or aromatic fractions was detected. If a particular carbon range was not detected in a sample, sums and % compositions were calculated using ½ the detection limit.

The second data type is derived from gravimetric analysis of the various operationally-defined organic fractions of the surface tar samples (Haddad and Countway, 2001). For this analysis, total extract (TE+), total aromatics, total aliphatics, and NSOs[9] were directly measured. The asphaltene fraction was estimated by subtracting total aromatics, total aliphatics, and NSOs from the total extract. The data are presented as %Aliphatic, %Aromatic, and % NSO/Asphaltenes. . If a particular organic fraction was not detected in a sample, the calculation used ½ the detection limit. This approach was undertaken to allow for a compositional comparison of the Site surface tar to other petroleum sources and crude oils. Because these analytical methods were operationally-defined for oils, soils were not subjected to this analysis.

[7] England GeoSystem, Inc., Shallow Soil Characterization, Avila Terminal, Avila Beach, California. England GeoSystem, Inc. Project No. 526.014, report in press

[8] Haddad, R.I. (2000). Standard Operating Procedures for the determination of Total Petroleum Hydrocarbons (TPH) and TPH Fractions by Gas Chromatography/Mass Spectrometry. Draft Version 2. Prepared for the Guadalupe Oil Field Mediation Process.
Haddad, R.I. and R. Countway (2001) Guadalupe Oil Field, TPH Fraction Data Processing Memorandum. Ver. 20.0, Prepared for The Guadalupe Restoration Mediation Fact Finding Process.

[9] NSO identifies the fraction of oil that contains nitrogen, sulfur, and oxygen-containing compounds. This fraction is also sometimes referred to as the NSO/resin fraction or as the polar fraction.

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2.2 CHROMATOGRAPHIC ANALYSIS OF ALIPHATIC AND AROMATIC ORGANIC FRACTIONS

The Chromatographic results for the aliphatic and aromatic organic fraction analyses are presented in sections 3.2.1 for the soils and in 3.2.2 for the surface tar samples. These data are summarized in Table 2-1.

Table 2-1. Summary of Chromatographic Aliphatic and Aromatic results for Soils and Tars (samples with detectable aliphatics/aromatics).

	Total Organic Fraction (TOF)	EC10-EC12	EC12-EC16	EC16-EC21	EC21-EC40
Soils					
Aliphatic					
Concentration Range (mg/kg)	242-8,464	3.5-1,050	22-1,380	53-1,630	163-7,760
Percent of Total Range		0.62-28%	1.9-39%	5.8-25%	20-92%
Median Value	1,695 mg/kg	13%	20%	21%	45%
Aromatic					
Concentration Range (mg/kg)	232-6,635	1.2-288	7.5-338	35-551	56-6,260
Percent of Total Range		0.09-43%	0.66-41%	4.9-27%	4.7-94%
Median Value	669 mg/kg	4%	17%	22%	55%
Tars					
Aliphatic					
Concentration Range (mg/kg)	30-124,700	3-2,500	6-9,200	6-28,000	22-85,000
Percent of Total Range		0.04-5.1%	0.08-10%	4.6-22%	68-94%
Median Value	36,940 mg/kg	0.33%	2.7%	13%	81%
Aromatic					
Concentration Range (95% UCL) (mg/kg)	1,058-107,450	5-280	10-3,400	60-18,000	990-86,000
Percent of Total Range		0.05-0.65%	0.15-3.5%	3.1-17%	79-97%
Median Value	34,407 mg/kg	0.07%	0.79%	6.6%	92%

2.2.1 Soil Samples

Twelve soil samples were collected and subjected to the chromatographic analysis of the aliphatic and aromatic organic fractions. Of these 12 samples, 92% (11/12) had detectable concentrations of both aliphatic and aromatic organic material. One sample, B-72 at 10 ft. bgs, had no detectable concentrations in any carbon range for either of the aliphatic or aromatic organic fractions. Unlike the earlier TPH distribution analysis, some of the samples included in the aliphatic and aromatic soil analysis were obtained from depths below 10 ft. These included sample B-68 at 15 ft. bgs, B-69 at 15 ft. bgs, and B-70 at 13 ft. bgs. The remaining 8 samples were collected from soil depths ranging from 5 to 10 ft. bgs. For purposes of conservativeness, the carbon range distribution summarized in Table 2-1 included all 11 of the samples that contained detectable material in the aliphatic and/or aromatic organic fractions.

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The data as presented in Table 2-1 and illustrated for the median values in Figure 1 show that like the TPH distributions, the chromatographically-derived aliphatic and aromatic distributions are also dominated by the higher molecular weight material. This is not surprising as the aliphatic and aromatic materials are theoretically a subset of the TPH measurement. As noted above, this finding is consistent with expectations based on the circumstances of the release, the likely source of the released material, and the likely date of the release.

Table 2-2. Summary of Chromatographic Data for Total Aliphatic and Aromatic results for Soils (samples with detectable aliphatics/aromatics).

		C4-C40 TPH	Total Aliphatics		Total Aromatics	
Station	**Top Depth**	**mg/kg**	**Sum (mg/kg)**	**% Total TPH**	**Sum (mg/kg)**	**% Total TPH**
B-68	10	5007	2392	47.8%	974.5	19.5%
B-68	15	14143	7253	51.3%	2450	17.3%
B-69	6	39924	8464	21.2%	6635	16.6%
B-69	15	26408	7810	29.6%	2592	9.8%
B-70	10	7760	2552	32.9%	1189	15.3%
B-70	13	1752	809	46.2%	364	20.8%
B-71	5	3029	692.4	22.9%	657.3	21.7%
B-71	10	1277	588.8	46.1%	430.6	33.7%
B-72	5	688.4	241.8	35.1%	243.2	35.3%
B-73	5	8423	1965	23.3%	669.4	7.9%
B-73	10	1978	664	33.6%	231.5	11.7%
Various Measures of Central Tendency for all Samples						
Average		**10035**	**3039**	**35.4%**	**1494**	**19.1%**
Std Dev		**12482**	**3189**	**10.9%**	**1894**	**8.8%**
Median		**5007**	**1965**	**33.6%**	**669**	**17.3%**
Geomean		**4963**	**1682**	**33.9%**	**860**	**17.3%**

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Table 2-3. Summary of Chromatographic Data for Total Aliphatic and Aromatic results for Tars (samples with detectable aliphatics/aromatics).

		C4-C40 TPH	Total Aliphatics		Total Aromatics	
Station	**Top Depth**	**mg/kg**	**Sum (mg/kg)**	**% Total TPH**	**Sum (mg/kg)**	**% Total TPH**
ST-18	0.5	209016	85070	41%	89930	43%
ST-19	0.5	108	29.5	27%	Not Det.	
ST-20	0.5	44205	11865	27%	42980	15%
ST-21	0.5	310190	77100	25%	34407	14%
ST-22	0.5	143005	41060	29%	15125	24%
ST-23	0.5	53605	19696	37%	20797	28%
ST-24	0.5	172005	27020	16%	107450	12%
ST-25	0.5	290036	124700	43%	1057.5	37%
ST-26	0.5	11105	2230.5	20%	100970	10%
ST-27	0.5	225024	105520	47%	78870	45%
ST-28	0.5	190005	75810	40%	34350	42%
ST-29	0.5	149005	32820	22%	89930	23%
Various Measures of Central Tendency for all Samples						
Average		**149776**	**50243**	**31%**	**48433**	**27%**
Std Dev		**103906**	**41938**	**10%**	**38943**	**13%**
Median		**160505**	**36940**	**28%**	**34407**	**24%**
Geomean		**67130**	**19815**	**30%**	**28173**	**23%**

The data presented above in Tables 2.2 and 2.3 provide an assessment of, on average, how much of the total TPH (as determined chromatographically) in either the soil samples (Table 2-2) or tar samples (Table 2-3) can be accounted for by the aliphatic and aromatic organic fractions.

2.2.2 Tar Samples

Twelve surface tar samples were collected and subjected to the chromatographic analysis of the aliphatic and aromatic organic fractions. Of these 12 samples, 100% (12/12) and 92% (11/12) had detectable concentrations of both aliphatic and aromatic organic material, respectively. One sample, ST-19 had no detectable concentrations in any carbon range for the aromatic organic fraction.

The data as illustrated in Figure 2 show that like the TPH distributions, the chromatographically-derived aliphatic and aromatic distributions are also dominated by the higher molecular weight material. As noted above, this finding is consistent with expectations based on the circumstances of the release, the likely source of the released material, and the likely date of the release.

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2.3 GRAVIMETRIC ANALYSIS OF ALIPHATIC, AROMATIC, NSO/ASPHALTENE ORGANIC FRACTIONS

As noted above, the gravimetric analysis was limited to tar samples. There was only one non-detectable fraction in these 12 tar samples: the aromatic fraction of tar sample ST-19 (detection limit ≤ 50 mg/kg). Table 2-4 presents a summary of these gravimetric distributions.

Table 2-4. Gravimetric Distributions for surface Tar Samples.

	Total Extract	Aliphatics	Aromatics	NSO/Asphaltenes
Concentration Range (mg/kg)	1,500-640,000	100-100,000	50-130,000	1,375-465,000
Percent of Total Range		6.6-18%	1.7-26%	56-92%
Median Value	450,000	12%	13%	74%

These results are consistent with earlier conclusions regarding the nature of the petroleum material present at the Site. Specifically, these results indicate that the hydrocarbons are characterized and dominated by organic compounds that are structurally and chemically complex (i.e., the NSO/Asphaltenes) and of high molecular weight. This observation is consistent with a conclusion that the hydrocarbons are derived from a weathered source (such is sometimes seen in crude oils from the San Joaquin basin) and/or they have been weathered in place. Either or both of these conclusions are consistent with our understanding of the likely source, circumstance, and age of the release.

Figure 3 provides an illustration of where these tar samples fit in compositionally with other oils from around the world. As indicated, the Site tar samples are characterized by higher percentages of NSO/Asphaltenes, relative to the aliphatic and aromatic fractions. As pointed out in Tissot and Welte (1978)[10], this region of the ternary diagram is dominated by heavy (viscous) and degraded oils. Such an interpretation is consistent based on our understanding of the sources and environmental history of the surface tar at the Site.

3. USE OF TPH TO ESTIMATE PAH CONCENTRATIONS

3.1 DATA INCLUDED IN ASSESSMENT

Only co-located TPH and PAH soil and surface tar data are included in this assessment. Based on the results of the overall carbon-range distribution analyses, the Sum TPH (EC10-EC40) data were used in these analyses. The limited contribution of the EC4-EC10 to the overall TPH composition at the site makes it unlikely that the omission of this fraction compromises the regression analyses. Moreover, as indicated in Section 1, there is much more data available in the EC10-EC40 range than in the EC4-EC40 range. Because the true concentrations are unknown, including non-detect data would be inappropriate to assess correlations or develop relationships between TPH and PAH. Thus, only paired TPH-PAH where both analytes were detected are included in the regression analyses (Tables 3-1 and 3-2). The sum PAH parameter was calculated

[10] Tissot, B.P. and D.H. Welte (1978) Petroleum Formation and Occurrence. Springer-Verlag, 538 p.

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following the procedures presented in the July 9, 2003 Draft Data Verification and Analysis Technical Memorandum prepared by BBL. Briefly, the sum PAH parameter was obtained by summing the 16 PAHs listed in Table 3-1. The sum PAH parameter was considered non-detected if none of the 16 PAH analytes listed in Table 3-1 were detected. In those cases were 1 or more PAHs were detected, the sum PAH parameter was calculated by including ½ the detection limit for any non-detected PAHs in the sample.

All data were natural log transformed prior to regression. Regression analyses were conducted independently for soil and tar data. Based on a preliminary assessment of the soil data, it was determined that for the purposes of the risk assessment, the on-site soils TPH-PAH correlation analysis would focus on samples from ≤10 ft. bgs. This eliminates concerns related to possible effects due to differences in weathering between soils at the surface and those at depth, but provides a greater number of samples (and therefore more statistical power) than the pERA dataset. Note that the regression analyses for surface tars are evaluated primarily for comparison with soil regressions, as only two tar samples (Trench-2 at 2.2 ft. bgs and Trench-5 at 3 ft. bgs) lack PAH data.

3.1.1 Regression Results for Soil Samples

When all ≤10 ft. bgs on-site soils are considered, paired TPH-PAH data are available for 85 samples, except for TPH-naphthalene, for which there are 117 pairs.[11] However, as illustrated in Table 3-1, the number of paired detections ranges from 6 for TPH-dibenzo[a,h]anthracene to 53 for TPH-Sum PAH. TPH-phenanthrene and pyrene are the most frequently detected TPH-individual PAH pair, followed by chrysene, benzo[b]fluoranthene, and naphthalene. The TPH-Sum PAH is the most frequently detected pair (53 samples) suggesting a significant amount of heterogeneity in the PAHs detected in each sample, as there are only 34 TPH-phenanthrene and TPH-pyrene pairs. Attachment A provides illustrations of all of the TPH-PAH ln-ln regression plots. Note that for each plot, the regression equation and upper and lower 95th confidence intervals are plotted.

[11] For some samples no semi-volatile organic compound (SVOC) analyses were conducted, but naphthalene was reported as part of the volatile organic compound (VOC) analytical suite.

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Table 3-1. TPH-PAH Regressions for On-site Soils and Sediments < 10 ft. bgs.

	Paired Samples	Paired Detects	Freq. of Detect	Slope	Intercept	p	R^2
LN-Naphthalene	117	22	19%	1.0834	-9.7	**3.90E-03**	0.35
LN-Acenaphthylene	85	15	18%	0.4913	-6.4	**1.46E-02**	0.38
LN-Acenaphthene	85	17	20%	0.9581	-10.	**1.89E-05**	**0.72**
LN-Fluorene	85	20	24%	0.8324	-8.2	**4.27E-05**	**0.61**
LN-Phenanthrene	85	34	40%	0.8112	-6.9	**6.31E-11**	**0.74**
LN-Anthracene	85	11	13%	0.7004	-8.0	**1.41E-03**	**0.70**
LN-Fluoranthene	85	17	20%	0.6524	-7.1	**5.96E-03**	0.40
LN-Pyrene	85	34	40%	0.6700	-7.1	**2.25E-06**	0.51
LN-Benzo[a]anthracene	85	17	20%	0.7786	-8.4	**2.79E-03**	0.46
LN-Chrysene	85	28	33%	0.7254	-7.6	**4.47E-07**	**0.63**
LN-Benzo[b]fluoranthene	85	26	31%	0.8500	-8.7	**1.58E-06**	**0.62**
LN-Benzo[k]fluoranthene	85	9	11%	0.6458	-7.2	**1.33E-02**	**0.61**
LN-Benzo[a]pyrene	85	19	22%	0.8063	-8.0	**3.16E-05**	**0.65**
LN-Indeno(1,2,3-cd)pyrene	85	14	16%	0.8585	-8.8	**2.38E-04**	**0.69**
LN-Benzo(g,h,i)perylene	85	18	21%	0.9152	-9.2	**2.95E-06**	**0.75**
LN-Dibenzo(a,h)anthracene	85	6	7%	0.6100	-7.3	**1.963E-02**	**0.78**
LN-Sum PAH	85	53[12]	62%	0.9286	-6.7	**1.11E-16**	**0.74**

Note: Bold PAHs refer to regressions that were statistically significant ($p<0.05$) **and** had a regression coefficient value > 0.6.

Table 3-1 illustrates that statistically significant log-linear relationships were obtained for all 16 individual PAHs and Sum PAH ($p<0.05$). However, coefficients of determination (R^2) less than 0.60, indicating that the TPH concentration alone did not substantially account for the variability in the corresponding PAH concentrations, were observed for the following five PAHs: naphthalene, acenaphthylene, fluoranthene, pyrene, and benzo(a,h)anthracene. The choice of the R^2 criterion of 0.60, while arbitrary, does provide some indication of the potential usefulness of the regressions. Specifically, this information warns the reader that while a significant correlation may exist between TPH and PAH, the high degree of variability associated with the correlation suggests that other factors appear to have a degree of control on the correlations. For this reason, the use of these correlations as a predictive tool must take this uncertainty into account. As will be described below, there are additional important concerns with the analysis that add to the uncertainties associated with using these regressions to obtain PAH concentration estimates from TPH (EC10-EC40) concentrations.

[12] Unlike the individual PAHs presented in this table, the Sum PAH-TPH correlation was performed using a Sum PAH value derived from summing both the detected values and ½ the detection limit for non-detected PAHs in the sample. The sample was only included in the regression if at least one of the PAHs were detected in the sample. If no PAH compounds were detected in the sample, it was excluded from the regression analysis. Thus there is an inherent uncertainty in the Sum PAH value and its regression analysis due to the inclusion of the ½ non-detect values.

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3.1.2 Heterogeneity in the Measured Soil PAH Results

A close review of Table 3-1 shows that there is considerable heterogeneity in the detections of PAHs in these samples. For the ≤10 ft. bgs soils, PAHs were not detected in the 22 samples where Sum TPH (EC10-EC40) was not detected. Additionally, PAHs were not detected in on-site soil samples ≤10 ft. bgs with TPH concentrations <143 mg/kg. At this concentration there appears to be a great deal of heterogeneity in the PAHs detected. For example, a Sum TPH (EC10-EC40) concentration of approximately 143 mg/kg was detected in both the S-45 at 0.5 ft. bgs and S-67 at 0.5 ft. bgs samples. However despite having similar Sum TPH (EC10-EC40) concentrations, only 5 PAHs were detected in the former sample (S-45 at 0.5) while 12 PAHs were detected in the latter sample (S-67 at 0.5 ft. bgs; see Table 3-2).

The PAHs detected also vary in samples with higher Sum TPH and Sum PAH concentrations. For example, only 4 PAHs were detected in the sample with the greatest Sum TPH concentration (S-43 at 0.5 feet bgs), and only one PAH was detected in the sample with the highest Sum PAH concentration (B-42 at 10 feet bgs) (see Table 3-2, below). Finally, not only does there appear to be heterogeneity with respect to the individual PAHs detected across samples, but neither high (HMW) nor low molecular weight (LMW) PAHs are consistently detected. For example, while the half-foot samples from S-43, S-45, and S-67 are dominated by HMW PAHs, a single low molecular weight PAHs was detected in the sample with the highest Sum PAH concentration.

Table 3-2. PAHs Detected in Various Soil Samples.

Sample ID	S-45 at 0.5 ft.	S-67 at 0.5 ft.	S-43 at 0.5 ft.	B-42 at 10 ft.
Sum TPH Conc.	143.5 mg/kg	143.8 mg/kg	111,389 mg/kg	53,798 mg/kg
Sum PAH Conc.	0.75 mg/kg	0.81 mg/kg	28.4 mg/kg	57.2 mg/kg
PAHs Detected:	Fluoranthene	Phenanthrene	Fluorene	Phenanthrene
	Pyrene	Anthracene	Pyrene	
	Chrysene	Fluoranthene	Benzo(b)fluoranthene	
	Benzo(b)fluoranthene	Pyrene	Benzo(a)pyrene	
	Benzo(a)pyrene	Benzo(a)anthracene		
		Chrysene		
		Benzo(b)fluoranthene		
		Benzo(k)fluoranthene		
		Benzo(a)pyrene		
		Indeno(1,2,3-cd)pyrene		
		Benzo(g,h,i)perylene		

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		Dibenzo(a,h)anthracene		

Based on the fact that PAHs were not detected in any of the 30 soil or sediment samples (≤10 ft. bgs) with Sum TPH (EC10-EC40) concentrations less than 143 mg/kg, it is recommended that PAHs not be estimated from soil samples with Sum TPH (EC10-EC40) concentrations less than 140 mg/kg. In addition, because they were infrequently detected (<10%) it is recommended that concentrations of dibenzo(a,h)anthracene not be estimated from Sum TPH (EC10-EC40) concentrations, despite the fact that the associated regressions were statistically significant.

3.1.3 Comparison of Measured versus Estimated PAH results

Table 3-3 presents a comparison of the measured and estimated PAH concentrations. These values provide a means of assessing how accurately the regressions estimate the measured values. In earlier discussions regarding the use of a 0.6 R^2 value as a minimum indicator of the robustness of the regression, it was stated that this value was arbitrary. The results presented in Table 3-3 provide a realistic understanding of just how arbitrary the value really is. Use of these regression equations to derive estimated PAH concentrations leads to substantial over- and under-estimates of the measured concentrations. More interestingly, for PAHs not detected above a given detection limit, the regressions can also lead to the derivation of estimated PAH concentration that is greater than the detection limit. Considering just the Sum PAH comparison, the differences between the measured and estimated values can range from -88% to +424% of the detected measured values. On average, the regression results in an over-prediction of the Sum PAH concentration by about 63%.

The risk assessors should look closely at these tables and consider the uncertainty associated with using these estimated individual and sum PAH concentrations to assess the potential risks at the Site.

3.2 REGRESSION RESULTS FOR TAR SAMPLES

Paired TPH-PAH data are available for 36 surface tar samples, ranging from 0 to 0.5 feet bgs. Unlike the soil data set, PAHs have been measured on most tar samples collected for use in the risk assessments.[13] Thus, there is little reason to estimate PAH concentration from the TPH results. However, for completeness, the analysis was done and the results are summarized below.

As presented in Table 3-4, the number of paired detections ranged from one for THP-acenaphthylene to 29 for TPH-Sum PAH. TPH-pyrene is the most frequently detected TPH-individual PAH pair, followed by phenanthrene, benzo[b]fluoranthene, and benzo[a]pyrene. Unlike surface soils, PAHs were detected in tar samples with TPH concentrations less than 143 mg/kg. Benzo(g,h,i)perylene was detected in both St-14 and St-19, with Sum TPH (EC10-EC40) concentrations of 20 and 103 mg/kg, respectively. However, no PAHs were detected in 7 samples, with Sum TPH (EC10-EC40) concentrations ranging from 868 to 400,000 mg/kg (PAH

[13] PAHs were not analyzed in "other solid waste" samples from Trench-2 at 2.2 ft. bgs and Trench-5 at 3 ft. bgs.

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detection limits ranged from 0.05 to 50 mg/kg).[14] No more than a single PAH (benzo(g,h,i)perylene or phenanthrene) was detected in tar samples with TPH concentrations less than 11,100 mg/kg.

Table 3-4. TPH-PAH Regressions for All Tar Samples.

	Paired Samples	Paired Detects	Frequency of Detect	Slope	Intercept	P	R2
LN-Naphthalene	36	7	19%	1.6308	-18.6171	**6.62E-03**	**0.799397**
LN-Acenaphthylene	36	1	3%	Not enough valid cases for statistics			
LN-Acenaphthene	36	8	22%	1.9866	-22.9491	**1.38E-03**	**0.839472**
LN-Fluorene	36	8	22%	1.6211	-17.6105	**6.69E-03**	**0.732644**
LN-Phenanthrene	36	22	61%	1.1191	-11.0909	**1.54E-07**	**0.755307**
LN-Anthracene	36	4	11%	0.8422	-9.7697	2.39E-01	0.578504
LN-Fluoranthene	36	14	39%	1.4652	-15.6555	**5.36E-07**	**0.885462**
LN-Pyrene	36	25	69%	1.0964	-11.0168	**3.04E-08**	**0.743328**
LN-Benzo[a]anthracene	36	13	36%	1.3328	-14.2819	**1.90E-04**	**0.732438**
LN-Chrysene	36	16	44%	1.2646	-13.1560	**5.96E-06**	**0.779223**
LN-Benzo[b]fluoranthene	36	19	53%	0.9578	-9.8638	**5.14E-06**	**0.714980**
LN-Benzo[k]fluoranthene	36	9	25%	1.2990	-14.6858	**3.51E-03**	**0.726483**
LN-Benzo[a]pyrene	36	19	53%	1.0051	-10.5371	**2.73E-05**	**0.654595**
LN-Indeno(1,2,3-cd)pyrene	36	12	33%	1.0100	-11.0534	**1.49E-03**	**0.652158**
LN-Benzo(g,h,i)perylene	36	18	50%	0.7637	-7.8658	**3.24E-09**	**0.894178**
LN-Dibenzo(a,h)anthracene	36	4	11%	1.7132	-20.0717	**7.84E-03**	**0.984385**
LN-Sum PAH	36	29	81%	0.8680	-6.4443	**8.92E-14**	**0.876414**

Note: Bold PAHs refer to regressions that were statistically significant ($p<0.05$) **and** had a regression coefficient value > 0.6.

Table 3-4 illustrates that statistically significant log-linear relationships were obtained for 14 individual PAHs and Sum PAH ($p<0.05$). Because acenaphthylene was detected in only one sample, no relationship with TPH concentration could be evaluated. The 4 detected TPH-anthracene pairs did not result in a statistically significant relationship ($p=0.24$). Unlike soils, all coefficients of determination (R^2) for statistically significant relationships were greater than 0.6. In general, slopes of TPH-PAHs regressions in tars are greater than one, whereas they are less than one in soils. This indicates that for a given TPH concentration, there is a greater concentration of PAHs in tars than in soils. For this reason, tar and soil samples have not been combined in the regression analysis.

[14] Elevated PAH detection limits are associated with surface tar samples Tar-1 through –6, although pyrene was detected in Tar-4.

Figure 1. Soil Aliphatic & Aromatic Distributions

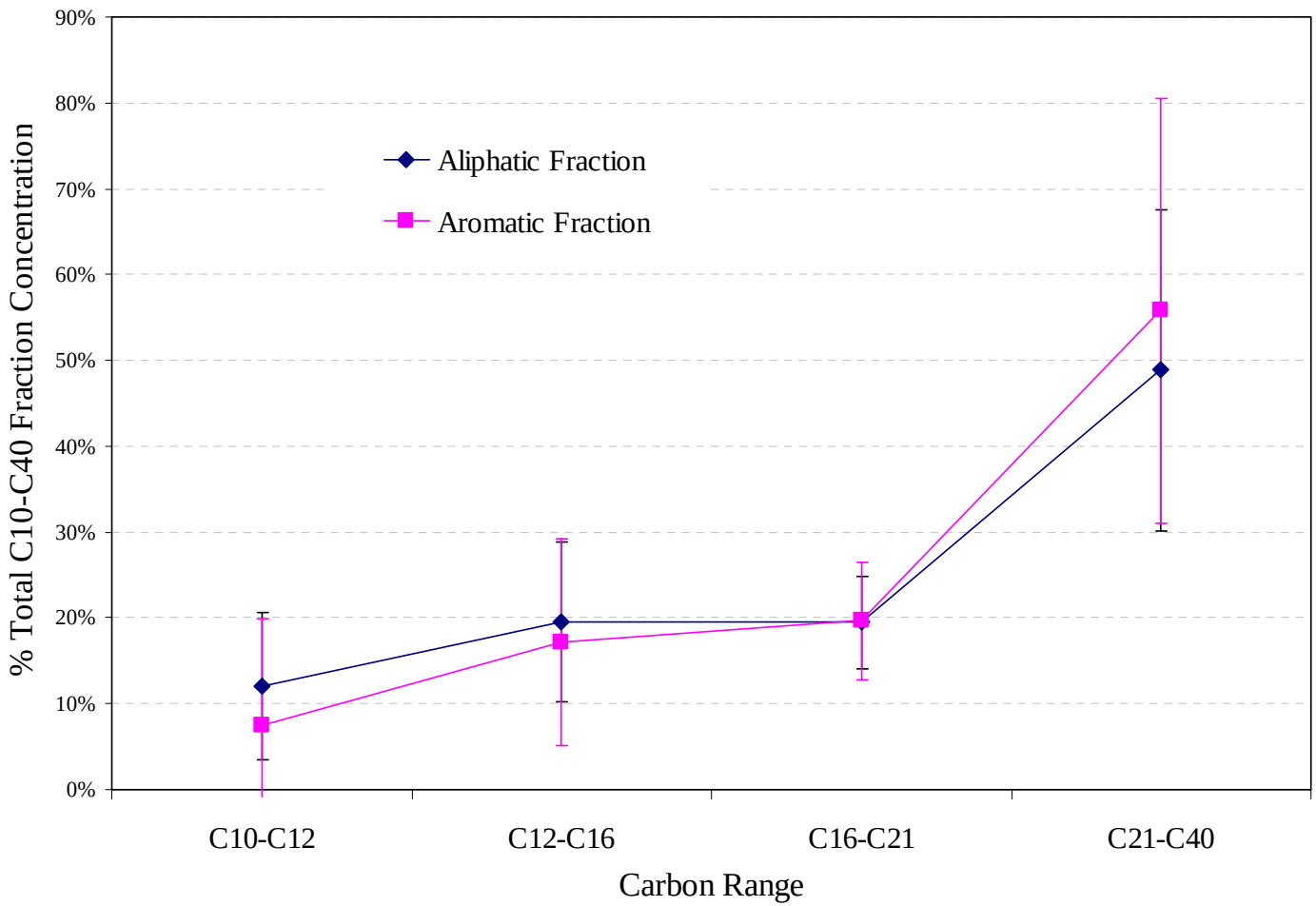


Figure 2. Tar Aliphatic & Aromatic Distributions

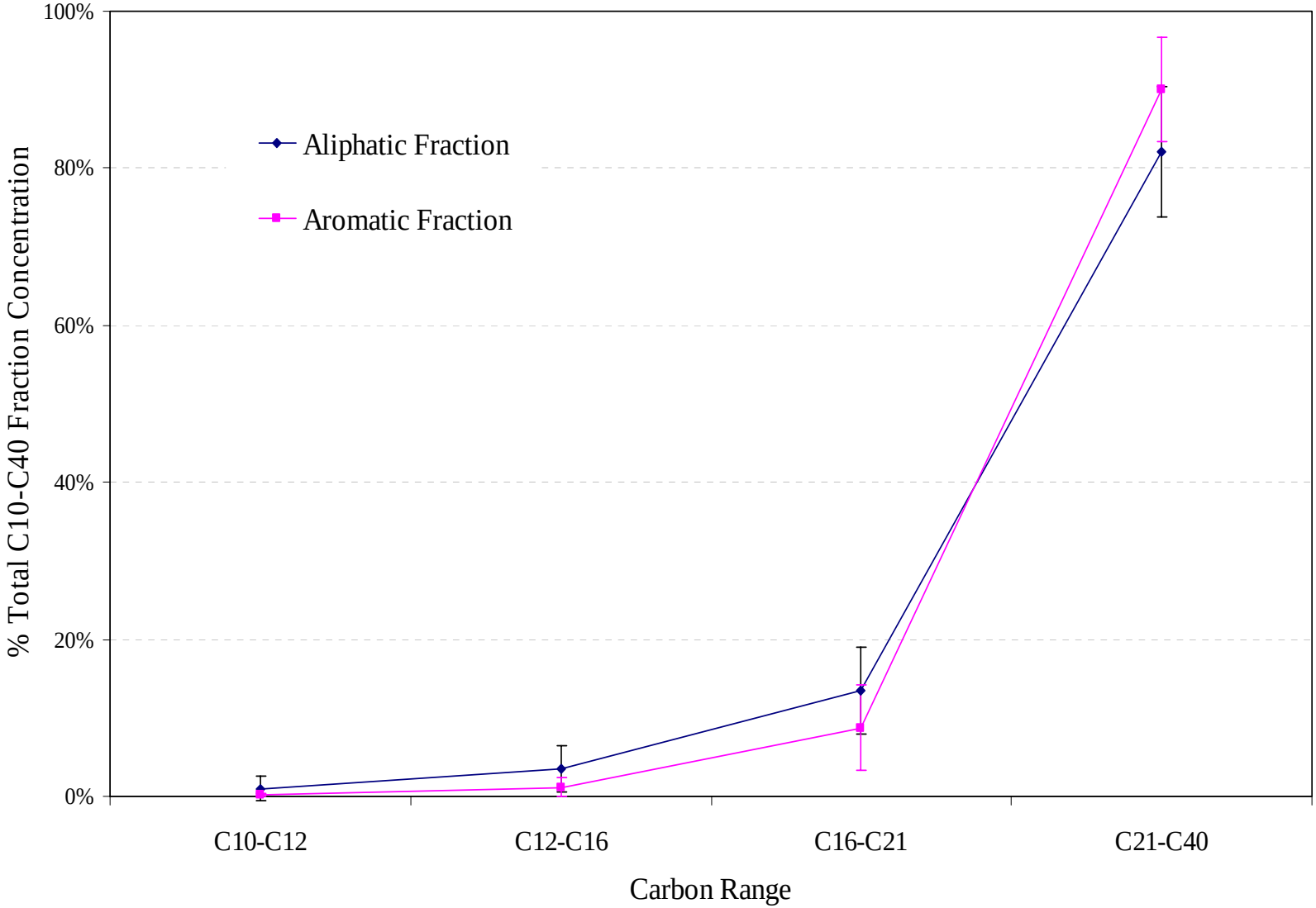
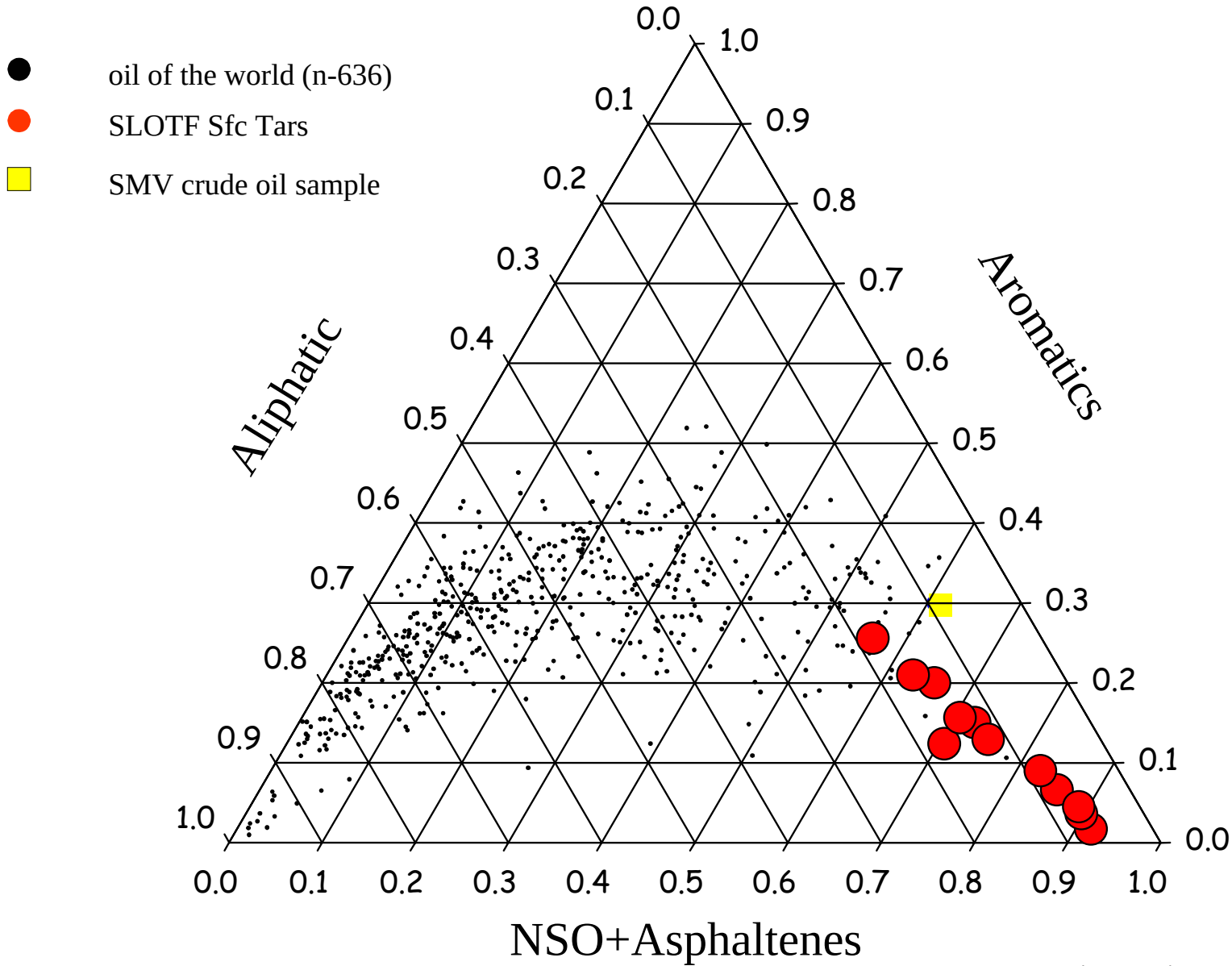


Figure 3. Surface Tar Compositional Comparison with Oils of the World



Attachment A

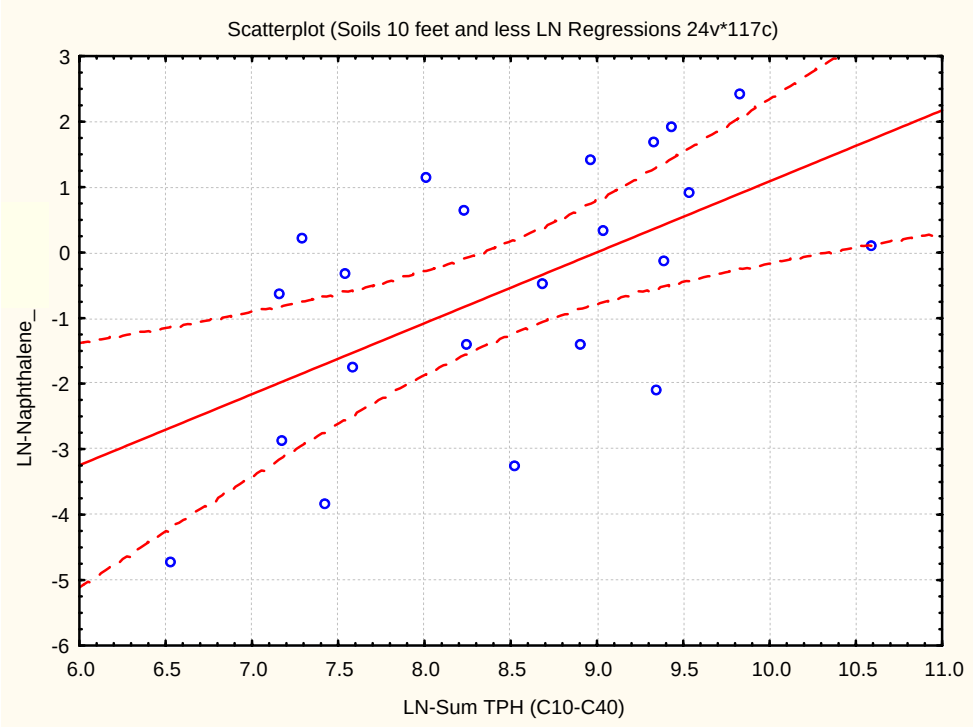
Ln – Ln TPH-PAH Regression Figures

Soil/Sediment Samples ≤ 10 ft. bgs.

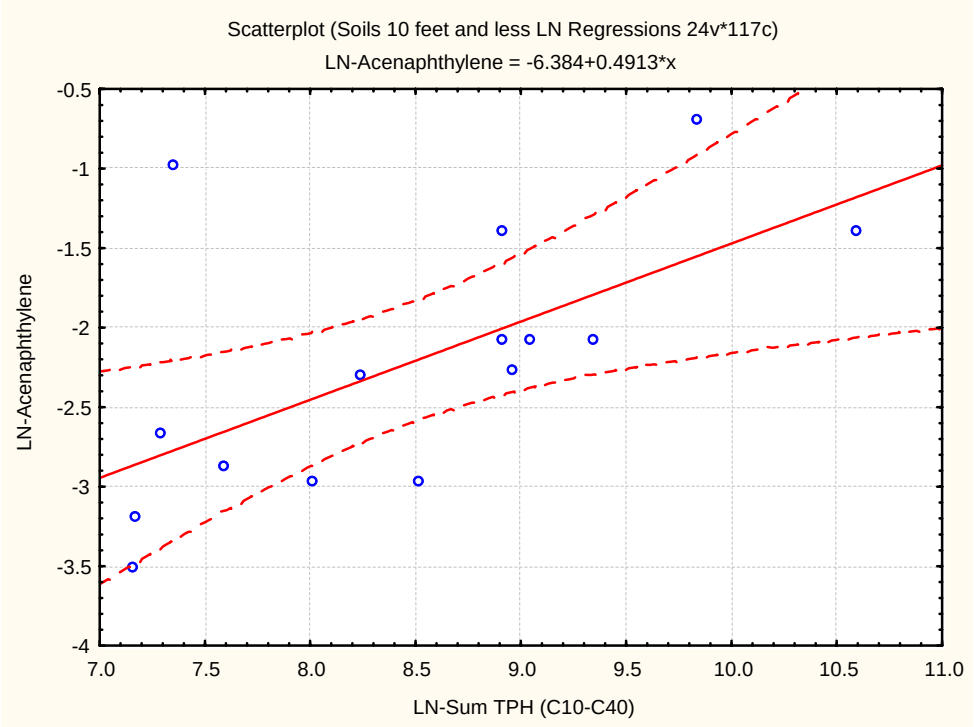
With Regression and Upper and Lower 95th Confidence Intervals

SLO Tank Farm: On-site Soil and Sediment Less than or Equal to 10 feet - Detects Only – Natural Log Transformed

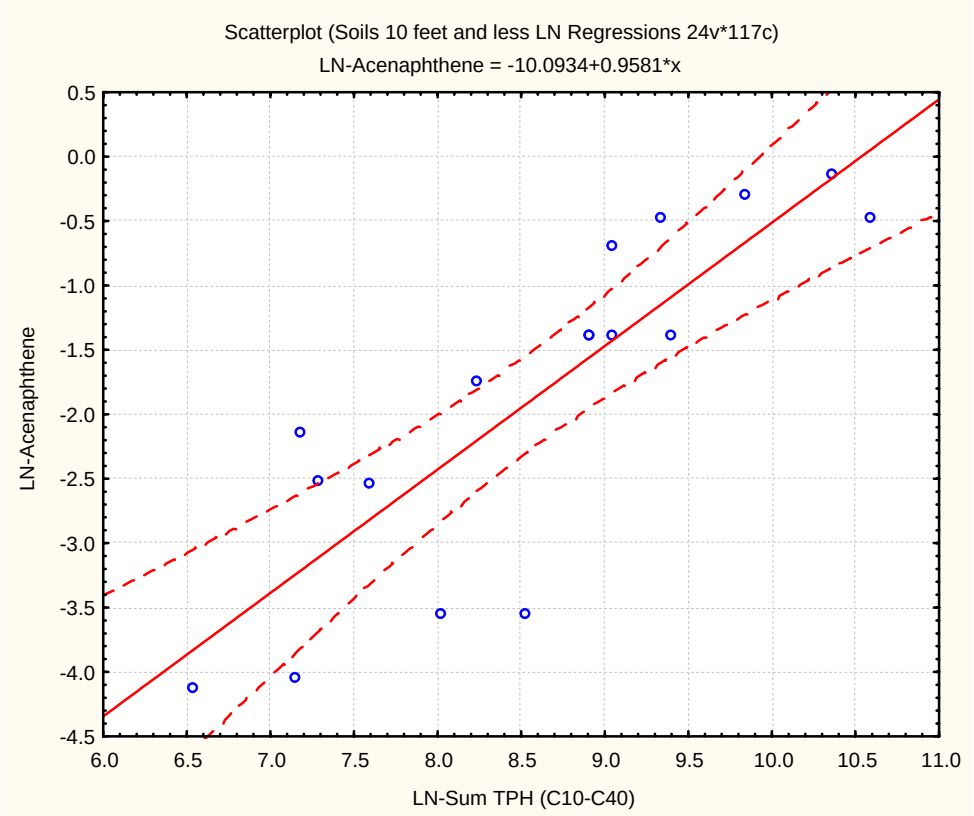
Paired TPH – PAH data



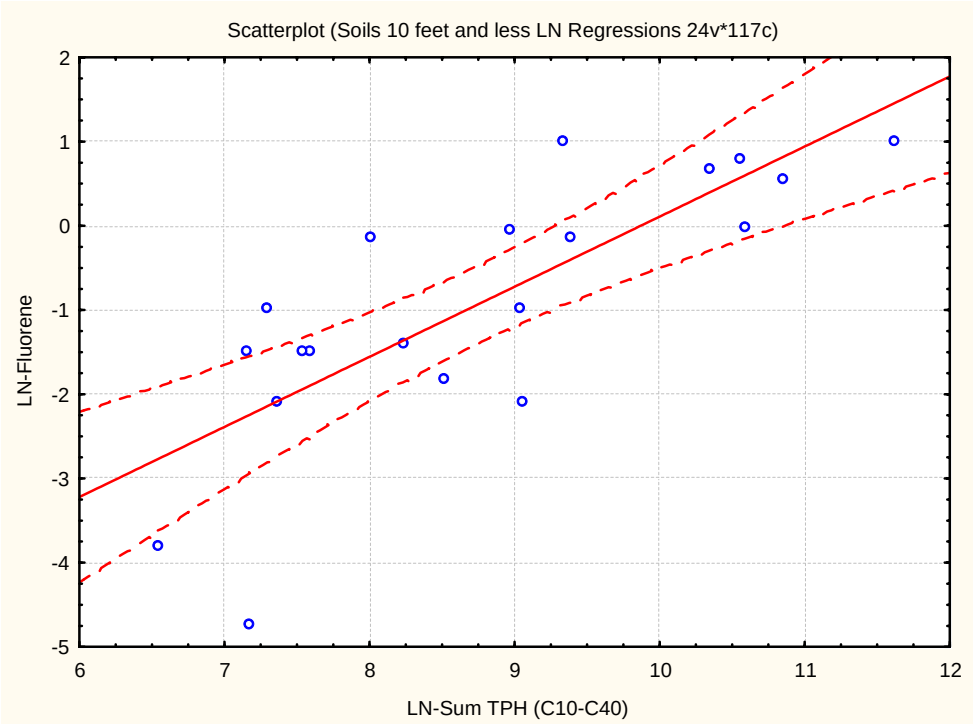
LN-Sum TPH (C10-C40):LN-Naphthalene: $r^2 = 0.3472$; r = 0.5893, p = 0.0039; y = -9.74597278 + 1.08344929*x



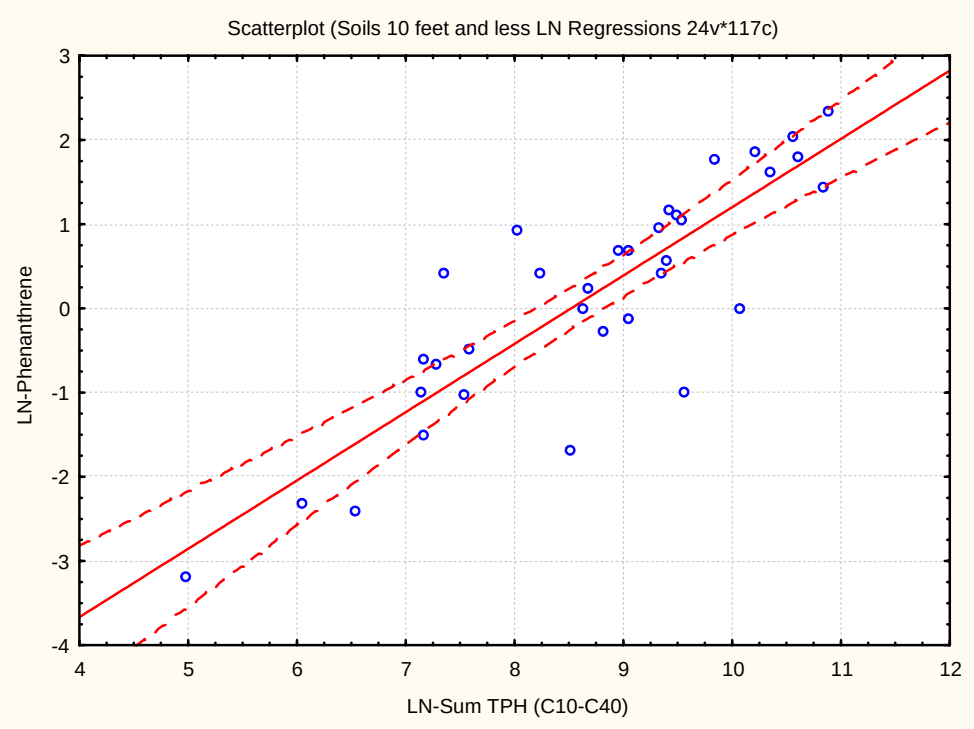
LN-Sum TPH (C10-C40):LN-Acenaphthylene: $r^2 = 0.3786$; r = 0.6153, p = 0.0146; y = -6.3839823 + 0.491274641*x



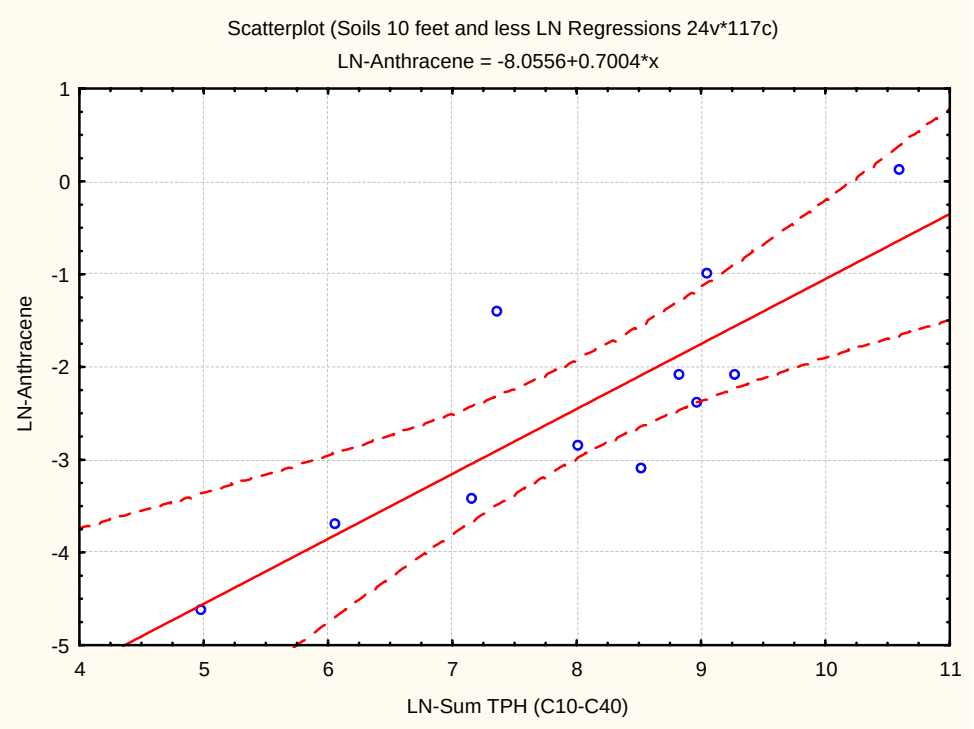
LN-Sum TPH (C10-C40):LN-Acenaphthene: $r^2 = 0.7154$; r = 0.8458, p = 0.00002; y = -10.0933741 + 0.958102216*x



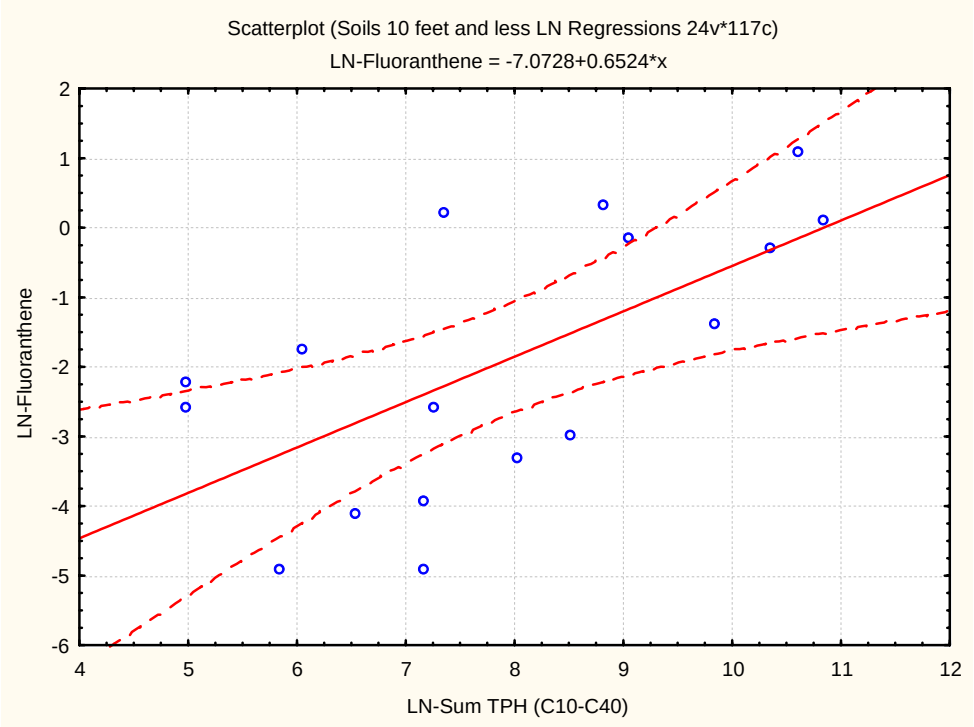
LN-Sum TPH (C10-C40):LN-Fluorene: $r^2 = 0.6150$; r = 0.7842, p = 0.00004; y = -8.21528633 + 0.832374421*x



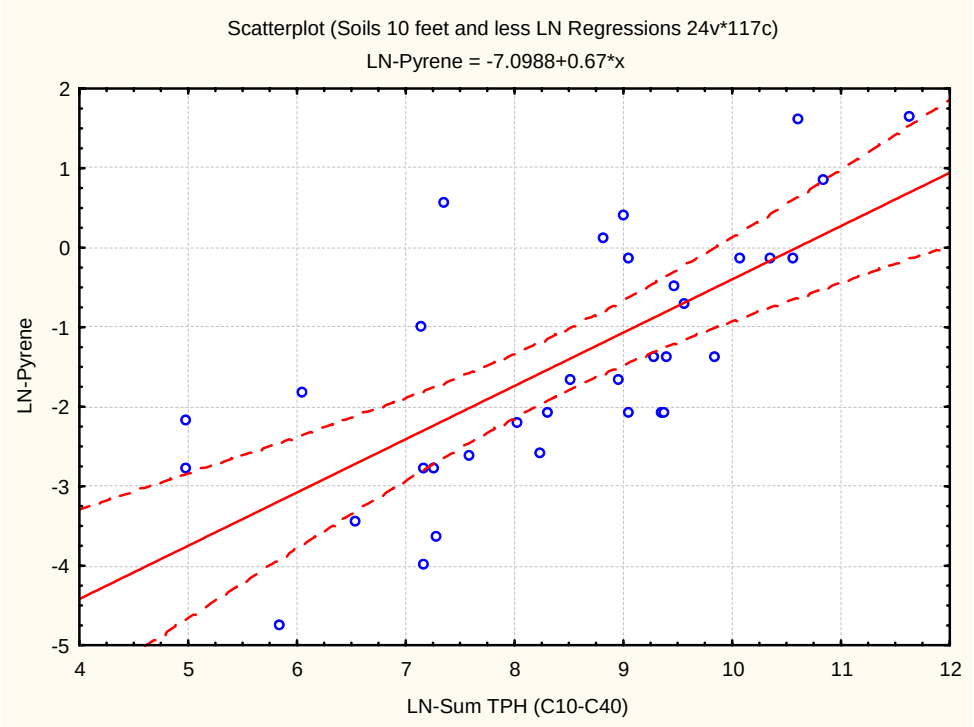
LN-Sum TPH (C10-C40):LN-Phenanthrene: $r^2 = 0.7417$; $r = 0.8612$, $p = 0.0000$; $y = -6.91100142 + 0.811190438*x$



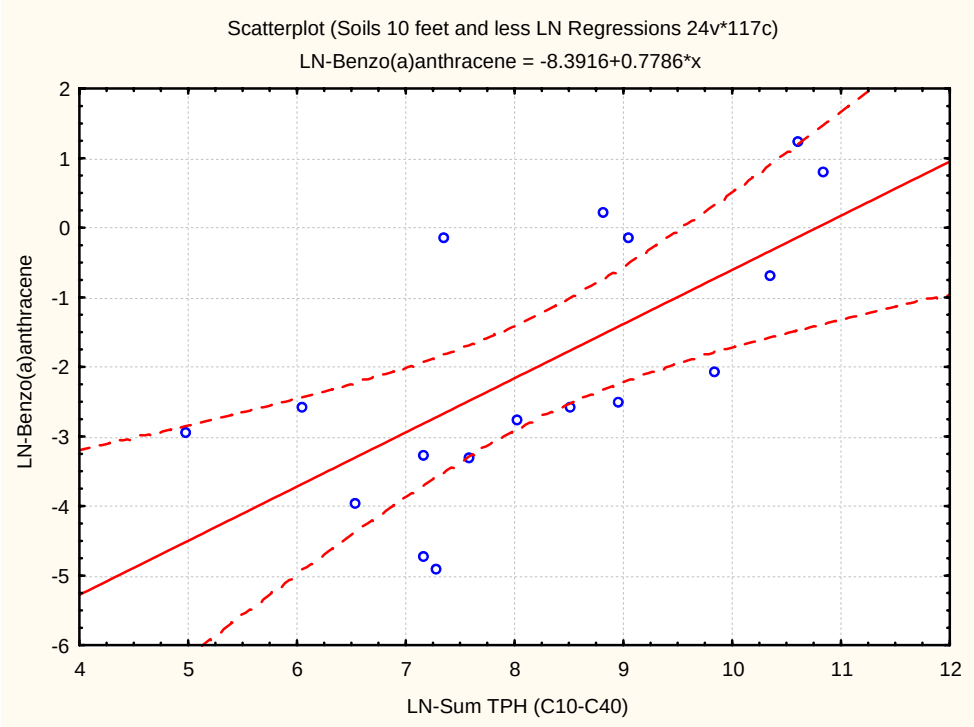
LN-Sum TPH (C10-C40):LN-Anthracene: $r^2 = 0.6960$; $r = 0.8343$, $p = 0.0014$; $y = -8.05559248 + 0.700359639*x$



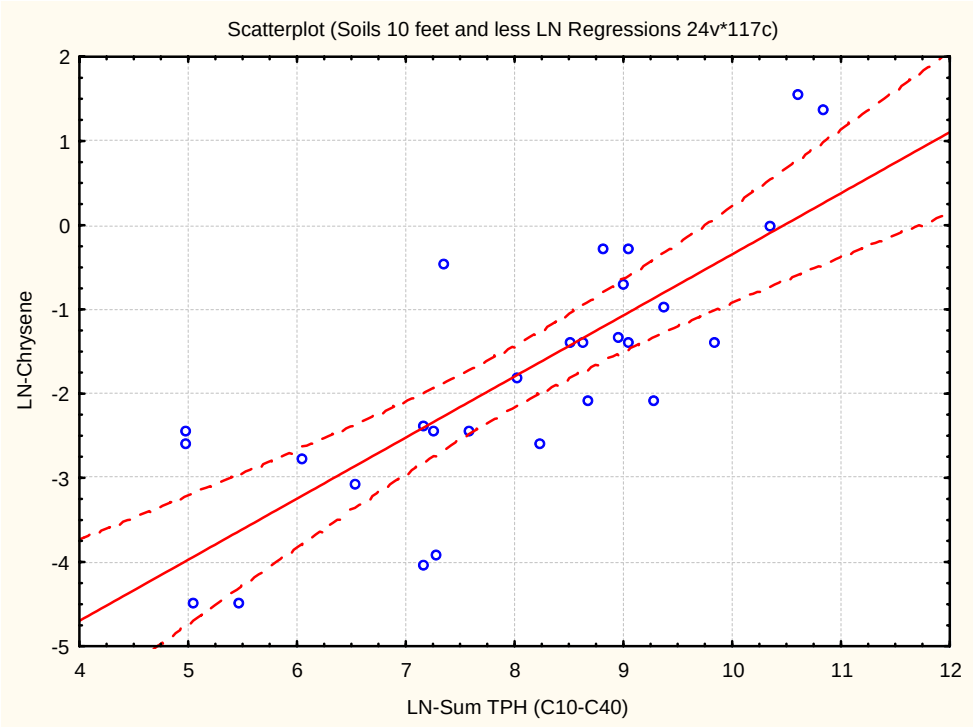
LN-Sum TPH (C10-C40):LN-Fluoranthene: $r^2 = 0.4058$; $r = 0.6370$, $p = 0.0060$; $y = -7.07283943 + 0.652424492*x$



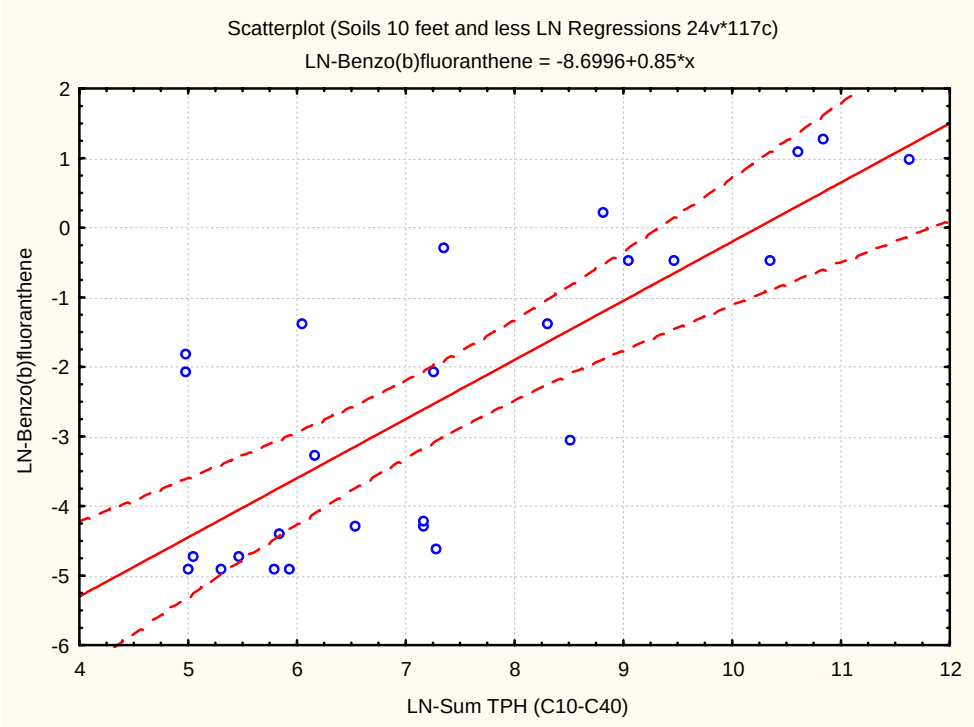
LN-Sum TPH (C10-C40):LN-Pyrene: $r^2 = 0.5080$; $r = 0.7127$, $p = 0.000002$; $y = -7.09884655 + 0.670048222*x$



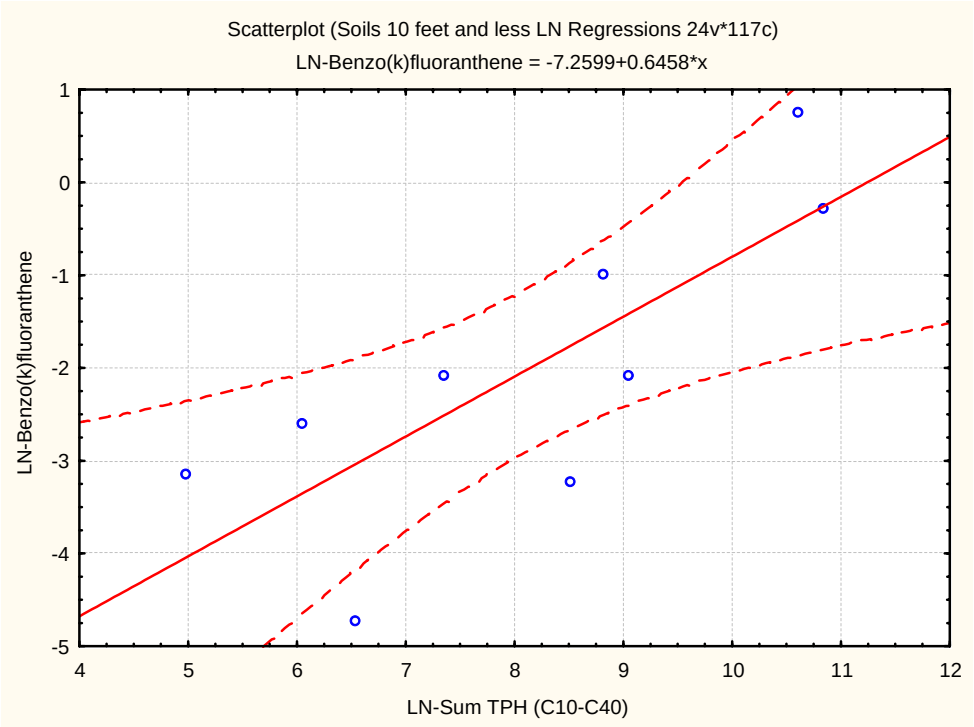
LN-Sum TPH (C10-C40):LN-Benzo(a)anthracene: $r^2 = 0.4594$; $r = 0.6778$, $p = 0.0028$; $y = -8.39157833 + 0.778557841*x$



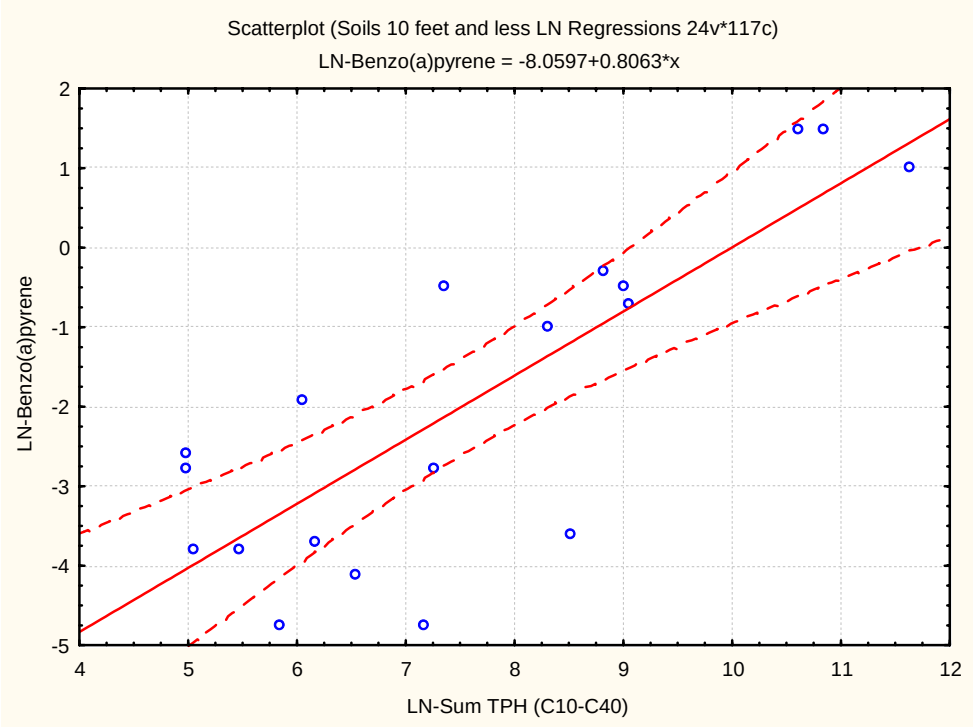
LN-Sum TPH (C10-C40):LN-Chrysene: $r^2 = 0.6312$; $r = 0.7945$, $p = 0.0000004$; $y = -7.60004858 + 0.725392036*x$



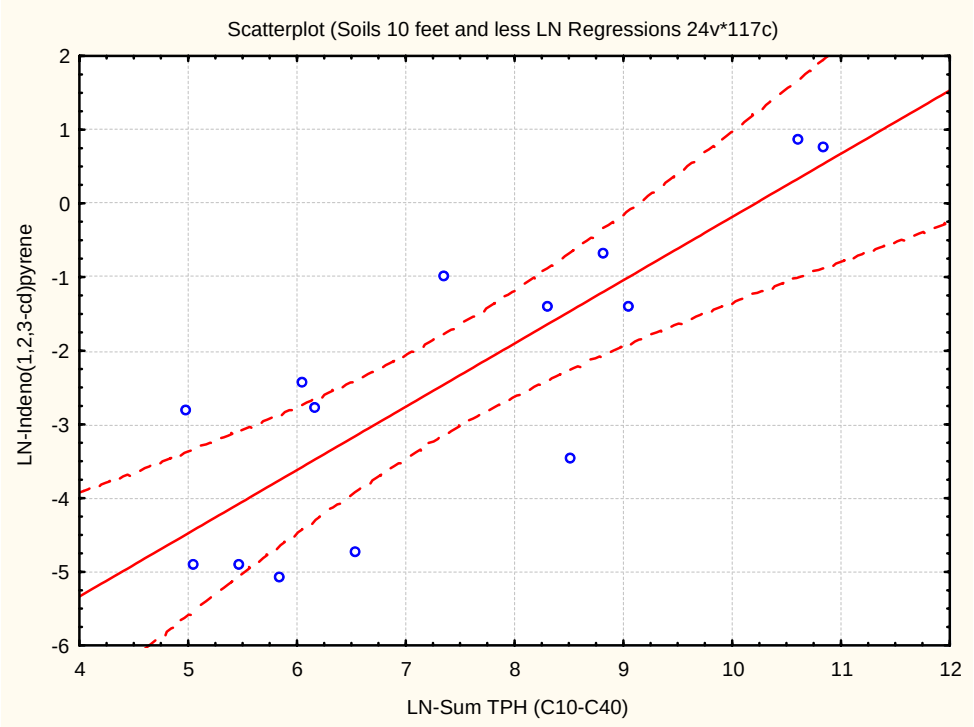
LN-Sum TPH (C10-C40):LN-Benzo(b)fluoranthene: $r^2 = 0.6242$; $r = 0.7901$, $p = 0.000002$; $y = -8.69961129 + 0.849955427*x$



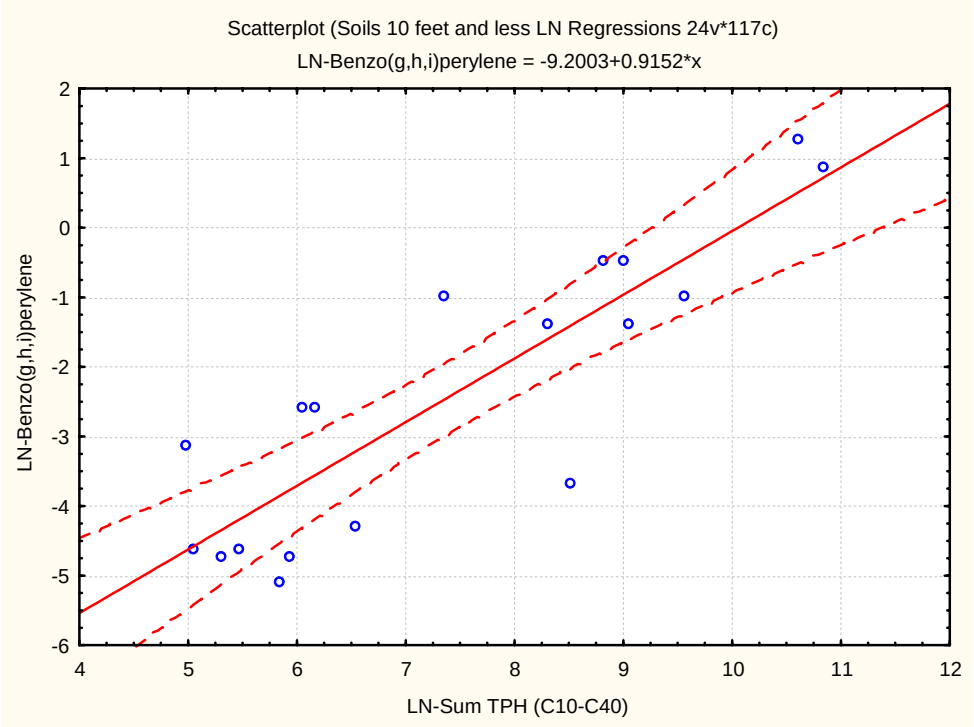
LN-Sum TPH (C10-C40):LN-Benzo(k)fluoranthene: $r^2 = 0.6071$; $r = 0.7792$, $p = 0.0133$; $y = -7.25985376 + 0.645804925*x$



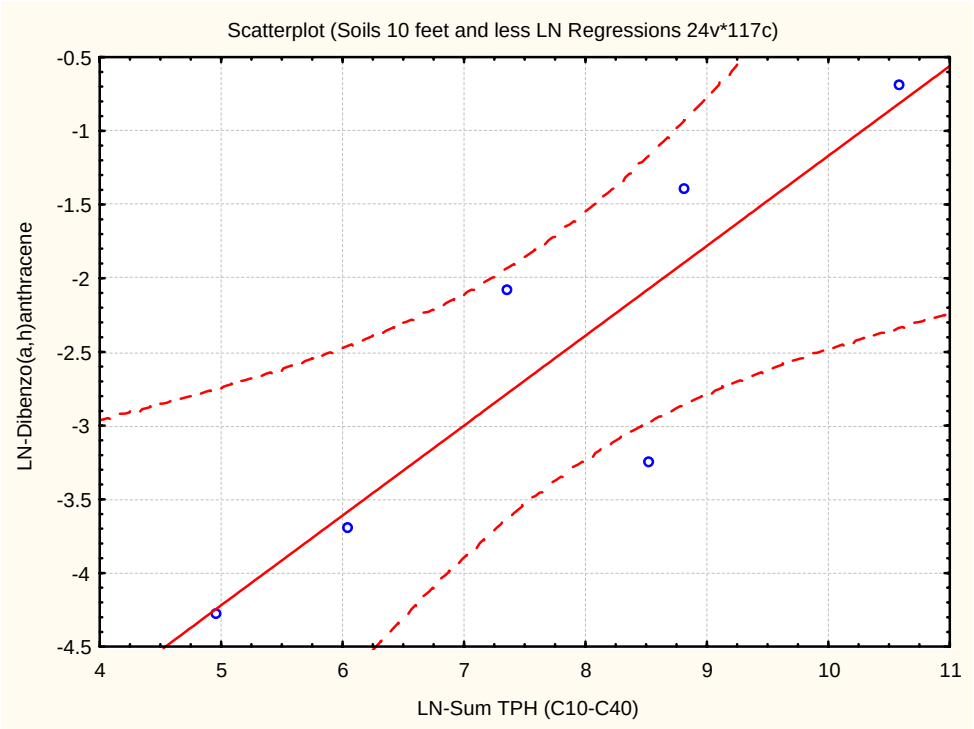
LN-Sum TPH (C10-C40):LN-Benzo(a)pyrene: $r^2 = 0.6489$; r = 0.8055, p = 0.00003; y = -8.05974261 + 0.806319808*x



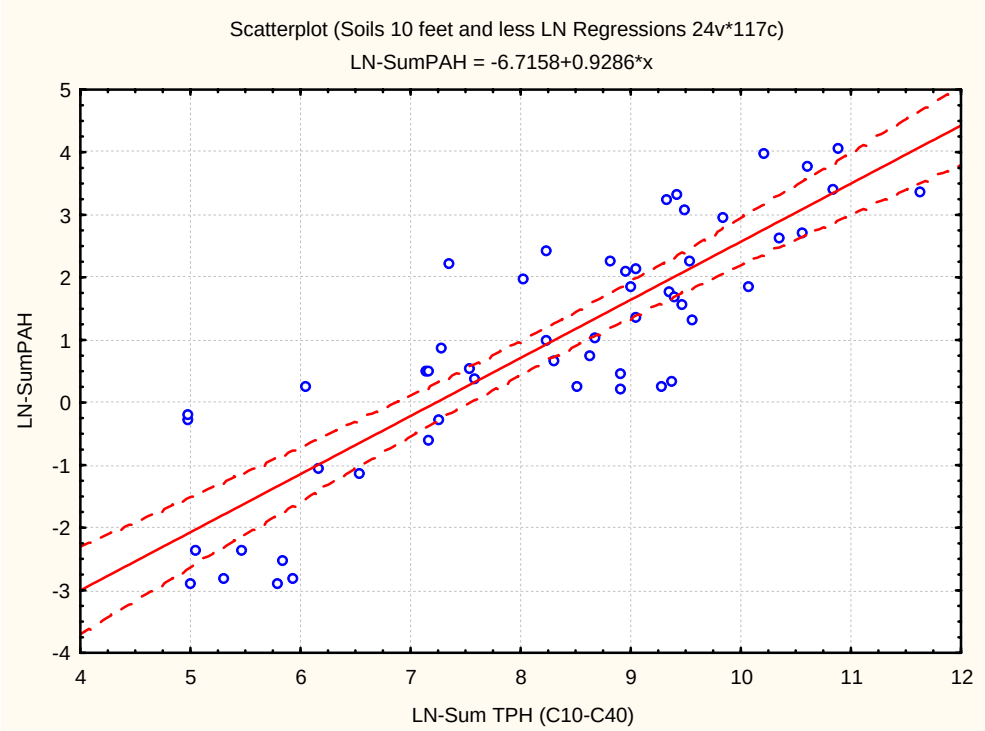
LN-Sum TPH (C10-C40):LN-Indeno(1,2,3-cd)pyrene: $r^2 = 0.6892$; r = 0.8302, p = 0.0002; y = -8.76999179 + 0.858464677*x



LN-Sum TPH (C10-C40):LN-Benzo(g,h,i)perylene: $r^2 = 0.7543$; r = 0.8685, p = 0.000003; y = -9.20033 + 0.915242095*x



LN-Sum TPH (C10-C40):LN-Dibenzo(a,h)anthracene: $r^2 = 0.7802$; r = 0.8833, p = 0.0196; y = -7.27038193 + 0.609996795*x



LN-Sum TPH (C10-C40):LN-SumPAH: $r^2 = 0.7446$; $r = 0.8629$, $p = 0.0000$; $y = -6.71581073 + 0.928586429*x$

Table 3-3. Measured and Estimated PAH Concentrations for Paired TPH-PAH Results from On-Site Soil and Sediment Samples Collected from </= 10 ft. bgs.

			Acenaphthene			Acenaphthylene			Anthracene			Benzo(a)anthracene			Benzo(a)pyrene			Benzo(b)fluoranthene			Benzc
Station	Top Depth	Sum TPH (C10-C40)	Measured (mg/kg)	Estimated (mg/kg)	Ace DELTA	Measured (mg/kg)	Estimated (mg/kg)	Acy DELTA	Measured (mg/kg)	Estimated (mg/kg)	Anth DELTA	Measured (mg/kg)	Estimated (mg/kg)	B(a)A DELTA	Measured (mg/kg)	Estimated (mg/kg)	B(a)P DELTA	Measured (mg/kg)	Estimated (mg/kg)	B(b)F DELTA	Measured (mg/kg)
B-12	5	1413.75	< 0.031	0.043	37.8%	< 0.031	0.060	90.4%	< 0.031	0.051	63.0%	< 0.031	0.064	105.5%	< 0.031	0.110	250.2%	< 0.031	0.079	153.4%	< 0.031
B-14	10	1302.45	**0.119**	**0.040**	**-66.5%**	**0.041**	**0.057**	**38.6%**	< 0.003	0.048	1440.0%	**0.009**	**0.060**	**589.1%**	**0.009**	**0.103**	**1071.9%**	**0.014**	**0.074**	**436.2%**	< 0.003
B-15	10	1462.64	**0.080**	**0.045**	**-44.4%**	**0.070**	**0.061**	**-13.5%**	< 0.003	0.052	1570.4%	**0.008**	**0.066**	**779.8%**	< 0.003	0.113	3500.7%	**0.010**	**0.082**	**716.5%**	< 0.003
B-21	5	3320.93	< 0.062	0.098	56.5%	< 0.062	0.091	45.1%	< 0.062	0.093	48.6%	< 0.062	0.125	100.2%	< 0.062	0.218	249.3%	< 0.062	0.164	162.4%	< 0.062
B-23	2.5	11384.41	**0.626**	**0.318**	**-49.2%**	**0.125**	**0.166**	**32.8%**	< 0.062	0.220	252.1%	< 0.062	0.326	422.3%	< 0.062	0.589	843.4%	< 0.062	0.467	647.8%	< 0.062
B-28	0.5	3971.90	< 0.125	0.116	-7.2%	< 0.125	0.099	-20.8%	< 0.125	0.105	-15.9%	< 0.125	0.144	15.0%	< 0.125	0.252	101.6%	< 0.125	0.191	52.6%	< 0.125
B-28	5	31288.32	**0.876**	**0.839**	**-4.3%**	< 0.251	0.273	8.9%	< 0.251	0.447	78.2%	**0.501**	**0.717**	**43.1%**	< 0.251	1.332	431.5%	**0.626**	**1.103**	**76.2%**	< 0.251
B-29	0.5	2293.88	< 0.062	0.069	9.8%	< 0.062	0.076	21.0%	< 0.062	0.072	14.7%	< 0.062	0.094	50.1%	< 0.062	0.162	159.2%	< 0.062	0.120	91.6%	< 0.062
B-29	2.5	2980.96	< 0.062	0.088	41.1%	< 0.062	0.086	37.6%	< 0.062	0.086	37.8%	< 0.062	0.115	84.0%	< 0.062	0.200	220.2%	< 0.062	0.150	139.4%	< 0.062
B-3	5	10625.37	< 0.062	0.298	376.9%	< 0.062	0.161	156.9%	**0.125**	**0.210**	**67.6%**	< 0.062	0.309	395.0%	< 0.062	0.557	792.3%	< 0.062	0.441	605.2%	< 0.062
B-30	0.5	17154.23	< 0.313	0.471	50.7%	< 0.313	0.203	-35.1%	< 0.313	0.293	-6.3%	< 0.313	0.449	43.5%	< 0.313	0.820	162.2%	< 0.313	0.662	111.6%	< 0.313
B-30	2.5	12004.06	**0.250**	**0.335**	**33.9%**	< 0.125	0.170	36.3%	< 0.125	0.228	82.6%	< 0.125	0.340	171.9%	< 0.125	0.615	391.9%	< 0.125	0.489	290.8%	< 0.125
B-31	5	27309.78	< 3.130	0.736	-76.5%	< 3.130	0.255	-91.8%	< 3.130	0.406	-87.0%	< 3.130	0.645	-79.4%	< 3.130	1.193	-61.9%	< 3.130	0.983	-68.6%	< 3.130
B-31	10	38292.14	< 0.313	1.018	225.3%	< 0.313	0.301	-3.7%	< 0.313	0.514	64.4%	< 0.313	0.839	168.2%	< 0.313	1.567	401.0%	< 0.313	1.310	318.7%	< 0.313
B-34	10	669.81	< 0.062	0.021	-66.2%	< 0.062	0.041	-33.9%	< 0.062	0.030	-51.6%	< 0.062	0.036	-42.4%	< 0.062	0.060	-3.9%	< 0.062	0.042	-32.7%	< 0.062
B-35	5	10383.78	< 1.250	0.291	-76.7%	< 1.250	0.159	-87.3%	< 1.250	0.206	-83.5%	< 1.250	0.304	-75.7%	< 1.250	0.547	-56.2%	< 1.250	0.432	-65.4%	< 1.250
B-35	10	487.85	< 0.062	0.016	-75.1%	< 0.062	0.035	-43.4%	< 0.062	0.024	-61.2%	< 0.062	0.028	-55.0%	< 0.062	0.046	-25.6%	< 0.062	0.032	-48.6%	< 0.062
B-38	5	3778.19	**0.175**	**0.111**	**-36.8%**	**0.100**	**0.097**	**-3.4%**	< 0.031	0.102	224.6%	< 0.031	0.138	341.7%	< 0.031	0.242	673.6%	< 0.031	0.183	484.4%	< 0.031
B-42	10	53798.45	< 3.130	1.409	-55.0%	< 3.130	0.356	-88.6%	< 3.130	0.653	-79.1%	< 3.130	1.093	-65.1%	< 3.130	2.062	-34.1%	< 3.130	1.749	-44.1%	< 3.130
B-43	5	11259.87	< 1.250	0.315	-74.8%	< 1.250	0.165	-86.8%	< 1.250	0.218	-82.5%	< 1.250	0.324	-74.1%	< 1.250	0.584	-53.3%	< 1.250	0.463	-63.0%	< 1.250
B-47	5	13266.54	< 1.250	0.369	-70.5%	< 1.250	0.179	-85.7%	< 1.250	0.245	-80.4%	< 1.250	0.368	-70.6%	< 1.250	0.667	-46.7%	< 1.250	0.532	-57.4%	< 1.250
B-52	5	18638.79	**0.751**	**0.511**	**-32.0%**	**0.501**	**0.212**	**-57.8%**	< 0.062	0.311	397.3%	**0.125**	**0.479**	**283.0%**	< 0.062	0.877	1303.8%	< 0.062	0.710	1037.0%	< 0.062
B-52	10	12394.40	< 1.250	0.345	-72.4%	< 1.250	0.173	-86.1%	< 1.250	0.233	-81.3%	< 1.250	0.349	-72.1%	< 1.250	0.631	-49.5%	< 1.250	0.502	-59.8%	< 1.250
B-53	10	1251.38	< 0.062	0.038	-38.6%	< 0.062	0.056	-10.2%	< 0.062	0.047	-25.0%	< 0.062	0.058	-6.4%	< 0.062	0.099	59.0%	< 0.062	0.072	14.5%	< 0.062
B-68	10	4999.03	**0.029**	**0.145**	**402.2%**	**0.051**	**0.111**	**116.0%**	**0.045**	**0.124**	**174.1%**	**0.075**	**0.172**	**129.0%**	**0.027**	**0.304**	**1004.2%**	**0.048**	**0.232**	**387.7%**	**0.025**
B-69	6	39894.75	**0.626**	**1.058**	**69.0%**	**0.250**	**0.307**	**22.9%**	**1.130**	**0.529**	**-53.1%**	**3.501**	**0.866**	**-75.3%**	**4.380**	**1.620**	**-63.0%**	**3.001**	**1.356**	**-54.8%**	**3.629**
B-70	10	7762.04	< 0.031	0.221	604.5%	**0.104**	**0.138**	**32.2%**	**0.093**	**0.168**	**81.6%**	**0.080**	**0.242**	**202.2%**	< 0.031	0.433	1282.5%	< 0.031	0.337	977.7%	< 0.031
B-71	5	3026.01	**0.029**	**0.089**	**210.4%**	**0.051**	**0.087**	**68.8%**	**0.058**	**0.087**	**51.0%**	**0.063**	**0.116**	**85.8%**	< 0.013	0.202	1519.8%	< 0.013	0.151	1111.9%	< 0.013
B-71	10	1276.66	**0.017**	**0.039**	**123.7%**	**0.030**	**0.057**	**89.0%**	**0.032**	**0.048**	**46.3%**	**0.038**	**0.059**	**58.4%**	< 0.006	0.101	1515.2%	**0.015**	**0.073**	**385.1%**	< 0.006
B-72	5	688.15	**0.016**	**0.022**	**32.8%**	< 0.003	0.042	1237.0%	< 0.003	0.031	885.1%	**0.019**	**0.037**	**95.3%**	**0.016**	**0.061**	**276.5%**	**0.014**	**0.043**	**211.7%**	**0.014**
B-73	5	8416.93	**0.250**	**0.238**	**-4.7%**	**0.125**	**0.143**	**14.5%**	< 0.062	0.178	185.0%	< 0.062	0.258	312.9%	< 0.062	0.462	639.5%	< 0.062	0.361	478.5%	< 0.062
B-73	10	1976.34	**0.079**	**0.059**	**-24.5%**	**0.056**	**0.070**	**24.8%**	< 0.013	0.065	416.3%	**0.036**	**0.083**	**130.0%**	< 0.013	0.144	1048.9%	< 0.013	0.105	743.8%	< 0.013
GB-17	9	5630.76	< 0.062	0.162	159.6%	< 0.062	0.117	88.1%	< 0.062	0.134	115.1%	< 0.062	0.189	201.9%	< 0.062	0.334	434.8%	< 0.062	0.257	311.1%	< 0.062
GB-18	9	13794.15	< 0.313	0.383	22.3%	< 0.313	0.182	-41.7%	< 0.313	0.252	-19.6%	< 0.313	0.379	21.1%	< 0.313	0.688	119.9%	< 0.313	0.550	75.8%	< 0.313
GB-19	9	5878.17	< 0.062	0.169	170.5%	< 0.062	0.120	92.1%	< 0.062	0.138	121.6%	< 0.062	0.195	212.2%	< 0.062	0.346	453.6%	< 0.062	0.266	326.4%	< 0.062
PW-3	10	127.74	< 0.062	0.004	-93.1%	< 0.062	0.018	-70.7%	< 0.062	0.009	-84.8%	< 0.062	0.010	-84.2%	< 0.062	0.016	-74.7%	< 0.062	0.010	-83.5%	< 0.062
PW-4	10	3755.59	< 0.625	0.110	-82.4%	< 0.625	0.096	-84.6%	< 0.625	0.101	-83.8%	< 0.625	0.138	-78.0%	< 0.625	0.241	-61.4%	< 0.625	0.182	-70.9%	< 0.625
S-10	2.5	182.55																			
S-11	2.5	131.50																			
S-12	0.5	1565.56	< 0.062	0.048	-23.9%	< 0.062	0.063	0.3%	< 0.062	0.055	-12.3%	< 0.062	0.070	11.5%	< 0.062	0.119	90.5%	< 0.062	0.087	38.5%	< 0.062
S-12	2.5	487.85																			
S-15	2.5	2489.91	< 0.062	0.074	18.8%	< 0.062	0.079	26.0%	< 0.062	0.076	21.4%	< 0.062	0.100	60.0%	< 0.062	0.173	177.0%	< 0.062	0.128	105.5%	< 0.062
S-16	2.5	7390.86	**0.250**	**0.210**	**-15.9%**	**0.250**	**0.134**	**-46.3%**	< 0.062	0.163	160.2%	< 0.062	0.233	273.2%	< 0.062	0.416	565.9%	< 0.062	0.324	418.0%	< 0.062
S-17	0.5	6761.50	< 0.062	0.193	209.3%	< 0.062	0.129	105.8%	**0.125**	**0.153**	**22.1%**	**1.250**	**0.218**	**-82.6%**	**0.751**	**0.387**	**-48.5%**	**1.250**	**0.300**	**-76.0%**	**0.626**
S-17	2.5	3979.85																			
S-18	2.5	8510.02	**0.501**	**0.241**	**-51.9%**	< 0.062	0.144	130.4%	**0.375**	**0.179**	**-52.1%**	**0.876**	**0.260**	**-70.3%**	**0.501**	**0.466**	**-7.0%**	**0.626**	**0.365**	**-41.7%**	**0.250**
S-19	2.5	7390.86	**0.250**	**0.210**	**-15.9%**	**0.125**	**0.134**	**7.4%**	< 0.062	0.163	160.2%	< 0.062	0.233	273.2%	< 0.062	0.416	565.9%	< 0.062	0.324	418.0%	< 0.062
S-20	0.5	1562.43	< 0.062	0.047	-24.0%	**0.375**	**0.063**	**-83.3%**	**0.250**	**0.055**	**-78.1%**	**0.876**	**0.070**	**-92.1%**	**0.626**	**0.119**	**-81.0%**	**0.751**	**0.086**	**-88.5%**	**0.375**
S-23	2.5	2337.88	< 0.062	0.070	11.8%	< 0.062	0.076	22.1%	< 0.062	0.073	16.2%	< 0.062	0.095	52.3%	< 0.062	0.164	163.2%	< 0.062	0.122	94.7%	< 0.062
S-24	2.5	1952.76	< 0.031	0.059	87.8%	< 0.031	0.070	123.1%	< 0.031	0.064	104.4%	< 0.031	0.083	164.2%	< 0.031	0.142	354.4%	< 0.031	0.104	233.5%	< 0.031
S-25	0.5	10636.00	< 0.125	0.298	138.5%	< 0.125	0.161	28.4%	< 0.125	0.210	67.7%	< 0.125	0.310	147.5%	< 0.125	0.558	346.1%	< 0.125	0.441	252.6%	< 0.125
S-25	2.5	4238.65																			
S-28	0.5	3068.67	< 0.062	0.091	45.1%	< 0.062	0.087	39.6%	< 0.062	0.088	40.6%	< 0.062	0.118	88.2%	< 0.062	0.205	227.8%	< 0.062	0.153	145.4%	< 0.062
S-29	2.5	68.79																			
S-30	2.5	275.06																			
S-31	2.5	71.31																			
S-32	0.5	3881.59	< 0.062	0.114	81.7%	< 0.062	0.098	56.7%	< 0.062	0.104	65.7%	< 0.062	0.141	126.0%	< 0.062	0.248	296.2%	< 0.062	0.187	199.6%	< 0.062
S-32	2.5	1664.03																			
S-33	2.5	952.41																			
S-35	2.5	90.11																			
S-36	2.5	376.15																			
S-37	2.5	269.08																			
S-38	0.5	501.70	< 0.006	0.016	155.8%	< 0.006	0.036	473.0%	< 0.006	0.025	295.2%	< 0.006	0.029	359.3%	< 0.006	0.048	660.6%	< 0.006	0.033	426.1%	< 0.006
S-39	2.5	12887.33	< 0.251	0.358	43.1%	< 0.251	0.176	-29.6%	< 0.251	0.240	-4.2%	< 0.251	0.359	43.4%	< 0.251	0.651	159.9%	**0.626**	**0.519**	**-17.1%**	< 0.251

Notes:
Measured non-detects are reported at half the detection limit.
Naphthalene italics indicate 8260 value used.
Bold indicates detected values/estimates.

Table 3-3. Measured and Estimated PAH Concentrations for Paired TPH-PAH Results from On-Site Soil and Sediment Samples Collected from </= 10 ft. bgs.

			Acenaphthene			Acenaphthylene			Anthracene			Benzo(a)anthracene			Benzo(a)pyrene			Benzo(b)fluoranthene			Benzc
Station	Top Depth	Sum TPH (C10-C40)	Measured (mg/kg)	Estimated (mg/kg)	Ace DELTA	Measured (mg/kg)	Estimated (mg/kg)	Acy DELTA	Measured (mg/kg)	Estimated (mg/kg)	Anth DELTA	Measured (mg/kg)	Estimated (mg/kg)	B(a)A DELTA	Measured (mg/kg)	Estimated (mg/kg)	B(a)P DELTA	Measured (mg/kg)	Estimated (mg/kg)	B(b)F DELTA	Measured (mg/kg)
S-41	0.5	23670.86	< 0.313	0.642	105.2%	< 0.313	0.238	-24.0%	< 0.313	0.367	17.4%	< 0.313	0.577	84.4%	< 0.313	1.063	239.9%	< 0.313	0.870	178.2%	< 0.313
S-43	0.5	111413.08	< 1.250	2.831	126.5%	< 1.250	0.509	-59.3%	< 1.250	1.087	-13.0%	< 1.250	1.927	54.2%	**2.751**	**3.708**	**34.8%**	**2.630**	**3.247**	**23.5%**	< 1.250
S-43	2.5	156.33	< 0.003	0.005	67.2%	< 0.003	0.020	545.6%	< 0.003	0.011	248.9%	< 0.003	0.012	270.1%	**0.023**	**0.019**	**-17.5%**	**0.009**	**0.012**	**39.4%**	**0.010**
S-44	0.5	328.65	< 0.003	0.011	240.7%	< 0.003	0.029	829.9%	< 0.003	0.018	487.1%	< 0.003	0.021	560.1%	< 0.003	0.034	980.4%	**0.008**	**0.023**	**205.8%**	< 0.003
S-44	2.5	201.74	< 0.003	0.007	113.5%	< 0.003	0.023	631.7%	< 0.003	0.013	317.1%	< 0.003	0.014	351.4%	< 0.003	0.023	628.9%	**0.008**	**0.015**	**102.0%**	**0.009**
S-45	0.5	143.45	< 0.031	0.005	-84.6%	< 0.031	0.019	-38.1%	< 0.031	0.010	-67.2%	< 0.031	0.011	-65.4%	**0.063**	**0.017**	**-72.3%**	**0.125**	**0.011**	**-90.9%**	< 0.031
S-49	0.5	237.46	< 0.003	0.008	149.5%	< 0.003	0.025	692.7%	< 0.003	0.015	367.6%	< 0.003	0.016	412.5%	**0.023**	**0.026**	**15.6%**	**0.009**	**0.017**	**98.9%**	**0.010**
S-5	0.5	3508.70	< 0.062	0.103	65.0%	< 0.062	0.093	49.1%	< 0.062	0.096	54.4%	< 0.062	0.131	108.9%	< 0.062	0.228	265.2%	< 0.062	0.172	175.0%	< 0.062
S-5	2.5	105.11																			
S-51	2.5	147.23	< 0.003	0.005	57.8%	< 0.003	0.020	526.8%	< 0.003	0.010	234.5%	< 0.003	0.011	253.2%	< 0.003	0.018	465.4%	**0.008**	**0.012**	**54.6%**	< 0.003
S-52	0.5	376.91	< 0.003	0.012	288.5%	< 0.003	0.031	894.7%	< 0.003	0.020	546.2%	< 0.003	0.023	634.4%	< 0.003	0.038	1106.5%	**0.008**	**0.026**	**243.6%**	**0.009**
S-52	2.5	1402.48	< 0.031	0.043	36.8%	< 0.031	0.059	89.6%	< 0.031	0.051	62.1%	< 0.031	0.064	104.2%	**0.063**	**0.109**	**74.0%**	**0.125**	**0.079**	**-37.0%**	< 0.031
S-53	0.5	4044.04	< 0.062	0.118	89.0%	< 0.062	0.100	59.8%	< 0.062	0.107	70.6%	< 0.062	0.146	133.3%	**0.375**	**0.256**	**-31.8%**	**0.250**	**0.194**	**-22.5%**	**0.250**
S-54	2.5	8127.43	< 0.251	0.230	-8.0%	< 0.251	0.141	-43.8%	< 0.251	0.174	-30.7%	< 0.251	0.251	0.2%	**0.626**	**0.449**	**-28.3%**	< 0.251	0.351	40.0%	**0.626**
S-57	0.5	479.14	< 0.013	0.015	22.4%	< 0.013	0.035	180.2%	< 0.013	0.024	91.4%	< 0.013	0.028	121.6%	**0.025**	**0.046**	**83.3%**	**0.038**	**0.032**	**-15.7%**	**0.075**
S-58	0.5	913.24	< 0.031	0.028	-9.3%	< 0.031	0.048	53.6%	< 0.031	0.038	20.1%	< 0.031	0.046	46.2%	< 0.031	0.077	146.2%	< 0.031	0.055	74.8%	< 0.031
S-58	2.5	1876.19	< 0.031	0.057	80.7%	< 0.031	0.068	118.7%	< 0.031	0.062	98.8%	< 0.031	0.080	156.1%	< 0.031	0.138	339.9%	< 0.031	0.101	222.4%	< 0.031
S-59	0.5	1362.40	< 0.031	0.042	33.0%	< 0.031	0.059	86.9%	< 0.031	0.050	58.9%	< 0.031	0.062	99.6%	< 0.031	0.106	239.9%	< 0.031	0.077	145.6%	< 0.031
S-59	2.5	14143.35	< 0.187	0.392	109.0%	< 0.187	0.185	-1.5%	< 0.187	0.256	36.6%	< 0.187	0.386	106.1%	< 0.187	0.702	274.4%	< 0.187	0.562	199.6%	**0.375**
S-62	0.5	1587.63	< 0.031	0.048	54.0%	< 0.031	0.063	101.5%	< 0.031	0.055	76.8%	< 0.031	0.070	124.9%	< 0.031	0.120	284.5%	< 0.031	0.088	179.7%	< 0.031
S-62	2.5	11637.64	< 0.062	0.325	420.4%	< 0.062	0.168	168.7%	< 0.062	0.223	257.6%	< 0.062	0.332	431.4%	< 0.062	0.600	860.2%	< 0.062	0.476	661.9%	< 0.062
S-63	0.5	51277.12	< 0.313	1.346	330.3%	< 0.313	0.348	11.2%	< 0.313	0.631	101.7%	**2.250**	**1.053**	**-53.2%**	**4.509**	**1.983**	**-56.0%**	**3.629**	**1.679**	**-53.7%**	**2.380**
S-66	0.5	339.34	< 0.003	0.011	251.3%	< 0.003	0.030	844.7%	< 0.003	0.019	500.4%	< 0.003	0.021	576.7%	**0.009**	**0.035**	**296.2%**	**0.013**	**0.024**	**88.7%**	**0.006**
S-67	0.5	143.74	< 0.003	0.005	54.3%	< 0.003	0.019	519.5%	**0.010**	**0.010**	**2.9%**	**0.053**	**0.011**	**-79.4%**	**0.076**	**0.017**	**-77.3%**	**0.163**	**0.011**	**-93.0%**	**0.044**
S-7	0.5	1452.44	< 0.062	0.044	-29.1%	< 0.062	0.060	-3.3%	< 0.062	0.052	-16.7%	< 0.062	0.066	5.1%	< 0.062	0.112	79.3%	< 0.062	0.081	29.9%	< 0.062
S-9	2.5	90.11																			
Sd-1	0.5	257.49	< 0.003	0.008	169.7%	< 0.003	0.026	724.9%	< 0.003	0.015	394.9%	< 0.003	0.017	445.9%	< 0.003	0.028	787.4%	< 0.003	0.019	496.3%	< 0.003
Sd-2	0.5	35.06	< 0.003	0.001	-60.1%	< 0.003	0.010	209.7%	< 0.003	0.004	22.5%	< 0.003	0.004	15.6%	< 0.003	0.006	77.8%	< 0.003	0.003	9.5%	< 0.003
Sd-3	0.5	601.24	< 0.013	0.019	52.1%	< 0.013	0.039	213.2%	< 0.013	0.028	124.3%	< 0.013	0.033	164.4%	< 0.013	0.055	340.1%	< 0.013	0.038	206.9%	< 0.013
T-19	2.5	789.18	< 0.013	0.025	97.4%	< 0.013	0.045	258.0%	< 0.013	0.034	171.4%	< 0.013	0.041	226.8%	< 0.013	0.069	448.1%	< 0.013	0.048	286.7%	< 0.013
T-2	0.5	424.96	< 0.006	0.014	118.2%	< 0.006	0.033	428.2%	**0.025**	**0.022**	**-12.0%**	**0.075**	**0.025**	**-66.4%**	**0.150**	**0.042**	**-72.3%**	**0.250**	**0.029**	**-88.6%**	**0.075**
All ND:																					
B-24	5	< 12.50																			
B-72	10	< 12.50																			
MW-48D	3	< 6.25																			
MW-48D	4	< 6.25																			
MW-53D	10	< 6.25																			
S-1	2.5	< 12.50																			
S-13	2.5	< 12.50																			
S-14	2.5	< 12.50																			
S-2	2.5	< 12.50																			
S-20	2.5	< 12.50																			
S-21	2.5	< 12.50																			
S-22	2.5	< 12.50																			
S-26	2.5	< 12.50																			
S-27	2.5	< 12.50																			
S-28	2.5	< 12.50																			
S-3	2.5	< 12.50																			
S-34	2.5	< 12.50																			
S-38	2.5	< 12.50																			
S-4	2.5	< 12.50																			
S-6	2.5	< 12.50																			
S-7	2.5	< 12.50																			
S-8	2.5	< 12.50																			

Notes:
Measured non-detects are reported at half the detection limit.
Naphthalene italics indicate 8260 value used.
Bold indicates detected values/estimates.

Table 3-3. Measured and Estimated PAH Concentrations for Paired TPH-PAH Results from On-Site Soil and Sediment Samples Collected from </= 10 ft. bgs.

			›(g,h,i)perylene		Benzo(k)fluoranthene			Chrysene			Dibenzo(a,h)anthracene			Fluoranthene			Fluorene			Indeno(1,2,3-cd)pyr	
Station	Top Depth	Sum TPH (C10-C40)	Estimated (mg/kg)	B(ghi)P DELTA	Measured (mg/kg)	Estimated (mg/kg)	B(k)F DELTA	Measured (mg/kg)	Estimated (mg/kg)	Chr DELTA	Measured (mg/kg)	Estimated (mg/kg)	Dibenzo DELTA	Measured (mg/kg)	Estimated (mg/kg)	Fluoranth DELTA	Measured (mg/kg)	Estimated (mg/kg)	Fluorene DELTA	Measured (mg/kg)	Estimated (mg/kg)
B-12	5	1413.75	0.077	146.7%	< 0.031	0.076	143.2%	< 0.031	0.097	208.3%	< 0.031	0.058	85.6%	< 0.031	0.096	207.7%	< 0.031	0.113	262.1%	< 0.031	0.079
B-14	10	1302.45	0.072	2189.2%	< 0.003	0.072	2207.8%	**0.017**	**0.091**	**419.9%**	< 0.003	0.055	1666.4%	**0.008**	**0.091**	**1116.2%**	**0.009**	**0.106**	**1109.2%**	< 0.003	0.073
B-15	10	1462.64	0.080	2445.6%	< 0.003	0.078	2387.3%	**0.020**	**0.099**	**394.6%**	< 0.003	0.059	1795.9%	< 0.003	0.098	3047.0%	**0.375**	**0.117**	**-68.9%**	< 0.003	0.081
B-21	5	3320.93	0.169	170.1%	< 0.062	0.132	111.6%	< 0.062	0.179	187.0%	< 0.062	0.098	56.6%	< 0.062	0.168	169.1%	< 0.062	0.231	269.4%	< 0.062	0.164
B-23	2.5	11384.41	0.521	734.0%	< 0.062	0.293	368.8%	< 0.062	0.438	601.5%	< 0.062	0.207	232.0%	< 0.062	0.376	501.2%	**2.751**	**0.643**	**-76.6%**	< 0.062	0.471
B-28	0.5	3971.90	0.199	58.9%	< 0.125	0.148	18.6%	< 0.125	0.204	63.3%	< 0.125	0.109	-12.7%	< 0.125	0.189	51.1%	< 0.125	0.268	114.2%	< 0.125	0.191
B-28	5	31288.32	1.314	424.5%	< 0.251	0.563	124.5%	**1.000**	**0.913**	**-8.7%**	< 0.251	0.384	53.4%	**0.751**	**0.726**	**-3.3%**	**2.000**	**1.493**	**-25.4%**	< 0.251	1.123
B-29	0.5	2293.88	0.120	92.5%	< 0.062	0.104	66.6%	< 0.062	0.137	119.5%	< 0.062	0.078	25.0%	< 0.062	0.132	111.4%	< 0.062	0.170	171.5%	< 0.062	0.119
B-29	2.5	2980.96	0.153	144.6%	< 0.062	0.123	97.3%	< 0.062	0.166	165.4%	< 0.062	0.092	46.6%	< 0.062	0.157	150.8%	< 0.062	0.211	237.6%	< 0.062	0.149
B-3	5	10625.37	0.489	682.9%	< 0.062	0.280	348.3%	**0.125**	**0.417**	**233.4%**	< 0.062	0.199	218.3%	< 0.062	0.359	474.8%	< 0.062	0.608	872.5%	< 0.062	0.444
B-30	0.5	17154.23	0.758	142.4%	< 0.313	0.382	22.0%	< 0.313	0.590	88.6%	< 0.313	0.266	-14.9%	< 0.313	0.491	56.9%	< 0.313	0.905	189.3%	< 0.313	0.670
B-30	2.5	12004.06	0.547	337.3%	< 0.125	0.303	142.3%	< 0.125	0.455	264.2%	< 0.125	0.214	71.3%	< 0.125	0.389	210.9%	**0.876**	**0.672**	**-23.3%**	< 0.125	0.493
B-31	5	27309.78	1.161	-62.9%	< 3.130	0.515	-83.5%	< 3.130	0.827	-73.6%	< 3.130	0.354	-88.7%	< 3.130	0.665	-78.8%	< 3.130	1.333	-57.4%	< 3.130	0.999
B-31	10	38292.14	1.581	405.4%	< 0.313	0.641	104.9%	< 0.313	1.057	237.7%	< 0.313	0.435	38.9%	< 0.313	0.829	164.9%	**2.250**	**1.766**	**-21.5%**	< 0.313	1.336
B-34	10	669.81	0.039	-37.6%	< 0.062	0.047	-24.8%	< 0.062	0.056	-10.1%	< 0.062	0.037	-41.0%	< 0.062	0.059	-5.3%	< 0.062	0.061	-2.6%	< 0.062	0.041
B-35	5	10383.78	0.479	-61.7%	< 1.250	0.276	-77.9%	< 1.250	0.410	-67.2%	< 1.250	0.196	-84.3%	< 1.250	0.354	-71.7%	< 1.250	0.596	-52.3%	< 1.250	0.436
B-35	10	487.85	0.029	-53.3%	< 0.062	0.038	-38.7%	< 0.062	0.045	-28.6%	< 0.062	0.030	-51.4%	< 0.062	0.048	-23.0%	< 0.062	0.047	-25.2%	< 0.062	0.032
B-38	5	3778.19	0.190	506.5%	< 0.031	0.144	358.9%	**0.075**	**0.197**	**162.2%**	< 0.031	0.106	238.1%	< 0.031	0.183	484.3%	**0.250**	**0.257**	**2.7%**	< 0.031	0.183
B-42	10	53798.45	2.158	-31.0%	< 3.130	0.798	-74.5%	< 3.130	1.352	-56.8%	< 3.130	0.535	-82.9%	< 3.130	1.035	-66.9%	< 3.130	2.344	-25.1%	< 3.130	1.788
B-43	5	11259.87	0.516	-58.7%	< 1.250	0.291	-76.7%	< 1.250	0.435	-65.2%	< 1.250	0.206	-83.5%	< 1.250	0.373	-70.2%	< 1.250	0.638	-49.0%	< 1.250	0.467
B-47	5	13266.54	0.599	-52.0%	< 1.250	0.323	-74.1%	< 1.250	0.490	-60.8%	< 1.250	0.228	-81.8%	< 1.250	0.415	-66.8%	< 1.250	0.731	-41.5%	< 1.250	0.538
B-52	5	18638.79	0.818	1209.5%	< 0.062	0.403	544.5%	**0.250**	**0.627**	**150.6%**	< 0.062	0.280	348.5%	**0.250**	**0.518**	**107.2%**	< 0.062	0.970	1452.5%	< 0.062	0.720
B-52	10	12394.40	0.563	-54.9%	< 1.250	0.309	-75.2%	< 1.250	0.466	-62.7%	< 1.250	0.218	-82.5%	< 1.250	0.397	-68.2%	< 1.250	0.691	-44.7%	< 1.250	0.507
B-53	10	1251.38	0.069	10.5%	< 0.062	0.070	12.6%	< 0.062	0.088	41.4%	< 0.062	0.054	-13.7%	< 0.062	0.089	42.4%	< 0.062	0.102	63.9%	< 0.062	0.071
B-68	10	4999.03	**0.245**	**881.4%**	**0.040**	**0.172**	**329.1%**	**0.250**	**0.241**	**-3.5%**	**0.039**	**0.126**	**223.5%**	**0.051**	**0.220**	**328.0%**	**0.163**	**0.324**	**99.0%**	**0.031**	**0.233**
B-69	6	39894.75	**1.642**	**-54.8%**	**2.130**	**0.658**	**-69.1%**	**4.759**	**1.088**	**-77.1%**	**0.501**	**0.446**	**-11.0%**	**3.001**	**0.851**	**-71.6%**	**1.000**	**1.827**	**82.7%**	**2.380**	**1.383**
B-70	10	7762.04	0.367	1072.2%	< 0.031	0.229	630.5%	**0.263**	**0.332**	**26.3%**	< 0.031	0.164	424.5%	< 0.031	0.293	834.6%	**0.964**	**0.468**	**-51.5%**	< 0.031	0.339
B-71	5	3026.01	0.155	1139.6%	< 0.013	0.124	895.7%	**0.163**	**0.168**	**2.8%**	< 0.013	0.092	639.5%	**0.036**	**0.158**	**335.9%**	**0.889**	**0.214**	**-76.0%**	< 0.013	0.151
B-71	10	1276.66	0.070	1025.1%	< 0.006	0.071	1040.4%	**0.093**	**0.090**	**-3.3%**	< 0.006	0.055	773.5%	**0.020**	**0.090**	**350.6%**	**0.225**	**0.104**	**-53.7%**	< 0.006	0.072
B-72	5	688.15	**0.040**	**189.5%**	**0.009**	**0.048**	**446.2%**	**0.046**	**0.057**	**23.7%**	< 0.003	0.037	1096.9%	**0.016**	**0.060**	**269.5%**	**0.023**	**0.062**	**176.6%**	**0.009**	**0.042**
B-73	5	8416.93	0.395	532.6%	< 0.062	0.241	285.7%	**0.250**	**0.352**	**40.8%**	< 0.062	0.173	176.1%	< 0.062	0.308	393.7%	**0.375**	**0.500**	**33.5%**	< 0.062	0.364
B-73	10	1976.34	0.105	739.3%	< 0.013	0.095	656.2%	**0.088**	**0.123**	**40.5%**	< 0.013	0.071	470.2%	< 0.013	0.120	858.7%	**0.225**	**0.150**	**-33.4%**	< 0.013	0.105
GB-17	9	5630.76	0.274	337.8%	< 0.062	0.186	197.5%	**0.250**	**0.263**	**5.2%**	< 0.062	0.135	116.1%	< 0.062	0.237	279.8%	< 0.062	0.358	473.2%	< 0.062	0.258
GB-18	9	13794.15	0.621	98.5%	< 0.313	0.332	6.0%	< 0.313	0.504	61.0%	< 0.313	0.233	-25.5%	< 0.313	0.426	36.1%	< 0.313	0.755	141.3%	< 0.313	0.556
GB-19	9	5878.17	0.285	355.4%	< 0.062	0.191	205.9%	**0.125**	**0.271**	**117.0%**	< 0.062	0.139	121.8%	< 0.062	0.244	290.6%	< 0.062	0.371	494.1%	< 0.062	0.267
PW-3	10	127.74	0.009	-86.3%	< 0.062	0.016	-74.2%	< 0.062	0.017	-73.0%	< 0.062	0.013	-78.5%	< 0.062	0.020	-67.9%	< 0.062	0.015	-75.5%	< 0.062	0.010
PW-4	10	3755.59	0.189	-69.8%	< 0.625	0.143	-77.1%	< 0.625	0.196	-68.6%	< 0.625	0.105	-83.1%	< 0.625	0.182	-70.9%	< 0.625	0.256	-59.1%	< 0.625	0.182
S-10	2.5	182.55																			
S-11	2.5	131.50																			
S-12	0.5	1565.56	0.085	35.7%	< 0.062	0.081	30.2%	< 0.062	0.104	66.4%	< 0.062	0.062	-1.0%	< 0.062	0.103	64.8%	< 0.062	0.123	97.5%	< 0.062	0.086
S-12	2.5	487.85																			
S-15	2.5	2489.91	0.130	107.5%	< 0.062	0.110	75.7%	< 0.062	0.146	132.9%	< 0.062	0.082	31.4%	< 0.062	0.139	123.0%	< 0.062	0.182	190.6%	< 0.062	0.128
S-16	2.5	7390.86	0.351	461.6%	< 0.062	0.222	254.7%	< 0.062	0.320	412.8%	< 0.062	0.159	155.1%	< 0.062	0.283	353.6%	< 0.062	0.449	618.9%	< 0.062	0.325
S-17	0.5	6761.50	**0.323**	**-48.4%**	**0.375**	**0.209**	**-44.2%**	**0.751**	**0.300**	**-60.0%**	**0.250**	**0.151**	**-39.6%**	**1.380**	**0.267**	**-80.6%**	< 0.062	0.417	567.5%	**0.501**	**0.301**
S-17	2.5	3979.85																			
S-18	2.5	8510.02	**0.399**	**59.6%**	**0.125**	**0.243**	**94.1%**	**0.751**	**0.355**	**-52.8%**	< 0.062	0.174	178.0%	**0.876**	**0.311**	**-64.6%**	**0.125**	**0.505**	**303.8%**	**0.250**	**0.367**
S-19	2.5	7390.86	0.351	461.6%	< 0.062	0.222	254.7%	< 0.062	0.320	412.8%	< 0.062	0.159	155.1%	< 0.062	0.283	353.6%	< 0.062	0.449	618.9%	< 0.062	0.325
S-20	0.5	1562.43	**0.085**	**-77.4%**	**0.125**	**0.081**	**-35.1%**	**0.626**	**0.104**	**-83.4%**	**0.125**	**0.062**	**-50.6%**	**1.250**	**0.103**	**-91.8%**	**0.125**	**0.123**	**-1.5%**	**0.375**	**0.086**
S-23	2.5	2337.88	0.122	95.9%	< 0.062	0.105	68.6%	< 0.062	0.139	122.5%	< 0.062	0.079	26.4%	< 0.062	0.134	114.0%	< 0.062	0.172	175.8%	< 0.062	0.121
S-24	2.5	1952.76	0.104	231.5%	< 0.031	0.094	199.6%	< 0.031	0.122	289.7%	< 0.031	0.071	126.0%	< 0.031	0.119	279.8%	< 0.031	0.148	373.8%	< 0.031	0.104
S-25	0.5	10636.00	0.490	291.5%	< 0.125	0.280	124.1%	< 0.125	0.417	233.6%	< 0.125	0.199	59.1%	< 0.125	0.359	187.3%	< 0.125	0.608	386.2%	< 0.125	0.445
S-25	2.5	4238.65																			
S-28	0.5	3068.67	0.157	151.2%	< 0.062	0.126	101.0%	< 0.062	0.169	171.0%	< 0.062	0.093	49.2%	< 0.062	0.160	155.6%	< 0.062	0.216	245.9%	< 0.062	0.153
S-29	2.5	68.79																			
S-30	2.5	275.06																			
S-31	2.5	71.31																			
S-32	0.5	3881.59	0.195	211.5%	< 0.062	0.146	134.0%	< 0.062	0.201	221.4%	< 0.062	0.108	72.2%	< 0.062	0.186	198.0%	< 0.062	0.263	320.6%	< 0.062	0.187
S-32	2.5	1664.03																			
S-33	2.5	952.41																			
S-35	2.5	90.11																			
S-36	2.5	376.15																			
S-37	2.5	269.08																			
S-38	0.5	501.70	0.030	378.6%	< 0.006	0.039	523.9%	< 0.006	0.046	628.2%	< 0.006	0.031	394.1%	< 0.006	0.049	683.8%	< 0.006	0.048	665.5%	< 0.006	0.032
S-39	2.5	12887.33	0.584	132.9%	< 0.251	0.317	26.6%	< 0.251	0.480	91.4%	< 0.251	0.224	-10.7%	< 0.251	0.407	62.5%	< 0.251	0.713	184.7%	< 0.251	0.524

Notes:
Measured non-detects are reported at half the detection limit.
Naphthalene italics indicate 8260 value used.
Bold indicates detected values/estimates.

Table 3-3. Measured and Estimated PAH Concentrations for Paired TPH-PAH Results from On-Site Soil and Sediment Samples Collected from </= 10 ft. bgs.

			›(g,h,i)perylene		Benzo(k)fluoranthene			Chrysene			Dibenzo(a,h)anthracene			Fluoranthene			Fluorene			Indeno(1,2,3-cd)pyr	
Station	Top Depth	Sum TPH (C10-C40)	Estimated (mg/kg)	B(ghi)P DELTA	Measured (mg/kg)	Estimated (mg/kg)	B(k)F DELTA	Measured (mg/kg)	Estimated (mg/kg)	Chr DELTA	Measured (mg/kg)	Estimated (mg/kg)	Dibenzo DELTA	Measured (mg/kg)	Estimated (mg/kg)	Fluoranth DELTA	Measured (mg/kg)	Estimated (mg/kg)	Fluorene DELTA	Measured (mg/kg)	Estimated (mg/kg)
S-41	0.5	23670.86	1.018	225.4%	< 0.313	0.470	50.2%	< 0.313	0.745	138.2%	< 0.313	0.324	3.6%	< 0.313	0.606	93.6%	< 0.313	1.183	278.3%	< 0.313	0.884
S-43	0.5	111413.08	4.203	236.3%	< 1.250	1.278	2.2%	< 1.250	2.293	83.4%	< 1.250	0.834	-33.3%	< 1.250	1.664	33.1%	**2.751**	**4.296**	**56.2%**	< 1.250	3.341
S-43	2.5	156.33	**0.010**	**2.9%**	< 0.003	0.018	486.9%	**0.011**	**0.020**	**72.9%**	< 0.003	0.015	384.7%	< 0.003	0.023	631.7%	< 0.003	0.018	479.4%	**0.008**	**0.012**
S-44	0.5	328.65	0.020	549.2%	< 0.003	0.030	848.4%	< 0.003	0.033	970.4%	< 0.003	0.024	662.6%	< 0.003	0.037	1088.1%	< 0.003	0.034	975.4%	< 0.003	0.022
S-44	2.5	201.74	**0.013**	**48.4%**	< 0.003	0.022	592.0%	< 0.003	0.024	651.3%	< 0.003	0.018	466.3%	< 0.003	0.027	764.2%	< 0.003	0.022	616.4%	< 0.003	0.015
S-45	0.5	143.45	0.010	-69.6%	< 0.031	0.017	-44.5%	**0.088**	**0.018**	**-79.0%**	< 0.031	0.014	-54.0%	**0.075**	**0.022**	**-71.2%**	< 0.031	0.017	-46.1%	< 0.031	0.011
S-49	0.5	237.46	**0.015**	**50.8%**	< 0.003	0.024	668.8%	**0.011**	**0.026**	**134.2%**	< 0.003	0.020	525.4%	< 0.003	0.030	861.1%	< 0.003	0.026	720.5%	**0.008**	**0.017**
S-5	0.5	3508.70	0.177	184.0%	< 0.062	0.137	119.2%	< 0.062	0.187	198.7%	< 0.062	0.101	61.9%	< 0.062	0.174	179.0%	< 0.062	0.242	286.7%	< 0.062	0.172
S-5	2.5	105.11																			
S-51	2.5	147.23	0.010	211.3%	< 0.003	0.018	464.6%	< 0.003	0.019	497.8%	< 0.003	0.015	367.3%	< 0.003	0.022	603.6%	< 0.003	0.017	451.2%	< 0.003	0.011
S-52	0.5	376.91	**0.023**	**163.0%**	< 0.003	0.032	936.1%	< 0.003	0.037	1082.2%	< 0.003	0.026	729.1%	< 0.003	0.041	1199.2%	< 0.003	0.038	1105.4%	< 0.003	0.025
S-52	2.5	1402.48	0.077	144.9%	< 0.031	0.076	142.0%	**0.088**	**0.096**	**9.5%**	< 0.031	0.058	84.7%	**0.075**	**0.096**	**27.6%**	< 0.031	0.113	259.7%	< 0.031	0.078
S-53	0.5	4044.04	**0.202**	**-19.2%**	< 0.062	0.150	140.3%	< 0.062	0.207	231.1%	< 0.062	0.110	76.6%	< 0.062	0.191	206.0%	< 0.062	0.272	335.2%	**0.250**	**0.194**
S-54	2.5	8127.43	**0.383**	**-38.9%**	< 0.251	0.236	-6.0%	**0.501**	**0.343**	**-31.5%**	< 0.251	0.169	-32.6%	< 0.251	0.301	20.3%	< 0.251	0.486	94.0%	< 0.251	0.353
S-57	0.5	479.14	**0.029**	**-61.8%**	< 0.013	0.038	202.8%	< 0.013	0.044	252.2%	< 0.013	0.030	140.3%	< 0.013	0.048	280.4%	< 0.013	0.046	268.4%	**0.063**	**0.031**
S-58	0.5	913.24	0.052	65.3%	< 0.031	0.057	83.4%	< 0.031	0.070	124.6%	< 0.031	0.045	42.2%	< 0.031	0.072	131.3%	< 0.031	0.079	151.7%	< 0.031	0.054
S-58	2.5	1876.19	0.100	219.6%	< 0.031	0.091	192.0%	< 0.031	0.119	278.6%	< 0.031	0.069	120.6%	< 0.031	0.116	270.1%	**0.225**	**0.143**	**-36.2%**	< 0.031	0.100
S-59	0.5	1362.40	0.075	138.4%	< 0.031	0.074	137.5%	< 0.031	0.094	200.1%	< 0.031	0.057	81.5%	< 0.031	0.094	200.3%	< 0.031	0.110	251.1%	< 0.031	0.076
S-59	2.5	14143.35	**0.635**	**69.5%**	< 0.187	0.337	79.7%	< 0.187	0.513	173.6%	< 0.187	0.237	26.3%	< 0.187	0.433	130.8%	< 0.187	0.771	311.1%	< 0.187	0.568
S-62	0.5	1587.63	0.086	174.3%	< 0.031	0.082	162.1%	< 0.031	0.105	235.4%	< 0.031	0.062	99.2%	< 0.031	0.104	231.9%	< 0.031	0.125	298.8%	< 0.031	0.087
S-62	2.5	11637.64	0.532	750.9%	< 0.062	0.297	375.5%	**0.375**	**0.445**	**18.8%**	< 0.062	0.210	236.5%	< 0.062	0.381	509.9%	< 0.062	0.655	949.0%	< 0.062	0.480
S-63	0.5	51277.12	**2.066**	**-13.2%**	**0.751**	**0.774**	**3.0%**	**3.881**	**1.306**	**-66.4%**	< 0.313	0.519	66.0%	**1.130**	**1.003**	**-11.2%**	**1.751**	**2.252**	**28.6%**	**2.130**	**1.716**
S-66	0.5	339.34	**0.021**	**234.3%**	< 0.003	0.030	868.2%	< 0.003	0.034	995.5%	< 0.003	0.024	677.6%	**0.008**	**0.038**	**405.7%**	< 0.003	0.035	1004.5%	**0.006**	**0.023**
S-67	0.5	143.74	**0.010**	**-78.2%**	**0.043**	**0.017**	**-59.2%**	**0.075**	**0.018**	**-75.5%**	**0.014**	**0.014**	**4.4%**	**0.109**	**0.022**	**-80.1%**	< 0.003	0.017	440.3%	**0.061**	**0.011**
S-7	0.5	1452.44	0.079	26.7%	< 0.062	0.077	24.0%	< 0.062	0.098	57.5%	< 0.062	0.059	-5.4%	< 0.062	0.098	56.9%	< 0.062	0.116	85.6%	< 0.062	0.080
S-9	2.5	90.11																			
Sd-1	0.5	257.49	0.016	419.2%	< 0.003	0.025	710.1%	< 0.003	0.028	796.7%	< 0.003	0.021	557.1%	< 0.003	0.032	913.3%	< 0.003	0.027	777.8%	< 0.003	0.018
Sd-2	0.5	35.06	0.003	-16.3%	< 0.003	0.007	123.5%	< 0.003	0.007	111.1%	< 0.003	0.006	94.7%	< 0.003	0.009	175.9%	< 0.003	0.005	66.9%	< 0.003	0.003
Sd-3	0.5	601.24	0.035	182.4%	< 0.013	0.044	250.7%	< 0.013	0.052	315.3%	< 0.013	0.034	175.9%	< 0.013	0.055	341.1%	< 0.013	0.056	345.1%	< 0.013	0.038
T-19	2.5	789.18	0.045	262.3%	< 0.013	0.052	318.0%	< 0.013	0.063	405.8%	< 0.013	0.041	225.7%	< 0.013	0.066	426.7%	< 0.013	0.070	458.2%	< 0.013	0.048
T-2	0.5	424.96	**0.026**	**-65.8%**	**0.075**	**0.035**	**-53.3%**	**0.063**	**0.040**	**-35.5%**	**0.025**	**0.028**	**11.7%**	**0.175**	**0.044**	**-74.9%**	< 0.006	0.042	566.7%	**0.088**	**0.028**
All ND:																					
B-24	5	< 12.50																			
B-72	10	< 12.50																			
MW-48D	3	< 6.25																			
MW-48D	4	< 6.25																			
MW-53D	10	< 6.25																			
S-1	2.5	< 12.50																			
S-13	2.5	< 12.50																			
S-14	2.5	< 12.50																			
S-2	2.5	< 12.50																			
S-20	2.5	< 12.50																			
S-21	2.5	< 12.50																			
S-22	2.5	< 12.50																			
S-26	2.5	< 12.50																			
S-27	2.5	< 12.50																			
S-28	2.5	< 12.50																			
S-3	2.5	< 12.50																			
S-34	2.5	< 12.50																			
S-38	2.5	< 12.50																			
S-4	2.5	< 12.50																			
S-6	2.5	< 12.50																			
S-7	2.5	< 12.50																			
S-8	2.5	< 12.50																			

Notes:
Measured non-detects are reported at half the detection limit.
Naphthalene italics indicate 8260 value used.
Bold indicates detected values/estimates.

Table 3-3. Measured and Estimated PAH Concentrations for Paired TPH-PAH Results from On-Site Soil and Sediment Samples Collected from </= 10 ft. bgs.

			ene	Naphthalene			Phenanthrene			Pyrene			SumPAH		
Station	Top Depth	Sum TPH (C10-C40)	Indeno DELTA	Measured (mg/kg)	Estimated (mg/kg)	Naphth DELTA	Measured (mg/kg)	Estimated (mg/kg)	Phen DELTA	Measured (mg/kg)	Estimated (mg/kg)	Pyrene DELTA	Measured (mg/kg)	Estimated (mg/kg)	Sum PAH DELTA
B-12	5	1413.75	151.3%	< 0.031	0.152	384.2%	< 0.031	0.358	1044.3%	< 0.031	0.107	240.6%	< 0.501	1.020	103.6%
B-14	10	1302.45	2242.8%	**0.056**	**0.139**	**146.3%**	**0.225**	**0.335**	**49.0%**	**0.019**	**0.101**	**437.0%**	**0.541**	**0.946**	**74.7%**
B-15	10	1462.64	2488.1%	**1.250**	**0.157**	**-87.4%**	**0.513**	**0.368**	**-28.3%**	**0.026**	**0.109**	**314.7%**	**2.380**	**1.053**	-55.7%
B-21	5	3320.93	162.1%	< 0.062	0.382	512.0%	< 0.062	0.716	1046.3%	< 0.062	0.189	202.5%	< 1.000	2.255	125.5%
B-23	2.5	11384.41	654.6%	**0.125**	**1.453**	**1061.7%**	**1.499**	**1.945**	**29.8%**	**0.125**	**0.431**	**245.0%**	**5.883**	**7.079**	**20.3%**
B-28	0.5	3971.90	52.7%	< 0.125	0.464	271.2%	< 0.125	0.828	562.2%	< 0.125	0.213	70.4%	< 2.000	2.663	33.2%
B-28	5	31288.32	348.2%	< 0.251	4.344	1633.6%	**5.008**	**4.418**	**-11.8%**	**0.876**	**0.849**	**-3.1%**	**13.599**	**18.101**	**33.1%**
B-29	0.5	2293.88	90.8%	< 0.062	0.256	309.9%	< 0.062	0.530	749.1%	< 0.062	0.147	136.1%	< 1.000	1.599	59.9%
B-29	2.5	2980.96	138.9%	< 0.062	0.340	444.5%	< 0.062	0.656	950.2%	< 0.062	0.176	181.4%	< 1.000	2.040	104.0%
B-3	5	10625.37	611.2%	< 0.062	1.348	2057.8%	< 0.062	1.840	2844.6%	**0.250**	**0.412**	**64.7%**	**1.310**	**6.640**	**406.9%**
B-30	0.5	17154.23	114.3%	< 0.313	2.265	624.0%	< 0.313	2.713	767.2%	< 0.313	0.568	81.5%	< 5.008	10.360	106.9%
B-30	2.5	12004.06	294.5%	**0.876**	**1.539**	**75.6%**	**1.751**	**2.031**	**16.0%**	**0.250**	**0.447**	**78.8%**	**5.382**	**7.437**	**38.2%**
B-31	5	27309.78	-68.1%	< 3.130	3.749	19.8%	**6.379**	**3.956**	**-38.0%**	< 3.130	0.775	-75.2%	**53.303**	**15.954**	**-70.1%**
B-31	10	38292.14	326.9%	< 0.313	5.407	1628.2%	**7.629**	**5.204**	**-31.8%**	**0.876**	**0.973**	**11.0%**	**14.806**	**21.836**	**47.5%**
B-34	10	669.81	-33.7%	< 0.062	0.067	8.0%	< 0.062	0.195	212.8%	< 0.062	0.065	3.5%	< 1.000	0.510	-49.0%
B-35	5	10383.78	-65.1%	< 1.250	1.315	5.2%	< 1.250	1.806	44.5%	< 1.250	0.406	-67.5%	< 20.005	6.500	-67.5%
B-35	10	487.85	-49.5%	< 0.062	0.048	-23.4%	< 0.062	0.151	141.9%	< 0.062	0.052	-16.3%	< 1.000	0.380	-62.0%
B-38	5	3778.19	484.3%	**0.250**	**0.440**	**75.8%**	**1.499**	**0.795**	**-47.0%**	**0.075**	**0.206**	**174.4%**	**2.710**	**2.542**	**-6.2%**
B-42	10	53798.45	-42.9%	< 3.130	7.815	149.7%	**10.299**	**6.857**	**-33.4%**	< 3.130	1.221	-61.0%	**57.226**	**29.943**	**-47.7%**
B-43	5	11259.87	-62.6%	**5.382**	**1.436**	**-73.3%**	**2.630**	**1.928**	**-26.7%**	< 1.250	0.428	-65.7%	**25.508**	**7.007**	**-72.5%**
B-47	5	13266.54	-57.0%	< 1.250	1.715	37.2%	**3.001**	**2.203**	**-26.6%**	< 1.250	0.478	-61.8%	**21.802**	**8.160**	**-62.6%**
B-52	5	18638.79	1052.2%	**11.101**	**2.478**	**-77.7%**	**5.883**	**2.902**	**-50.7%**	**0.250**	**0.600**	**140.1%**	**19.609**	**11.190**	**-42.9%**
B-52	10	12394.40	-59.4%	**6.760**	**1.593**	**-76.4%**	**3.251**	**2.084**	**-35.9%**	< 1.250	0.457	-63.5%	**27.495**	**7.661**	**-72.1%**
B-53	10	1251.38	13.4%	< 0.062	0.133	112.6%	**0.375**	**0.324**	**-13.5%**	**0.375**	**0.098**	**-73.8%**	**1.631**	**0.911**	**-44.1%**
B-68	10	4999.03	**643.0%**	**0.039**	**0.596**	**1434.5%**	**0.188**	**0.998**	**430.6%**	**0.188**	**0.249**	**32.2%**	**1.290**	**3.297**	**155.5%**
B-69	6	39894.75	**-41.9%**	**1.130**	**5.652**	**400.3%**	**6.129**	**5.380**	**-12.2%**	**5.129**	**1.000**	**-80.5%**	**42.692**	**22.683**	**-46.9%**
B-70	10	7762.04	984.0%	**4.129**	**0.959**	**-76.8%**	**2.000**	**1.426**	**-28.7%**	**0.188**	**0.334**	**77.5%**	**8.069**	**4.961**	**-38.5%**
B-71	5	3026.01	1109.3%	**3.130**	**0.346**	**-89.0%**	**2.499**	**0.664**	**-73.4%**	**0.110**	**0.178**	**61.4%**	**7.114**	**2.068**	**-70.9%**
B-71	10	1276.66	1052.8%	**0.526**	**0.136**	**-74.2%**	**0.551**	**0.330**	**-40.2%**	**0.063**	**0.100**	**59.1%**	**1.640**	**0.928**	**-43.4%**
B-72	5	688.15	**384.1%**	**0.009**	**0.069**	**693.5%**	**0.090**	**0.200**	**121.7%**	**0.032**	**0.066**	**102.6%**	**0.322**	**0.523**	**62.3%**
B-73	5	8416.93	482.3%	**1.380**	**1.047**	**-24.1%**	**0.876**	**1.523**	**73.8%**	**0.125**	**0.352**	**181.8%**	**3.939**	**5.348**	**35.8%**
B-73	10	1976.34	738.9%	**0.175**	**0.218**	**24.5%**	**0.613**	**0.470**	**-23.3%**	**0.073**	**0.133**	**83.9%**	**1.451**	**1.393**	**-4.0%**
GB-17	9	5630.76	312.4%	< 0.062	0.678	984.5%	**1.000**	**1.099**	**9.9%**	< 0.062	0.269	330.9%	**2.130**	**3.682**	**72.9%**
GB-18	9	13794.15	77.7%	**2.499**	**1.789**	**-28.4%**	**2.881**	**2.273**	**-21.1%**	< 0.313	0.491	56.8%	**9.757**	**8.461**	**-13.3%**
GB-19	9	5878.17	327.9%	**0.626**	**0.710**	**13.3%**	**1.250**	**1.138**	**-8.9%**	< 0.062	0.277	343.5%	**2.821**	**3.832**	**35.9%**
PW-3	10	127.74	-84.0%	< 0.062	0.011	-82.1%	< 0.062	0.051	-18.4%	< 0.062	0.021	-65.9%	< 1.000	0.109	-89.1%
PW-4	10	3755.59	-70.9%	**1.879**	**0.437**	**-76.8%**	< 0.625	0.791	26.6%	< 0.625	0.205	-67.2%	**11.302**	**2.528**	**-77.6%**
S-10	2.5	182.55		< 0.003	0.016	427.3%									
S-11	2.5	131.50		< 0.003	0.012	269.6%									
S-12	0.5	1565.56	37.4%	< 0.062	0.169	171.0%	< 0.062	0.389	522.8%	< 0.062	0.114	82.8%	< 1.000	1.122	12.2%
S-12	2.5	487.85		< 0.003	0.048	1429.6%									
S-15	2.5	2489.91	104.7%	< 0.003	0.280	8844.3%	< 0.062	0.567	807.5%	< 0.062	0.156	149.4%	< 1.000	1.726	72.6%
S-16	2.5	7390.86	420.8%	**0.250**	**0.910**	**263.8%**	< 0.062	1.370	2093.5%	< 0.062	0.323	417.0%	**1.560**	**4.740**	**203.8%**
S-17	0.5	6761.50	**-39.8%**	< 0.062	0.826	1222.3%	**0.751**	**1.275**	**69.7%**	**1.130**	**0.304**	**-73.1%**	**9.393**	**4.364**	**-53.5%**
S-17	2.5	3979.85		< 0.003	0.465	14767.1%									
S-18	2.5	8510.02	**46.9%**	< 0.003	1.060	33771.5%	**2.000**	**1.536**	**-23.2%**	**0.876**	**0.355**	**-59.5%**	**8.323**	**5.403**	**-35.1%**
S-19	2.5	7390.86	420.8%	< 0.003	0.910	28973.0%	< 0.062	1.370	2093.5%	< 0.062	0.323	417.0%	**1.250**	**4.740**	**279.3%**
S-20	0.5	1562.43	**-77.1%**	< 0.062	0.169	170.4%	**1.499**	**0.388**	**-74.1%**	**1.751**	**0.114**	**-93.5%**	**9.263**	**1.120**	**-87.9%**
S-23	2.5	2337.88	93.9%	< 0.003	0.261	8254.1%	< 0.062	0.539	762.3%	< 0.062	0.149	139.1%	< 1.000	1.628	62.8%
S-24	2.5	1952.76	231.5%	< 0.003	0.215	6773.9%	< 0.031	0.466	1387.1%	< 0.031	0.132	323.0%	< 0.501	1.377	174.9%
S-25	0.5	10636.00	255.6%	< 0.125	1.350	979.2%	< 0.125	1.841	1372.2%	< 0.125	0.412	229.6%	< 2.000	6.646	232.4%
S-25	2.5	4238.65		< 0.003	0.498	15817.4%									
S-28	0.5	3068.67	144.9%	< 0.062	0.351	461.8%	< 0.062	0.672	975.2%	< 0.062	0.179	186.9%	< 1.000	2.096	109.6%
S-29	2.5	68.79		< 0.003	0.006	83.1%									
S-30	2.5	275.06		< 0.003	0.026	722.2%									
S-31	2.5	71.31		< 0.003	0.006	90.4%									
S-32	0.5	3881.59	199.6%	< 0.062	0.453	624.7%	< 0.062	0.813	1200.9%	< 0.062	0.210	235.8%	< 1.000	2.607	160.7%
S-32	2.5	1664.03		**0.021**	**0.181**	**749.1%**									
S-33	2.5	952.41		< 0.003	0.099	3057.6%									
S-35	2.5	90.11		< 0.003	0.008	145.4%									
S-36	2.5	376.15		< 0.003	0.036	1054.1%									
S-37	2.5	269.08		< 0.003	0.025	702.8%									
S-38	0.5	501.70	417.0%	< 0.006	0.049	689.3%	< 0.006	0.155	2372.9%	< 0.006	0.053	752.1%	< 0.100	0.390	290.1%
S-39	2.5	12887.33	109.3%	< 0.251	1.662	563.1%	< 0.251	2.151	758.6%	**0.626**	**0.469**	**-25.1%**	**4.759**	**7.943**	**66.9%**

Notes:
Measured non-detects are reported at half the detection limit.
Naphthalene italics indicate 8260 value used.
Bold indicates detected values/estimates.

Table 3-3. Measured and Estimated PAH Concentrations for Paired TPH-PAH Results from On-Site Soil and Sediment Samples Collected from </= 10 ft. bgs.

			ene		Naphthalene			Phenanthrene			Pyrene			SumPAH		
Station	Top Depth	Sum TPH (C10-C40)	Indeno DELTA		Measured (mg/kg)	Estimated (mg/kg)	Naphth DELTA		Measured (mg/kg)	Estimated (mg/kg)	Phen DELTA		Measured (mg/kg)	Estimated (mg/kg)	Pyrene DELTA		Measured (mg/kg)	Estimated (mg/kg)	Sum PAH DELTA
S-41	0.5	23670.86	182.5%	<	0.313	3.211	926.3%		**1.000**	**3.523**	**252.3%**		**0.876**	**0.705**	**-19.6%**		**6.259**	**13.970**	**123.2%**
S-43	0.5	111413.08	167.3%	<	1.250	17.198	1276.0%	<	1.250	12.377	890.3%		**5.259**	**1.989**	**-62.2%**		**28.389**	**58.868**	**107.4%**
S-43	2.5	156.33	**58.2%**	<	0.003	0.014	345.8%	<	0.003	0.060	1818.5%	<	0.003	0.024	679.3%		**0.095**	**0.132**	**39.7%**
S-44	0.5	328.65	618.4%	<	0.003	0.031	897.0%	<	0.003	0.110	3405.3%	<	0.003	0.040	1182.1%		**0.054**	**0.263**	**383.7%**
S-44	2.5	201.74	372.5%	<	0.003	0.018	487.6%	<	0.003	0.074	2259.4%	<	0.003	0.029	824.5%		**0.060**	**0.167**	**178.5%**
S-45	0.5	143.45	-64.8%	<	0.031	0.013	-59.4%	<	0.031	0.056	78.8%		**0.063**	**0.023**	**-63.2%**		**0.757**	**0.122**	**-83.9%**
S-49	0.5	237.46	**126.6%**	<	0.003	0.022	601.1%	<	0.003	0.084	2592.9%	<	0.003	0.032	931.2%		**0.095**	**0.195**	**106.0%**
S-5	0.5	3508.70	174.7%	<	0.062	0.406	549.6%	<	0.062	0.749	1098.6%	<	0.062	0.196	213.9%	<	1.000	2.373	137.3%
S-5	2.5	105.11		<	0.003	0.009	189.9%												
S-51	2.5	147.23	260.6%	<	0.003	0.013	317.7%	<	0.003	0.057	1727.4%	<	0.003	0.023	648.6%		**0.054**	**0.125**	**129.5%**
S-52	0.5	376.91	708.0%	<	0.003	0.036	1056.6%	<	0.003	0.123	3817.3%	<	0.003	0.044	1305.4%		**0.060**	**0.299**	**397.6%**
S-52	2.5	1402.48	149.5%	<	0.031	0.150	380.0%	<	0.031	0.356	1036.9%		**0.063**	**0.106**	**69.4%**		**0.757**	**1.013**	**33.7%**
S-53	0.5	4044.04	**-22.5%**	<	0.062	0.473	657.7%	<	0.062	0.840	1244.9%		**0.125**	**0.216**	**72.4%**		**1.941**	**2.708**	**39.5%**
S-54	2.5	8127.43	40.9%	<	0.251	1.008	302.4%	<	0.251	1.480	490.7%		**1.499**	**0.344**	**-77.0%**		**6.259**	**5.177**	**-17.3%**
S-57	0.5	479.14	**-50.4%**	<	0.013	0.047	275.5%	<	0.013	0.149	1091.3%	<	0.013	0.052	313.2%		**0.350**	**0.374**	**6.8%**
S-58	0.5	913.24	72.7%	<	0.031	0.094	201.6%	<	0.031	0.251	702.8%	<	0.031	0.080	154.2%	<	0.501	0.680	35.7%
S-58	2.5	1876.19	220.4%		**0.713**	**0.206**	**-71.1%**		**0.363**	**0.451**	**24.1%**	<	0.031	0.129	311.8%		1.709	1.327	-22.4%
S-59	0.5	1362.40	143.4%	<	0.031	0.146	365.2%	<	0.031	0.348	1010.5%	<	0.031	0.104	232.3%	<	0.501	0.986	96.8%
S-59	2.5	14143.35	202.9%	<	0.187	1.838	880.2%		**0.375**	**2.320**	**518.8%**		**0.501**	**0.499**	**-0.4%**		**3.691**	**8.660**	**134.6%**
S-62	0.5	1587.63	177.6%	<	0.031	0.172	449.1%	<	0.031	0.394	1157.2%	<	0.031	0.115	268.2%	<	0.501	1.136	126.8%
S-62	2.5	11637.64	669.0%	<	0.062	1.488	2281.4%	<	0.062	1.981	3070.1%		**0.125**	**0.438**	**250.1%**		**1.380**	**7.225**	**423.6%**
S-63	0.5	51277.12	**-19.4%**	<	0.313	7.419	2271.3%		**4.259**	**6.595**	**54.9%**		**2.380**	**1.183**	**-50.3%**		**30.600**	**28.637**	**-6.4%**
S-66	0.5	339.34	**269.2%**	<	0.003	0.032	932.2%	<	0.003	0.113	3497.4%		**0.009**	**0.041**	**368.1%**		**0.081**	**0.271**	**233.0%**
S-67	0.5	143.74	**-82.0%**	<	0.003	0.013	307.0%		**0.041**	**0.056**	**35.8%**		**0.113**	**0.023**	**-79.6%**		**0.814**	**0.122**	**-85.0%**
S-7	0.5	1452.44	28.9%	<	0.062	0.156	149.8%	<	0.062	0.366	486.1%	<	0.062	0.109	73.8%	<	1.000	1.046	4.6%
S-9	2.5	90.11		<	0.003	0.008	145.4%												
Sd-1	0.5	257.49	482.6%	<	0.003	0.024	665.4%	<	0.003	0.090	2775.8%	<	0.003	0.034	988.7%	<	0.050	0.210	319.0%
Sd-2	0.5	35.06	5.2%	<	0.003	0.003	-11.8%	<	0.003	0.018	470.5%	<	0.003	0.009	186.2%	<	0.050	0.033	-34.2%
Sd-3	0.5	601.24	202.0%	<	0.003	0.060	1818.3%	<	0.013	0.179	1332.2%	<	0.013	0.060	381.0%	<	0.200	0.461	130.5%
T-19	2.5	789.18	281.5%	<	0.013	0.081	544.8%	<	0.013	0.223	1685.8%	<	0.013	0.072	477.2%	<	0.200	0.594	196.8%
T-2	0.5	424.96	**-68.0%**	<	0.006	0.041	559.3%		**0.100**	**0.135**	**35.2%**		**0.163**	**0.048**	**-70.8%**		**1.290**	**0.334**	**-74.1%**
All ND:																			
B-24	5	<	12.50																
B-72	10	<	12.50																
MW-48D	3	<	6.25																
MW-48D	4	<	6.25																
MW-53D	10	<	6.25																
S-1	2.5	<	12.50																
S-13	2.5	<	12.50																
S-14	2.5	<	12.50																
S-2	2.5	<	12.50																
S-20	2.5	<	12.50																
S-21	2.5	<	12.50																
S-22	2.5	<	12.50																
S-26	2.5	<	12.50																
S-27	2.5	<	12.50																
S-28	2.5	<	12.50																
S-3	2.5	<	12.50																
S-34	2.5	<	12.50																
S-38	2.5	<	12.50																
S-4	2.5	<	12.50																
S-6	2.5	<	12.50																
S-7	2.5	<	12.50																
S-8	2.5	<	12.50																

Notes:
Measured non-detects are reported at half the detection limit.
Naphthalene italics indicate 8260 value used.
Bold indicates detected values/estimates.

Appendix I
Foodweb Calculations and pERA Dataset (on CD)

BBL®
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Song Sparrow
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.11	0.89	0.00	0.023	0.0054	0.093	0.00050	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	388	202	428	5.8	102	5.5	19	22	**4.6**
Lead	1.5	0.47	0.29	1151	1727	539	334	180	0.014	**12865**	8.8	**21**
Organics												
Acenaphthene	0.16	0.60	2.2	0.88	0.14	0.53	1.9	0.13	33	**0.0040**	325	**0.00040**
Acenaphthylene	0.16	0.55	2.2	0.50	0.080	0.28	1.1	0.07	33	**0.0022**	325	**0.00022**
Anthracene	0.16	0.40	2.2	0.38	0.060	0.15	0.83	0.04	33	**0.0012**	325	**0.00012**
Benzo(a)anthracene	0.16	0.14	2.2	2.3	0.36	0.32	5.0	0.12	33	**0.0038**	325	**0.00038**
Benzo(a)pyrene	0.16	0.05	2.2	4.5	0.72	0.23	9.9	0.16	33	**0.0050**	325	**0.00050**
Benzo(b)fluoranthene	0.16	0.10	2.2	3.6	0.58	0.35	8.0	0.17	33	**0.0051**	325	**0.00051**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.75	0.12	0.05	1.7	0.03	33	**0.00090**	325	**0.000090**
Benzo(ghi)perylene	0.16	0.09	2.2	2.4	0.38	0.23	5.2	0.11	33	**0.0033**	325	**0.00033**
Chrysene	0.16	0.21	2.2	3.9	0.62	0.82	8.5	0.27	33	**0.0083**	325	**0.00083**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.0089	33	**0.00027**	325	**0.000027**
Fluoranthene	0.16	0.27	2.2	1.4	0.22	0.37	3.0	0.11	33	**0.0034**	325	**0.00034**
Fluorene	0.16	0.50	2.2	2.8	0.44	1.4	6.1	0.36	33	**0.011**	325	**0.0011**
Indeno(1,2,3-cd)pyrene	0.16	0.06	2.2	2.1	0.34	0.13	4.7	0.081	33	**0.0025**	325	**0.00025**
Naphthalene	0.16	1.1	2.2	11	1.8	12	25	2.8	27	**0.11**	269	**0.011**
Phenanthrene	0.16	0.40	2.2	6.4	1.0	2.5	14	0.68	33	**0.021**	325	**0.0021**
Pyrene	0.16	0.27	2.2	5.3	0.84	1.4	12	0.43	33	**0.013**	325	**0.0013**
TPH (C10-C40)	NA	NA	NA	337922	NA	NA	NA	7288	218	**33**	2180	**3.3**

Song Sparrow
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.11	0.89	0.00	0.023	0.0054	0.093	0.00050	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	sed dw / kg inv	sed dw / kg veg	ed dw / kg ve	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	15	7.8	17	0.22	3.9	5.5	**0.72**	22	**0.18**
Lead	1.5	0.5	0.29	71	106	33	20	11	0.014	**789**	8.8	**1.3**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	0.16	0.60	2.2	0.33	0.052	0.20	0.72	0.049	33	**0.0015**	325	**0.00015**
Acenaphthylene	0.16	0.55	2.2	0.30	0.047	0.16	0.65	0.041	33	**0.0013**	325	**0.00013**
Anthracene	0.16	0.40	2.2	0.29	0.046	0.11	0.63	0.031	33	**0.00095**	325	**0.000095**
Benzo(a)anthracene	0.16	0.14	2.2	0.50	0.081	0.071	1.1	0.028	33	**0.00085**	325	**0.000085**
Benzo(a)pyrene	0.16	0.05	2.2	0.49	0.078	0.025	1.1	0.018	33	**0.00055**	325	**0.000055**
Benzo(b)fluoranthene	0.16	0.10	2.2	0.45	0.072	0.043	0.99	0.021	33	**0.00063**	325	**0.000063**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.34	0.054	0.022	0.74	0.013	33	**0.00040**	325	**0.000040**
Benzo(ghi)perylene	0.16	0.09	2.2	0.38	0.061	0.036	0.84	0.017	33	**0.00053**	325	**0.000053**
Chrysene	0.16	0.21	2.2	0.58	0.093	0.12	1.3	0.040	33	**0.0012**	325	**0.00012**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.009	33	**0.00027**	325	**0.000027**
Fluoranthene	0.16	0.27	2.2	0.52	0.084	0.14	1.2	0.042	33	**0.0013**	325	**0.00013**
Fluorene	0.16	0.50	2.2	0.77	0.12	0.38	1.7	0.099	33	**0.0030**	325	**0.00030**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	0.38	0.061	0.023	0.84	0.015	33	**0.00045**	325	**0.000045**
Naphthalene	0.16	1.1	2.2	0.35	0.056	0.39	0.77	0.089	27	**0.0033**	269	**0.00033**
Phenanthrene	0.16	0.40	2.2	2.4	0.38	0.94	5.2	0.254	33	**0.0078**	325	**0.00078**
Pyrene	0.16	0.27	2.2	0.91	0.15	0.25	2.0	0.074	33	**0.0023**	325	**0.00023**
TPH (C10-C40)	NA	NA	NA	20300	NA	NA	NA	437.802	218	**2.0**	2180	**0.20**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Soil Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

California Vole
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.00	1.00	0.00	0.0360	0.0053	0.024	0.000130	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	388	202	428	5.8	64	0.32	**201**	4.7	**13.7**
Lead	1.5	0.47	0.29	1151	1727	539	334	83	1.0	**83**	241	**0.3**
Organics												
Acenaphthene	0.16	0.60	2.2	0.88	0.14	0.53	1.9	0.080	175	**0.00046**	350	**0.00023**
Acenaphthylene	0.16	0.55	2.2	0.50	0.080	0.28	1.1	0.043	175	**0.00024**	350	**0.000122**
Anthracene	0.16	0.40	2.2	0.38	0.060	0.15	0.83	0.023	1000	**0.000023**	NA	**NA**
Benzo(a)anthracene	0.16	0.14	2.2	2.3	0.36	0.32	5.0	0.055	1.0	**0.055**	10	**0.0055**
Benzo(a)pyrene	0.16	0.05	2.2	4.5	0.72	0.23	9.9	0.05	1.0	**0.05**	10	**0.005**
Benzo(b)fluoranthene	0.16	0.10	2.2	3.6	0.58	0.35	8.0	0.06	1.0	**0.06**	10	**0.006**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.75	0.12	0.048	1.7	0.010	1.0	**0.010**	10	**0.0010**
Benzo(ghi)perylene	0.16	0.09	2.2	2.4	0.38	0.23	5.2	0.042	1.0	**0.042**	10	**0.0042**
Chrysene	0.16	0.21	2.2	3.9	0.62	0.82	8.5	0.13	1.0	**0.13**	10	**0.013**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.00	1.0	**0.0027**	10	**0.00027**
Fluoranthene	0.16	0.27	2.2	1.4	0.22	0.37	3.0	0.059	125	**0.00047**	250	**0.00023**
Fluorene	0.16	0.50	2.2	2.8	0.44	1.4	6.1	0.21	125	**0.00171**	250	**0.00085**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	2.1	0.34	0.13	4.7	0.026	1.0	**0.026**	10	**0.0026**
Naphthalene	0.16	1.1	2.2	11	1.8	12	25	1.85	50	**0.0370**	150	**0.0123**
Phenanthrene	0.16	0.40	2.2	6.4	1.0	2.5	14	0.39	125	**0.0032**	250	**0.0016**
Pyrene	0.16	0.27	2.2	5.3	0.84	1.4	12	0.23	75	**0.0030**	125	**0.0018**
TPH (C10-C40)	NA	NA	NA	337922	NA	NA	NA	1220	197	**6**	890	**1.4**

California Vole
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.00	1.00	0.00	0.0360	0.0053	0.024	0.000130	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	sed dw / kg inv	sed dw / kg veg	sed dw / kg ve	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	15	7.8	17	0.22	2.5	0.32	**7.8**	4.7	**0.53**
Lead	1.5	0.47	0.29	71	106	33	20	5	1.0	**5.1**	241	**0.021**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	0.16	0.60	2.20	0.33	0.052	0.20	0.72	0.030	175	**0.000172**	350	**0.000086**
Acenaphthylene	0.16	0.55	2.20	0.30	0.047	0.16	0.65	0.025	175	**0.000144**	350	**0.000072**
Anthracene	0.16	0.40	2.20	0.29	0.046	0.11	0.63	0.018	1000	**0.000018**	NA	**NA**
Benzo(a)anthracene	0.16	0.14	2.20	0.50	0.081	0.071	1.1	0.012	1.0	**0.012**	10	**0.0012**
Benzo(a)pyrene	0.16	0.05	2.20	0.49	0.078	0.025	1.1	0.006	1.0	**0.006**	10	**0.0006**
Benzo(b)fluoranthene	0.16	0.10	2.20	0.45	0.072	0.043	0.99	0.008	1.0	**0.008**	10	**0.0008**
Benzo(k)fluoranthene	0.16	0.06	2.20	0.34	0.054	0.022	0.74	0.004	1.0	**0.004**	10	**0.0004**
Benzo(ghi)perylene	0.16	0.09	2.20	0.38	0.061	0.036	0.84	0.007	1.0	**0.007**	10	**0.0007**
Chrysene	0.16	0.21	2.20	0.58	0.093	0.12	1.3	0.020	1.0	**0.020**	10	**0.0020**
Dibenzo(a,h)anthracene	0.16	0.047	2.20	0.25	0.040	0.012	0.55	0.003	1.0	**0.0027**	10	**0.00027**
Fluoranthene	0.16	0.27	2.20	0.52	0.084	0.14	1.2	0.022	125	**0.00018**	250	**0.000089**
Fluorene	0.16	0.50	2.20	0.77	0.122	0.38	1.7	0.059	125	**0.00047**	250	**0.00024**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.20	0.38	0.061	0.023	0.84	0.005	1.0	**0.005**	10	**0.0005**
Naphthalene	0.16	1.1	2.20	0.35	0.056	0.39	0.77	0.058	50	**0.00116**	150	**0.000388**
Phenanthrene	0.16	0.40	2.20	2.4	0.379	0.94	5.2	0.146	125	**0.00117**	250	**0.00059**
Pyrene	0.16	0.27	2.20	0.91	0.146	0.25	2.0	0.039	75	**0.00053**	125	**0.00032**
TPH (C10-C40)	NA	NA	NA	20300	NA	NA	NA	73	197	**0.37**	890	**0.08**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Soil Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

Western Meadowlark
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.63	0.37	0.00	0.091	0.013741	0.10	0.00143	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	388	202	428	5.8	49	5.5	**8.9**	22	**2.2**
Lead	1.5	0.47	0.29	1151	1727	539	334	213	0.014	**15183**	8.8	**24**
Organics												
Acenaphthene	0.16	0.60	2.2	0.88	0.14	0.53	1.9	0.056	33	**0.0017**	325	**0.00017**
Acenaphthylene	0.16	0.55	2.2	0.50	0.080	0.28	1.1	0.031	33	**0.00095**	325	**0.000095**
Anthracene	0.16	0.40	2.2	0.38	0.060	0.15	0.83	0.020	33	**0.00061**	325	**0.000061**
Benzo(a)anthracene	0.16	0.14	2.2	2.3	0.36	0.32	5.0	0.087	33	**0.0027**	325	**0.00027**
Benzo(a)pyrene	0.16	0.05	2.2	4.5	0.72	0.23	10	0.15	33	**0.0047**	325	**0.00047**
Benzo(b)fluoranthene	0.16	0.10	2.2	3.6	0.58	0.35	8.0	0.13	33	**0.0041**	325	**0.00041**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.75	0.12	0.048	1.7	0.026	33	**0.00080**	325	**0.000080**
Benzo(ghi)perylene	0.16	0.09	2.2	2.4	0.38	0.23	5.2	0.086	33	**0.0026**	325	**0.00026**
Chrysene	0.16	0.21	2.2	3.9	0.62	0.82	8.5	0.17	33	**0.0051**	325	**0.00051**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.0084	33	**0.00026**	325	**0.000026**
Fluoranthene	0.16	0.27	2.2	1.4	0.22	0.37	3.0	0.063	33	**0.0019**	325	**0.00019**
Fluorene	0.16	0.50	2.2	2.8	0.44	1.4	6.1	0.16	33	**0.0050**	325	**0.00050**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	2.1	0.34	0.13	4.7	0.073	33	**0.0022**	325	**0.00022**
Naphthalene	0.16	1.1	2.2	11	1.8	12	25	1.0	27	**0.038**	269	**0.0038**
Phenanthrene	0.16	0.40	2.2	6.4	1.0	2.5	14	0.34	33	**0.010**	325	**0.0010**
Pyrene	0.16	0.27	2.2	5.3	0.84	1.4	12	0.24	33	**0.0074**	325	**0.00074**
TPH (C10-C40)	NA	NA	NA	337922	NA	NA	NA	5295	218	**24**	2180	**2.4**

Western Meadowlark
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.63	0.37	0.00	0.091	0.013741	0.10	0.00143	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	sed dw / kg inv	ed dw / kg veg	ed dw / kg ve	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	15	8	17	0.22	1.9	5.5	**0.34**	22	**0.086**
Lead	1.5	0.5	0.29	71	106	33	20	13	0.014	**931**	8.8	**1.5**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	0.16	0.60	2.2	0.33	0.052	0.20	0.72	0.021	33	**0.00064**	325	**0.000064**
Acenaphthylene	0.16	0.55	2.2	0.30	0.047	0.16	0.65	0.018	33	**0.00056**	325	**0.000056**
Anthracene	0.16	0.40	2.2	0.29	0.046	0.11	0.63	0.015	33	**0.00047**	325	**0.000047**
Benzo(a)anthracene	0.16	0.14	2.2	0.50	0.081	0.071	1.1	0.020	33	**0.00060**	325	**0.000060**
Benzo(a)pyrene	0.16	0.05	2.2	0.49	0.078	0.025	1.1	0.017	33	**0.00051**	325	**0.000051**
Benzo(b)fluoranthene	0.16	0.10	2.2	0.45	0.072	0.043	0.99	0.016	33	**0.00050**	325	**0.000050**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.34	0.054	0.022	0.74	0.012	33	**0.00036**	325	**0.000036**
Benzo(ghi)perylene	0.16	0.09	2.2	0.38	0.061	0.036	0.84	0.014	33	**0.00043**	325	**0.000043**
Chrysene	0.16	0.21	2.2	0.58	0.093	0.12	1.3	0.025	33	**0.0008**	325	**0.000076**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.0084	33	**0.00026**	325	**0.000026**
Fluoranthene	0.16	0.27	2.2	0.52	0.084	0.14	1.2	0.024	33	**0.0007**	325	**0.000074**
Fluorene	0.16	0.50	2.2	0.77	0.12	0.38	1.7	0.045	33	**0.0014**	325	**0.00014**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	0.38	0.061	0.023	0.84	0.013	33	**0.00040**	325	**0.000040**
Naphthalene	0.16	1.1	2.2	0.35	0.056	0.39	0.77	0.032	27	**0.0012**	269	**0.00012**
Phenanthrene	0.16	0.40	2.2	2.4	0.38	0.94	5.2	0.13	33	**0.0038**	325	**0.00038**
Pyrene	0.16	0.27	2.2	0.91	0.15	0.25	2.0	0.042	33	**0.0013**	325	**0.00013**
TPH (C10-C40)	NA	NA	NA	20300	NA	NA	NA	318	218	**1.5**	2180	**0.15**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Soil Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

Loggerhead Shrike
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.88	0.00	0.12	0.048	0.0088	0.000	0.00000	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	388	202	428	5.8	33	5.5	**6**	22	**1.5**
Lead	1.5	0.5	0.29	1151	1727	539	334	286	0.014	**20428**	8.8	**33**
Organics												
Acenaphthene	0.16	0.60	2.2	0.88	0.14	0.53	1.9	0.07	33	**0.0020**	325	**0.00020**
Acenaphthylene	0.16	0.55	2.2	0.50	0.080	0.28	1.1	0.037	33	**0.0011**	325	**0.00011**
Anthracene	0.16	0.40	2.2	0.38	0.060	0.15	0.83	0.028	33	**0.0009**	325	**0.00009**
Benzo(a)anthracene	0.16	0.14	2.2	2.3	0.36	0.32	5.0	0.167	33	**0.0051**	325	**0.00051**
Benzo(a)pyrene	0.16	0.05	2.2	4.5	0.72	0.23	9.9	0.334	33	**0.0103**	325	**0.00103**
Benzo(b)fluoranthene	0.16	0.10	2.2	3.6	0.58	0.35	8.0	0.269	33	**0.0083**	325	**0.00083**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.75	0.12	0.05	1.7	0.056	33	**0.00171**	325	**0.000171**
Benzo(ghi)perylene	0.16	0.09	2.2	2.4	0.38	0.23	5.2	0.176	33	**0.0054**	325	**0.00054**
Chrysene	0.16	0.21	2.2	3.9	0.62	0.82	8.5	0.288	33	**0.0089**	325	**0.00089**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.019	33	**0.00057**	325	**0.000057**
Fluoranthene	0.16	0.27	2.2	1.4	0.22	0.37	3.0	0.102	33	**0.0031**	325	**0.00031**
Fluorene	0.16	0.50	2.2	2.8	0.44	1.4	6.1	0.204	33	**0.006**	325	**0.0006**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	2.1	0.34	0.13	4.7	0.158	33	**0.0049**	325	**0.00049**
Naphthalene	0.16	1.1	2.2	11	1.8	12	25	0.827	27	**0.03**	269	**0.003**
Phenanthrene	0.16	0.40	2.2	6.4	1.0	2.5	14	0.474	33	**0.015**	325	**0.0015**
Pyrene	0.16	0.27	2.2	5.3	0.84	1.4	12	0.390	33	**0.012**	325	**0.0012**
TPH (C10-C40)	NA	NA	NA	337922	NA	NA	NA	0.000	218	**0**	2180	**0.0**

Loggerhead Shrike
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.88	0.00	0.12	0.048	0.0088	0.000	0.00000	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	sed dw / kg inv	ed dw / kg veg	ed dw / kg ve	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	15	7.8	17	0.22	1.3	5.5	**0.23**	22	**0.06**
Lead	1.5	0.5	0.29	71	106	33	20	18	0.014	**1253**	8.8	**2.0**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	0.16	0.60	2.2	0.33	0.052	0.20	0.72	0.024	33	**0.0007**	325	**0.00007**
Acenaphthylene	0.16	0.55	2.2	0.30	0.047	0.16	0.65	0.022	33	**0.0007**	325	**0.00007**
Anthracene	0.16	0.40	2.2	0.29	0.046	0.11	0.63	0.021	33	**0.00066**	325	**0.000066**
Benzo(a)anthracene	0.16	0.14	2.2	0.50	0.081	0.071	1.1	0.037	33	**0.00115**	325	**0.000115**
Benzo(a)pyrene	0.16	0.05	2.2	0.49	0.078	0.025	1.1	0.036	33	**0.00112**	325	**0.000112**
Benzo(b)fluoranthene	0.16	0.10	2.2	0.45	0.072	0.043	0.99	0.033	33	**0.00103**	325	**0.000103**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.34	0.054	0.022	0.74	0.025	33	**0.00077**	325	**0.000077**
Benzo(ghi)perylene	0.16	0.09	2.2	0.38	0.061	0.036	0.84	0.028	33	**0.00087**	325	**0.000087**
Chrysene	0.16	0.21	2.2	0.58	0.093	0.12	1.3	0.043	33	**0.0013**	325	**0.00013**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.019	33	**0.00057**	325	**0.000057**
Fluoranthene	0.16	0.27	2.2	0.52	0.084	0.14	1.2	0.039	33	**0.0012**	325	**0.00012**
Fluorene	0.16	0.50	2.2	0.77	0.12	0.38	1.7	0.057	33	**0.0017**	325	**0.00017**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	0.38	0.061	0.023	0.84	0.028	33	**0.00088**	325	**0.000088**
Naphthalene	0.16	1.1	2.2	0.35	0.056	0.39	0.77	0.026	27	**0.0010**	269	**0.00010**
Phenanthrene	0.16	0.40	2.2	2.4	0.38	0.94	5.2	0.176	33	**0.0054**	325	**0.00054**
Pyrene	0.16	0.27	2.2	0.91	0.15	0.25	2.0	0.068	33	**0.0021**	325	**0.00021**
TPH (C10-C40)	NA	NA	NA	20300	NA	NA	NA	0.000	218	**0.0**	2180	**0.00**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Soil Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

Ornate Shrew
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	1.00	0.00	0.00	0.0048	0.0010	0.030	0.000030	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	388	202	428	5.8	44	0.32	**138**	4.7	**9.4**
Lead	1.5	0.47	0.29	1151	1727	539	334	364	1.0	**364**	241	**1.5**
Organics												
Acenaphthene	0.16	0.60	2.2	0.88	0.14	0.53	1.9	0.034	175	**0.00020**	350	**0.00010**
Acenaphthylene	0.16	0.55	2.2	0.50	0.080	0.28	1.1	0.020	175	**0.00011**	350	**0.000056**
Anthracene	0.16	0.40	2.2	0.38	0.060	0.15	0.83	0.015	1000	**0.000015**	NA	**NA**
Benzo(a)anthracene	0.16	0.14	2.2	2.3	0.36	0.32	5.0	0.088	1.0	**0.088**	10	**0.0088**
Benzo(a)pyrene	0.16	0.05	2.2	4.5	0.72	0.23	9.9	0.18	1.0	**0.18**	10	**0.018**
Benzo(b)fluoranthene	0.16	0.10	2.2	3.6	0.58	0.35	8.0	0.14	1.0	**0.14**	10	**0.014**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.75	0.12	0.048	1.7	0.029	1.0	**0.029**	10	**0.0029**
Benzo(ghi)perylene	0.16	0.09	2.2	2.4	0.38	0.23	5.2	0.093	1.0	**0.093**	10	**0.0093**
Chrysene	0.16	0.21	2.2	3.9	0.62	0.82	8.5	0.15	1.0	**0.15**	10	**0.015**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.01	1.0	**0.0098**	10	**0.00098**
Fluoranthene	0.16	0.27	2.2	1.4	0.22	0.37	3.0	0.054	125	**0.00043**	250	**0.00022**
Fluorene	0.16	0.50	2.2	2.8	0.44	1.4	6.1	0.11	125	**0.00086**	250	**0.00043**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	2.1	0.34	0.13	4.7	0.084	1.0	**0.084**	10	**0.0084**
Naphthalene	0.16	1.1	2.2	11	1.8	12	25	0.44	50	**0.0087**	150	**0.0029**
Phenanthrene	0.16	0.40	2.2	6.4	1.0	2.5	14	0.25	125	**0.0020**	250	**0.0010**
Pyrene	0.16	0.27	2.2	5.3	0.84	1.4	12	0.21	75	**0.0028**	125	**0.0017**
TPH (C10-C40)	NA	NA	NA	337922	NA	NA	NA	2094	197	**11**	890	**2.4**

Ornate Shrew
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	1.00	0.00	0.00	0.0048	0.0010	0.030	0.000030	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	sed dw / kg inv	sed dw / kg veg	d dw / kg ve	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	15	7.8	17	0.22	1.7	0.32	**5.3**	4.7	**0.36**
Lead	1.5	0.47	0.29	71	106	33	20	22	1.0	**22**	241	**0.093**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	0.16	0.60	2.20	0.33	0.052	0.20	0.72	0.013	175	**0.000073**	350	**0.000037**
Acenaphthylene	0.16	0.55	2.20	0.30	0.047	0.16	0.65	0.012	175	**0.000066**	350	**0.000033**
Anthracene	0.16	0.40	2.20	0.29	0.046	0.11	0.63	0.011	1000	**0.000011**	NA	**NA**
Benzo(a)anthracene	0.16	0.14	2.20	0.50	0.081	0.071	1.1	0.020	1.0	**0.020**	10	**0.0020**
Benzo(a)pyrene	0.16	0.05	2.20	0.49	0.078	0.025	1.1	0.019	1.0	**0.019**	10	**0.0019**
Benzo(b)fluoranthene	0.16	0.10	2.20	0.45	0.072	0.043	0.99	0.018	1.0	**0.018**	10	**0.0018**
Benzo(k)fluoranthene	0.16	0.06	2.20	0.34	0.054	0.022	0.74	0.013	1.0	**0.013**	10	**0.0013**
Benzo(ghi)perylene	0.16	0.09	2.20	0.38	0.061	0.036	0.84	0.015	1.0	**0.015**	10	**0.0015**
Chrysene	0.16	0.21	2.20	0.58	0.093	0.12	1.3	0.023	1.0	**0.023**	10	**0.0023**
Dibenzo(a,h)anthracene	0.16	0.047	2.20	0.25	0.040	0.012	0.55	0.010	1.0	**0.0098**	10	**0.00098**
Fluoranthene	0.16	0.27	2.20	0.52	0.084	0.14	1.2	0.021	125	**0.00016**	250	**0.000082**
Fluorene	0.16	0.50	2.20	0.77	0.122	0.38	1.7	0.030	125	**0.00024**	250	**0.00012**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.20	0.38	0.061	0.023	0.84	0.015	1.0	**0.015**	10	**0.0015**
Naphthalene	0.16	1.1	2.20	0.35	0.056	0.39	0.77	0.014	50	**0.00027**	150	**0.000092**
Phenanthrene	0.16	0.40	2.20	2.4	0.379	0.94	5.2	0.093	125	**0.00074**	250	**0.00037**
Pyrene	0.16	0.27	2.20	0.91	0.146	0.25	2.0	0.036	75	**0.00048**	125	**0.00029**
TPH (C10-C40)	NA	NA	NA	20300	NA	NA	NA	126	197	**0.64**	890	**0.14**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Soil Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

American Kestrel
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.26	0.00	0.74	0.111	0.0193	0	0	NA		1.0
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	388	202	428	5.8	10	5.5	**2**	22	**0.4**
Lead	1.5	0.5	0.29	1151	1727	539	334	121	0.014	**8646**	8.8	**14**
Organics												
Acenaphthene	0.16	0.60	2.2	0.88	0.14	0.53	1.9	0.25	33	**0.0078**	325	**0.00078**
Acenaphthylene	0.16	0.55	2.2	0.50	0.080	0.28	1.1	0.145	33	**0.0045**	325	**0.00045**
Anthracene	0.16	0.40	2.2	0.38	0.060	0.15	0.83	0.109	33	**0.0034**	325	**0.00034**
Benzo(a)anthracene	0.16	0.14	2.2	2.3	0.36	0.32	5.0	0.654	33	**0.0201**	325	**0.00201**
Benzo(a)pyrene	0.16	0.05	2.2	4.5	0.72	0.23	9.9	1.308	33	**0.0402**	325	**0.00402**
Benzo(b)fluoranthene	0.16	0.10	2.2	3.6	0.58	0.35	8.0	1.054	33	**0.0324**	325	**0.00324**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.75	0.12	0.05	1.7	0.218	33	**0.00671**	325	**0.000671**
Benzo(ghi)perylene	0.16	0.09	2.2	2.4	0.38	0.23	5.2	0.690	33	**0.0212**	325	**0.00212**
Chrysene	0.16	0.21	2.2	3.9	0.62	0.82	8.5	1.126	33	**0.0347**	325	**0.00347**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.073	33	**0.00224**	325	**0.000224**
Fluoranthene	0.16	0.27	2.2	1.4	0.22	0.37	3.0	0.400	33	**0.0123**	325	**0.00123**
Fluorene	0.16	0.50	2.2	2.8	0.44	1.4	6.1	0.799	33	**0.025**	325	**0.0025**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	2.1	0.34	0.13	4.7	0.618	33	**0.0190**	325	**0.00190**
Naphthalene	0.16	1.1	2.2	11	1.8	12	25	3.234	27	**0.12**	269	**0.012**
Phenanthrene	0.16	0.40	2.2	6.4	1.0	2.5	14	1.853	33	**0.057**	325	**0.0057**
Pyrene	0.16	0.27	2.2	5.3	0.84	1.4	12	1.526	33	**0.047**	325	**0.0047**
TPH (C10-C40)	NA	NA	NA	337922	NA	NA	NA	0.000	218	**0**	2180	**0.0**

American Kestrel
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.26	0.00	0.74	0.111	0.0193	0	0	NA		1.0
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	sed dw / kg inv	ed dw / kg veg	ed dw / kg ve	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	15	7.8	17	0.22	0.4	5.5	**0.07**	22	**0.02**
Lead	1.5	0.5	0.29	71	106	33	20	7	0.014	**530**	8.8	**0.8**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	0.16	0.60	2.2	0.33	0.052	0.20	0.72	0.095	33	**0.0029**	325	**0.00029**
Acenaphthylene	0.16	0.55	2.2	0.30	0.047	0.16	0.65	0.086	33	**0.0026**	325	**0.00026**
Anthracene	0.16	0.40	2.2	0.29	0.046	0.11	0.63	0.084	33	**0.00257**	325	**0.000257**
Benzo(a)anthracene	0.16	0.14	2.2	0.50	0.081	0.071	1.1	0.146	33	**0.00450**	325	**0.000450**
Benzo(a)pyrene	0.16	0.05	2.2	0.49	0.078	0.025	1.1	0.142	33	**0.00438**	325	**0.000438**
Benzo(b)fluoranthene	0.16	0.10	2.2	0.45	0.072	0.043	0.99	0.131	33	**0.00402**	325	**0.000402**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.34	0.054	0.022	0.74	0.098	33	**0.00302**	325	**0.000302**
Benzo(ghi)perylene	0.16	0.09	2.2	0.38	0.061	0.036	0.84	0.111	33	**0.00341**	325	**0.000341**
Chrysene	0.16	0.21	2.2	0.58	0.093	0.12	1.3	0.168	33	**0.0052**	325	**0.00052**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.073	33	**0.00223**	325	**0.000223**
Fluoranthene	0.16	0.27	2.2	0.52	0.084	0.14	1.2	0.152	33	**0.0047**	325	**0.00047**
Fluorene	0.16	0.50	2.2	0.77	0.12	0.38	1.7	0.222	33	**0.0068**	325	**0.00068**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	0.38	0.061	0.023	0.84	0.111	33	**0.00343**	325	**0.000343**
Naphthalene	0.16	1.1	2.2	0.35	0.056	0.39	0.77	0.102	27	**0.0038**	269	**0.00038**
Phenanthrene	0.16	0.40	2.2	2.4	0.38	0.94	5.2	0.688	33	**0.0212**	325	**0.00212**
Pyrene	0.16	0.27	2.2	0.91	0.15	0.25	2.0	0.264	33	**0.0081**	325	**0.00081**
TPH (C10-C40)	NA	NA	NA	20300	NA	NA	NA	0.000	218	**0.0**	2180	**0.00**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Soil Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

Northern Harrier
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.00	0.00	1.00	0.370	0.0430	0.000	0.00000	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	388	202	428	5.8	1	5.5	**0**	22	**0.0**
Lead	1.5	0.5	0.29	1151	1727	539	334	39	0.014	**2772**	8.8	**4**
Organics												
Acenaphthene	0.16	0.60	2.2	0.88	0.14	0.53	1.9	0.22	33	**0.0069**	325	**0.00069**
Acenaphthylene	0.16	0.55	2.2	0.50	0.080	0.28	1.1	0.128	33	**0.0039**	325	**0.00039**
Anthracene	0.16	0.40	2.2	0.38	0.060	0.15	0.83	0.096	33	**0.0030**	325	**0.00030**
Benzo(a)anthracene	0.16	0.14	2.2	2.3	0.36	0.32	5.0	0.576	33	**0.0177**	325	**0.00177**
Benzo(a)pyrene	0.16	0.05	2.2	4.5	0.72	0.23	9.9	1.152	33	**0.0354**	325	**0.00354**
Benzo(b)fluoranthene	0.16	0.10	2.2	3.6	0.58	0.35	8.0	0.928	33	**0.0286**	325	**0.00286**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.75	0.12	0.05	1.7	0.192	33	**0.00591**	325	**0.000591**
Benzo(ghi)perylene	0.16	0.09	2.2	2.4	0.38	0.23	5.2	0.608	33	**0.0187**	325	**0.00187**
Chrysene	0.16	0.21	2.2	3.9	0.62	0.82	8.5	0.992	33	**0.0305**	325	**0.00305**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.064	33	**0.00197**	325	**0.000197**
Fluoranthene	0.16	0.27	2.2	1.4	0.22	0.37	3.0	0.352	33	**0.0108**	325	**0.00108**
Fluorene	0.16	0.50	2.2	2.8	0.44	1.4	6.1	0.704	33	**0.022**	325	**0.0022**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	2.1	0.34	0.13	4.7	0.544	33	**0.0167**	325	**0.00167**
Naphthalene	0.16	1.1	2.2	11	1.8	12	25	2.848	27	**0.11**	269	**0.011**
Phenanthrene	0.16	0.40	2.2	6.4	1.0	2.5	14	1.632	33	**0.050**	325	**0.0050**
Pyrene	0.16	0.27	2.2	5.3	0.84	1.4	12	1.344	33	**0.041**	325	**0.0041**
TPH (C10-C40)	NA	NA	NA	337922	NA	NA	NA	0.000	218	**0**	2180	**0.0**

Northern Harrier
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.00	0.00	1.00	0.370	0.0430	0.000	0.00000	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	sed dw / kg inv	ed dw / kg veg	ed dw / kg vei	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	15	7.8	17	0.22	0.0	5.5	**0.00**	22	**0.00**
Lead	1.5	0.5	0.29	71	106	33	20	2	0.014	**170**	8.8	**0.3**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	0.16	0.60	2.2	0.33	0.052	0.20	0.72	0.084	33	**0.0026**	325	**0.00026**
Acenaphthylene	0.16	0.55	2.2	0.30	0.047	0.16	0.65	0.076	33	**0.0023**	325	**0.00023**
Anthracene	0.16	0.40	2.2	0.29	0.046	0.11	0.63	0.074	33	**0.00227**	325	**0.000227**
Benzo(a)anthracene	0.16	0.14	2.2	0.50	0.081	0.071	1.1	0.129	33	**0.00396**	325	**0.000396**
Benzo(a)pyrene	0.16	0.05	2.2	0.49	0.078	0.025	1.1	0.125	33	**0.00385**	325	**0.000385**
Benzo(b)fluoranthene	0.16	0.10	2.2	0.45	0.072	0.043	0.99	0.115	33	**0.00354**	325	**0.000354**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.34	0.054	0.022	0.74	0.086	33	**0.00266**	325	**0.000266**
Benzo(ghi)perylene	0.16	0.09	2.2	0.38	0.061	0.036	0.84	0.098	33	**0.00301**	325	**0.000301**
Chrysene	0.16	0.21	2.2	0.58	0.093	0.12	1.3	0.148	33	**0.0046**	325	**0.00046**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.064	33	**0.00197**	325	**0.000197**
Fluoranthene	0.16	0.27	2.2	0.52	0.084	0.14	1.2	0.134	33	**0.0041**	325	**0.00041**
Fluorene	0.16	0.50	2.2	0.77	0.12	0.38	1.7	0.196	33	**0.0060**	325	**0.00060**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	0.38	0.061	0.023	0.84	0.098	33	**0.00302**	325	**0.000302**
Naphthalene	0.16	1.1	2.2	0.35	0.056	0.39	0.77	0.089	27	**0.0033**	269	**0.00033**
Phenanthrene	0.16	0.40	2.2	2.4	0.38	0.94	5.2	0.606	33	**0.0186**	325	**0.00186**
Pyrene	0.16	0.27	2.2	0.91	0.15	0.25	2.0	0.233	33	**0.0072**	325	**0.00072**
TPH (C10-C40)	NA	NA	NA	20300	NA	NA	NA	0.000	218	**0.0**	2180	**0.00**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Soil Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

Coyote
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.10	0.03	0.87	10.0000	0.3300	0.028	0.009300	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	388	202	428	5.8	2	0.32	**5**	4.7	**0.4**
Lead	1.5	0.47	0.29	1151	1727	539	334	17	1.0	**17**	241	**0.1**
Organics												
Acenaphthene	0.16	0.60	2.2	0.88	0.14	0.53	1.9	0.057	175	**0.00033**	350	**0.00016**
Acenaphthylene	0.16	0.55	2.2	0.50	0.080	0.28	1.1	0.033	175	**0.00019**	350	**0.000093**
Anthracene	0.16	0.40	2.2	0.38	0.060	0.15	0.83	0.024	1000	**0.000024**	NA	**NA**
Benzo(a)anthracene	0.16	0.14	2.2	2.3	0.36	0.32	5.0	0.146	1.0	**0.146**	10	**0.0146**
Benzo(a)pyrene	0.16	0.05	2.2	4.5	0.72	0.23	9.9	0.29	1.0	**0.29**	10	**0.029**
Benzo(b)fluoranthene	0.16	0.10	2.2	3.6	0.58	0.35	8.0	0.23	1.0	**0.23**	10	**0.023**
Benzo(k)fluoranthene	0.16	0.06	2.2	0.75	0.12	0.048	1.7	0.049	1.0	**0.049**	10	**0.0049**
Benzo(ghi)perylene	0.16	0.09	2.2	2.4	0.38	0.23	5.2	0.154	1.0	**0.154**	10	**0.0154**
Chrysene	0.16	0.21	2.2	3.9	0.62	0.82	8.5	0.25	1.0	**0.25**	10	**0.025**
Dibenzo(a,h)anthracene	0.16	0.047	2.2	0.25	0.040	0.012	0.55	0.02	1.0	**0.0162**	10	**0.00162**
Fluoranthene	0.16	0.27	2.2	1.4	0.22	0.37	3.0	0.089	125	**0.00071**	250	**0.00036**
Fluorene	0.16	0.50	2.2	2.8	0.44	1.4	6.1	0.18	125	**0.00144**	250	**0.00072**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.2	2.1	0.34	0.13	4.7	0.138	1.0	**0.138**	10	**0.0138**
Naphthalene	0.16	1.1	2.2	11	1.8	12	25	0.73	50	**0.0147**	150	**0.0049**
Phenanthrene	0.16	0.40	2.2	6.4	1.0	2.5	14	0.42	125	**0.0033**	250	**0.0017**
Pyrene	0.16	0.27	2.2	5.3	0.84	1.4	12	0.34	75	**0.0046**	125	**0.0027**
TPH (C10-C40)	NA	NA	NA	337922	NA	NA	NA	314	197	**2**	890	**0.4**

Coyote
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR soil	IR soil	home range	site area	SUF
Value	0.10	0.03	0.87	10.0000	0.3300	0.028	0.009300	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Soil Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	sed dw / kg inv	sed dw / kg veg	d dw / kg ve	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.52	1.1	0.015	15	7.8	17	0.22	0.1	0.32	**0.2**	4.7	**0.01**
Lead	1.5	0.47	0.29	71	106	33	20	1	1.0	**1**	241	**0.004**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	0.16	0.60	2.20	0.33	0.052	0.20	0.72	0.021	175	**0.000122**	350	**0.000061**
Acenaphthylene	0.16	0.55	2.20	0.30	0.047	0.16	0.65	0.019	175	**0.000110**	350	**0.000055**
Anthracene	0.16	0.40	2.20	0.29	0.046	0.11	0.63	0.019	1000	**0.000019**	NA	**NA**
Benzo(a)anthracene	0.16	0.14	2.20	0.50	0.081	0.071	1.1	0.033	1.0	**0.033**	10	**0.0033**
Benzo(a)pyrene	0.16	0.05	2.20	0.49	0.078	0.025	1.1	0.032	1.0	**0.032**	10	**0.0032**
Benzo(b)fluoranthene	0.16	0.10	2.20	0.45	0.072	0.043	0.99	0.029	1.0	**0.029**	10	**0.0029**
Benzo(k)fluoranthene	0.16	0.06	2.20	0.34	0.054	0.022	0.74	0.022	1.0	**0.022**	10	**0.0022**
Benzo(ghi)perylene	0.16	0.09	2.20	0.38	0.061	0.036	0.84	0.025	1.0	**0.025**	10	**0.0025**
Chrysene	0.16	0.21	2.20	0.58	0.093	0.12	1.3	0.038	1.0	**0.038**	10	**0.0038**
Dibenzo(a,h)anthracene	0.16	0.047	2.20	0.25	0.040	0.012	0.55	0.016	1.0	**0.0162**	10	**0.00162**
Fluoranthene	0.16	0.27	2.20	0.52	0.084	0.14	1.2	0.034	125	**0.00027**	250	**0.000136**
Fluorene	0.16	0.50	2.20	0.77	0.122	0.38	1.7	0.050	125	**0.00040**	250	**0.00020**
Indeno(1,2,3-cd)pyrene	0.16	0.060	2.20	0.38	0.061	0.023	0.84	0.025	1.0	**0.025**	10	**0.0025**
Naphthalene	0.16	1.1	2.20	0.35	0.056	0.39	0.77	0.023	50	**0.00046**	150	**0.000154**
Phenanthrene	0.16	0.40	2.20	2.4	0.379	0.94	5.2	0.154	125	**0.00123**	250	**0.00062**
Pyrene	0.16	0.27	2.20	0.91	0.146	0.25	2.0	0.059	75	**0.00079**	125	**0.00047**
TPH (C10-C40)	NA	NA	NA	20300	NA	NA	NA	19	197	**0.10**	890	**0.02**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Soil Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

Mallard
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR sed	IR sed	home range	site area	SUF
Value	0.078	0.92	0.00	1.04	0.075	0.033	0.0025	NA		1.0
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Sed. Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.69	1.1	0.015	28	19	30	0.41	2.2	5.5	**0.39**	22	**0.10**
Lead	0.61	0.47	0.34	1001	611	469	340	37	0.014	**2617**	8.8	**4.2**
Organics												
Acenaphthene	2.3	0.60	2.2	0.31	0.72	0.19	0.69	0.017	33	**0.00053**	325	**0.000053**
Acenaphthylene	2.3	0.55	2.2	0.31	0.72	0.17	0.69	0.016	33	**0.00050**	325	**0.000050**
Anthracene	2.3	0.4	2.2	0.025	0.058	0.010	0.055	0.0010	33	**0.000032**	325	**0.0000032**
Benzo(a)anthracene	2.3	0.14	2.2	2.3	5.2	0.32	5.0	0.055	33	**0.0017**	325	**0.00017**
Benzo(a)pyrene	2.3	0.052	2.2	4.5	10.4	0.23	9.9	0.084	33	**0.0026**	325	**0.00026**
Benzo(b)fluoranthene	2.3	0.10	2.2	3.6	8.3	0.35	8.0	0.078	33	**0.0024**	325	**0.00024**
Benzo(k)fluoranthene	2.3	0.064	2.2	0.75	1.7	0.048	1.7	0.015	33	**0.00045**	325	**0.000045**
Benzo(ghi)perylene	2.3	0.095	2.2	2.4	5.5	0.23	5.2	0.051	33	**0.0016**	325	**0.00016**
Chrysene	2.3	0.21	2.2	3.9	8.9	0.82	8.5	0.11	33	**0.0035**	325	**0.00035**
Dibenzo(a,h)anthracene	2.3	0.047	2.2	0.025	0.058	0.0012	0.055	0.00046	33	**0.000014**	325	**0.0000014**
Fluoranthene	2.3	0.27	2.2	1.1	2.6	0.30	2.5	0.037	33	**0.0011**	325	**0.00011**
Fluorene	2.3	0.50	2.2	1.8	4.0	0.88	3.9	0.085	33	**0.0026**	325	**0.00026**
Indeno(1,2,3-cd)pyrene	2.3	0.060	2.2	2.1	4.9	0.13	4.7	0.041	33	**0.0013**	325	**0.00013**
Naphthalene	2.3	1.10	2.2	0.31	0.72	0.35	0.69	0.028	27	**0.0010**	269	**0.00010**
Phenanthrene	2.3	0.40	2.2	4.3	9.8	1.7	9.4	0.175	33	**0.0054**	325	**0.00054**
Pyrene	2.3	0.27	2.2	2.4	5.5	0.64	5.2	0.078	33	**0.0024**	325	**0.00024**
TPH (C10-C40)	NA	NA	NA	51314	NA	NA	NA	121	218	**0.56**	2180	**0.056**

Mallard
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR sed	IR sed	home range	site area	SUF
Value	0.078	0.92	0.00	1.04	0.075	0.033	0.0025	NA		1.0
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Sed. Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	g sed dw / kg inv	dsed dw / kg veg	sed dw / kg vert	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.69	1.1	0.015	6.4	4.4	7.1	0.10	0.51	5.5	**0.092**	22	**0.023**
Lead	0.61	0.47	0.34	190	116	89	65	7.0	0.014	**497**	8.8	**0.79**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	2.3	0.60	2.2	0.31	0.72	0.19	0.69	0.017	33	**0.00053**	325	**0.000053**
Acenaphthylene	2.3	0.55	2.2	0.31	0.72	0.17	0.69	0.016	33	**0.00050**	325	**0.000050**
Anthracene	2.3	0.40	2.2	0.025	0.06	0.010	0.055	0.0010	33	**0.000032**	325	**0.0000032**
Benzo(a)anthracene	2.3	0.14	2.2	0.49	1.1	0.069	1.1	0.012	33	**0.00037**	325	**0.000037**
Benzo(a)pyrene	2.3	0.052	2.2	4.5	10	0.23	9.9	0.084	33	**0.0026**	325	**0.00026**
Benzo(b)fluoranthene	2.3	0.10	2.2	3.6	8.3	0.35	8.0	0.078	33	**0.0024**	325	**0.00024**
Benzo(k)fluoranthene	2.3	0.064	2.2	0.20	0.45	0.013	0.43	0.004	33	**0.00012**	325	**0.000012**
Benzo(ghi)perylene	2.3	0.095	2.2	2.4	5.5	0.23	5.2	0.051	33	**0.0016**	325	**0.00016**
Chrysene	2.3	0.21	2.2	0.82	1.9	0.17	1.8	0.024	33	**0.00073**	325	**0.000073**
Dibenzo(a,h)anthracene	2.3	0.047	2.2	0.025	0.058	0.0012	0.055	0.00046	33	**0.000014**	325	**0.0000014**
Fluoranthene	2.3	0.27	2.2	0.28	0.65	0.075	0.62	0.0092	33	**0.00028**	325	**0.000028**
Fluorene	2.3	0.50	2.2	0.39	0.89	0.19	0.85	0.019	33	**0.00058**	325	**0.000058**
Indeno(1,2,3-cd)pyrene	2.3	0.060	2.2	2.1	4.9	0.13	4.7	0.041	33	**0.0013**	325	**0.00013**
Naphthalene	2.3	1.1	2.2	0.31	0.72	0.35	0.69	0.028	27	**0.0010**	269	**0.00010**
Phenanthrene	2.3	0.40	2.2	0.93	2.1	0.37	2.1	0.038	33	**0.0012**	325	**0.00012**
Pyrene	2.3	0.27	2.2	2.4	5.5	0.64	5.2	0.078	33	**0.0024**	325	**0.00024**
TPH (C10-C40)	NA	NA	NA	51314	NA	NA	NA	121	218	**0.56**	2180	**0.056**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Sediment Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

Western Sandpiper
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR sed	IR sed	home range	site area	SUF
Value	1.00	0.00	0.00	0.024	0.0061	0.18	0.0011	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Sed. Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.69	1.1	0.015	28	19	30	0.41	6.0	5.5	**1.1**	22	**0.27**
Lead	0.61	0.47	0.34	1001	611	469	340	198	0.014	**14127**	8.8	**23**
Organics												
Acenaphthene	2.3	0.60	2.2	0.31	0.72	0.19	0.69	0.19	33	**0.0060**	325	**0.00060**
Acenaphthylene	2.3	0.55	2.2	0.31	0.72	0.17	0.69	0.19	33	**0.0060**	325	**0.00060**
Anthracene	2.3	0.40	2.2	0.025	0.058	0.010	0.055	0.016	33	**0.00048**	325	**0.000048**
Benzo(a)anthracene	2.3	0.14	2.2	2.3	5.2	0.32	5.0	1.4	33	**0.043**	325	**0.0043**
Benzo(a)pyrene	2.3	0.052	2.2	4.5	10	0.23	9.9	2.8	33	**0.086**	325	**0.0086**
Benzo(b)fluoranthene	2.3	0.10	2.2	3.6	8.3	0.35	8.0	2.3	33	**0.069**	325	**0.0069**
Benzo(k)fluoranthene	2.3	0.064	2.2	0.75	1.7	0.048	1.7	0.47	33	**0.014**	325	**0.0014**
Benzo(ghi)perylene	2.3	0.095	2.2	2.4	5.5	0.23	5.2	1.5	33	**0.045**	325	**0.0045**
Chrysene	2.3	0.21	2.2	3.9	8.9	0.82	8.5	2.4	33	**0.074**	325	**0.0074**
Dibenzo(a,h)anthracene	2.3	0.047	2.2	0.025	0.058	0.0012	0.055	0.016	33	**0.00048**	325	**0.000048**
Fluoranthene	2.3	0.27	2.2	1.1	2.6	0.30	2.5	0.70	33	**0.021**	325	**0.0021**
Fluorene	2.3	0.50	2.2	1.8	4.0	0.88	3.9	1.1	33	**0.033**	325	**0.0033**
Indeno(1,2,3-cd)pyrene	2.3	0.060	2.2	2.1	4.9	0.13	4.7	1.3	33	**0.041**	325	**0.0041**
Naphthalene	2.3	1.1	2.2	0.31	0.72	0.35	0.69	0.19	27	**0.0072**	269	**0.00072**
Phenanthrene	2.3	0.40	2.2	4.3	9.8	1.7	9.4	2.6	33	**0.081**	325	**0.0081**
Pyrene	2.3	0.27	2.2	2.4	5.5	0.64	5.2	1.5	33	**0.045**	325	**0.0045**
TPH (C10-C40)	NA	NA	NA	51314	NA	NA	NA	2309	218	**11**	2180	**1.1**

Western Sandpiper
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR sed	IR sed	home range	site area	SUF
Value	1.00	0.00	0.00	0.024	0.0061	0.18	0.0011	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Sed. Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	sed dw / kg inv	sed dw / kg veg	ed dw / kg ve	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.69	1.1	0.015	6.4	4.4	7.1	0.10	1.4	5.5	**0.25**	22	**0.063**
Lead	0.61	0.47	0.34	190	116	89	65	38	0.014	**2681**	8.8	**4.3**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	2.3	0.60	2.2	0.31	0.72	0.19	0.69	0.19	33	**0.0060**	325	**0.00060**
Acenaphthylene	2.3	0.55	2.2	0.31	0.72	0.17	0.69	0.19	33	**0.0060**	325	**0.00060**
Anthracene	2.3	0.40	2.2	0.025	0.058	0.010	0.055	0.016	33	**0.00048**	325	**0.000048**
Benzo(a)anthracene	2.3	0.14	2.2	0.49	1.1	0.069	1.1	0.30	33	**0.0093**	325	**0.00093**
Benzo(a)pyrene	2.3	0.052	2.2	4.5	10	0.23	9.9	2.8	33	**0.086**	325	**0.0086**
Benzo(b)fluoranthene	2.3	0.10	2.2	3.6	8.3	0.35	8.0	2.3	33	**0.069**	325	**0.0069**
Benzo(k)fluoranthene	2.3	0.064	2.2	0.20	0.45	0.013	0.43	0.12	33	**0.0038**	325	**0.00038**
Benzo(ghi)perylene	2.3	0.095	2.2	2.4	5.5	0.23	5.2	1.5	33	**0.045**	325	**0.0045**
Chrysene	2.3	0.21	2.2	0.82	1.9	0.17	1.8	0.51	33	**0.016**	325	**0.0016**
Dibenzo(a,h)anthracene	2.3	0.047	2.2	0.025	0.058	0.0012	0.055	0.016	33	**0.00048**	325	**0.000048**
Fluoranthene	2.3	0.27	2.2	0.28	0.65	0.075	0.62	0.17	33	**0.0054**	325	**0.00054**
Fluorene	2.3	0.50	2.2	0.39	0.89	0.19	0.85	0.24	33	**0.0074**	325	**0.00074**
Indeno(1,2,3-cd)pyrene	2.3	0.060	2.2	2.1	4.9	0.13	4.7	1.3	33	**0.041**	325	**0.0041**
Naphthalene	2.3	1.1	2.2	0.31	0.72	0.35	0.69	0.19	27	**0.0072**	269	**0.00072**
Phenanthrene	2.3	0.40	2.2	0.93	2.1	0.37	2.1	0.58	33	**0.018**	325	**0.0018**
Pyrene	2.3	0.27	2.2	2.4	5.5	0.64	5.2	1.5	33	**0.045**	325	**0.0045**
TPH (C10-C40)	NA	NA	NA	51314	NA	NA	NA	2309	218	**11**	2180	**1.1**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Sediment Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

Great Blue Heron
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR sed	IR sed	home range	site area	SUF
Value	0.00	0.00	1.00	2.204	0.1400	0.03	0.0040	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Sed. Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.69	1.1	0.015	28	19	30	0.41	0.1	5.5	**0.0**	22	**0.00**
Lead	0.61	0.47	0.34	1001	611	469	340	23	0.014	**1674**	8.8	**3**
Organics												
Acenaphthene	2.3	0.60	2.2	0.31	0.72	0.19	0.69	0.04	33	**0.0014**	325	**0.00014**
Acenaphthylene	2.3	0.55	2.2	0.31	0.72	0.17	0.69	0.04	33	**0.0014**	325	**0.00014**
Anthracene	2.3	0.40	2.2	0.025	0.058	0.010	0.055	0.004	33	**0.00011**	325	**0.000011**
Benzo(a)anthracene	2.3	0.14	2.2	2.3	5.2	0.32	5.0	0.3	33	**0.010**	325	**0.0010**
Benzo(a)pyrene	2.3	0.052	2.2	4.5	10	0.23	9.9	0.6	33	**0.020**	325	**0.0020**
Benzo(b)fluoranthene	2.3	0.10	2.2	3.6	8.3	0.35	8.0	0.5	33	**0.016**	325	**0.0016**
Benzo(k)fluoranthene	2.3	0.064	2.2	0.75	1.7	0.048	1.7	0.11	33	**0.003**	325	**0.0003**
Benzo(ghi)perylene	2.3	0.095	2.2	2.4	5.5	0.23	5.2	0.3	33	**0.010**	325	**0.0010**
Chrysene	2.3	0.21	2.2	3.9	8.9	0.82	8.5	0.5	33	**0.017**	325	**0.0017**
Dibenzo(a,h)anthracene	2.3	0.047	2.2	0.025	0.058	0.0012	0.055	0.004	33	**0.00011**	325	**0.000011**
Fluoranthene	2.3	0.27	2.2	1.1	2.6	0.30	2.5	0.16	33	**0.005**	325	**0.0005**
Fluorene	2.3	0.50	2.2	1.8	4.0	0.88	3.9	0.2	33	**0.008**	325	**0.0008**
Indeno(1,2,3-cd)pyrene	2.3	0.060	2.2	2.1	4.9	0.13	4.7	0.3	33	**0.009**	325	**0.0009**
Naphthalene	2.3	1.1	2.2	0.31	0.72	0.35	0.69	0.04	27	**0.0016**	269	**0.00016**
Phenanthrene	2.3	0.40	2.2	4.3	9.8	1.7	9.4	0.6	33	**0.019**	325	**0.0019**
Pyrene	2.3	0.27	2.2	2.4	5.5	0.64	5.2	0.3	33	**0.010**	325	**0.0010**
TPH (C10-C40)	NA	NA	NA	51314	NA	NA	NA	93	218	**0**	2180	**0.0**

Great Blue Heron
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR sed	IR sed	home range	site area	SUF
Value	0.00	0.00	1.00	2.204	0.1400	0.03	0.0040	NA		1.00
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Sed. Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	sed dw / kg inv	sed dw / kg veg	ed dw / kg ve	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.69	1.1	0.015	6.4	4.4	7.1	0.10	0.0	5.5	**0.00**	22	**0.001**
Lead	0.61	0.47	0.34	190	116	89	65	4	0.014	**318**	8.8	**0.5**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	2.3	0.60	2.2	0.31	0.72	0.19	0.69	0.04	33	**0.0014**	325	**0.00014**
Acenaphthylene	2.3	0.55	2.2	0.31	0.72	0.17	0.69	0.04	33	**0.0014**	325	**0.00014**
Anthracene	2.3	0.40	2.2	0.025	0.058	0.010	0.055	0.004	33	**0.00011**	325	**0.000011**
Benzo(a)anthracene	2.3	0.14	2.2	0.49	1.1	0.069	1.1	0.07	33	**0.0021**	325	**0.00021**
Benzo(a)pyrene	2.3	0.052	2.2	4.5	10	0.23	9.9	0.6	33	**0.020**	325	**0.0020**
Benzo(b)fluoranthene	2.3	0.10	2.2	3.6	8.3	0.35	8.0	0.5	33	**0.016**	325	**0.0016**
Benzo(k)fluoranthene	2.3	0.064	2.2	0.20	0.45	0.013	0.43	0.03	33	**0.0009**	325	**0.00009**
Benzo(ghi)perylene	2.3	0.095	2.2	2.4	5.5	0.23	5.2	0.3	33	**0.010**	325	**0.0010**
Chrysene	2.3	0.21	2.2	0.82	1.9	0.17	1.8	0.12	33	**0.004**	325	**0.0004**
Dibenzo(a,h)anthracene	2.3	0.047	2.2	0.025	0.058	0.0012	0.055	0.004	33	**0.00011**	325	**0.000011**
Fluoranthene	2.3	0.27	2.2	0.28	0.65	0.075	0.62	0.04	33	**0.0012**	325	**0.00012**
Fluorene	2.3	0.50	2.2	0.39	0.89	0.19	0.85	0.05	33	**0.0017**	325	**0.00017**
Indeno(1,2,3-cd)pyrene	2.3	0.060	2.2	2.1	4.9	0.13	4.7	0.3	33	**0.009**	325	**0.0009**
Naphthalene	2.3	1.1	2.2	0.31	0.72	0.35	0.69	0.04	27	**0.0016**	269	**0.00016**
Phenanthrene	2.3	0.40	2.2	0.93	2.1	0.37	2.1	0.13	33	**0.004**	325	**0.0004**
Pyrene	2.3	0.27	2.2	2.4	5.5	0.64	5.2	0.3	33	**0.010**	325	**0.0010**
TPH (C10-C40)	NA	NA	NA	51314	NA	NA	NA	93	218	**0**	2180	**0.0**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Sediment Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

Raccoon
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR sed	IR sed	home range	site area	SUF
Value	0.17	0.58	0.25	5.45	0.15	0.094	0.014	NA		1.0
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on Maximum Concentration

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Sed. Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	kg soil dw / kg plant, invert or prey dw			mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.69	1.1	0.015	28	19	30	0.41	0.6	0.32	**2.0**	5	**0.14**
Lead	0.61	0.47	0.34	1001	611	469	340	15	1.0	**15**	241	**0**
Organics												
Acenaphthene	2.3	0.60	2.2	0.31	0.72	0.19	0.69	0.01	175	**0.0001**	350	**0.00003**
Acenaphthylene	2.3	0.55	2.2	0.31	0.72	0.17	0.69	0.01	175	**0.0001**	350	**0.00003**
Anthracene	2.3	0.40	2.2	0.025	0.058	0.010	0.055	0.001	1000	**0.00000**	NA	**NA**
Benzo(a)anthracene	2.3	0.14	2.2	2.3	5.2	0.32	5.0	0.1	1.0	**0.068**	10	**0.0068**
Benzo(a)pyrene	2.3	0.052	2.2	4.5	10	0.23	9.9	0.1	1.0	**0.129**	10	**0.0129**
Benzo(b)fluoranthene	2.3	0.10	2.2	3.6	8.3	0.35	8.0	0.1	1.0	**0.106**	10	**0.0106**
Benzo(k)fluoranthene	2.3	0.064	2.2	0.75	1.7	0.048	1.7	0.02	1.0	**0.022**	10	**0.0022**
Benzo(ghi)perylene	2.3	0.095	2.2	2.4	5.5	0.23	5.2	0.1	1.0	**0.070**	10	**0.0070**
Chrysene	2.3	0.21	2.2	3.9	8.9	0.82	8.5	0.1	1.0	**0.121**	10	**0.0121**
Dibenzo(a,h)anthracene	2.3	0.047	2.2	0.025	0.058	0.0012	0.055	0.001	1.0	**0.00071**	10	**0.000071**
Fluoranthene	2.3	0.27	2.2	1.1	2.6	0.30	2.5	0.04	125	**0.000**	250	**0.0001**
Fluorene	2.3	0.50	2.2	1.8	4.0	0.88	3.9	0.1	125	**0.001**	250	**0.0003**
Indeno(1,2,3-cd)pyrene	2.3	0.060	2.2	2.1	4.9	0.13	4.7	0.1	1	**0.061**	10	**0.0061**
Naphthalene	2.3	1.1	2.2	0.31	0.72	0.35	0.69	0.01	50	**0.0003**	150	**0.00009**
Phenanthrene	2.3	0.40	2.2	4.3	9.8	1.7	9.4	0.1	125	**0.001**	250	**0.0006**
Pyrene	2.3	0.27	2.2	2.4	5.5	0.64	5.2	0.1	75	**0.001**	125	**0.0006**
TPH (C10-C40)	NA	NA	NA	51314	NA	NA	NA	132	197	**1**	890	**0.1**

Raccoon
Dose and Hazard Quotient Calculations
San Luis Obispo Tank Farm

Parameter	% invertebrates	% vegetation	% prey	BW	IR food	IR sed	IR sed	home range	site area	SUF
Value	0.17	0.58	0.25	5.45	0.15	0.094	0.014	NA		1.0
Units	proportion	proportion	proportion	kg	kg/day dw	fraction	kg/day dw	hectares	hectares	no unit

Based on EPC

Exposure Parameter	BAF for Invertebrates	BAF for Vegetation	BAF for Prey	Exposure Point Sed. Conc.	Calculated Inv. Conc.	Calculated Plant. Conc.	Calculated Prey Conc.	Calculated Dose	NOAEL TRV (mg/kg/day)	NOAEL Hazard Quotient	LOAEL TRV (mg/kg/day)	LOAEL Hazard Quotient
Metals	sed dw / kg inv	sed dw / kg veg	ed dw / kg ve	mg/kg sed dw	mg/kg inv dw	mg/kg inv dw	mg/kg inv dw	mg/kg bw/d				
Arsenic	0.69	1.1	0.015	6.4	4.4	7.1	0.10	0.1	5.5	**0.03**	22	**0.007**
Lead	0.61	0.47	0.34	190	116	89	65	3	0.014	**204**	8.8	**0.3**
Polycyclic Atomatic Hydrocarbons												
Acenaphthene	2.3	0.60	2.2	0.31	0.72	0.19	0.69	0.01	33	**0.0004**	325	**0.00004**
Acenaphthylene	2.3	0.55	2.2	0.31	0.72	0.17	0.69	0.01	33	**0.0004**	325	**0.00004**
Anthracene	2.3	0.40	2.2	0.025	0.058	0.010	0.055	0.001	33	**0.00003**	325	**0.000003**
Benzo(a)anthracene	2.3	0.14	2.2	0.49	1.1	0.069	1.1	0.01	33	**0.0004**	325	**0.00004**
Benzo(a)pyrene	2.3	0.052	2.2	4.5	10	0.23	9.9	0.1	33	**0.004**	325	**0.0004**
Benzo(b)fluoranthene	2.3	0.10	2.2	3.6	8.3	0.35	8.0	0.1	33	**0.003**	325	**0.0003**
Benzo(k)fluoranthene	2.3	0.064	2.2	0.20	0.45	0.013	0.43	0.01	33	**0.0002**	325	**0.00002**
Benzo(ghi)perylene	2.3	0.095	2.2	2.4	5.5	0.23	5.2	0.1	33	**0.002**	325	**0.0002**
Chrysene	2.3	0.21	2.2	0.82	1.9	0.17	1.8	0.03	33	**0.001**	325	**0.0001**
Dibenzo(a,h)anthracene	2.3	0.047	2.2	0.025	0.058	0.0012	0.055	0.001	33	**0.00002**	325	**0.000002**
Fluoranthene	2.3	0.27	2.2	0.28	0.65	0.075	0.62	0.01	33	**0.0003**	325	**0.00003**
Fluorene	2.3	0.50	2.2	0.39	0.89	0.19	0.85	0.01	33	**0.0004**	325	**0.00004**
Indeno(1,2,3-cd)pyrene	2.3	0.060	2.2	2.1	4.9	0.13	4.7	0.1	33	**0.002**	325	**0.0002**
Naphthalene	2.3	1.1	2.2	0.31	0.72	0.35	0.69	0.01	27	**0.0005**	269	**0.00005**
Phenanthrene	2.3	0.40	2.2	0.93	2.1	0.37	2.1	0.03	33	**0.001**	325	**0.0001**
Pyrene	2.3	0.27	2.2	2.4	5.5	0.64	5.2	0.1	33	**0.002**	325	**0.0002**
TPH (C10-C40)	NA	NA	NA	51314	NA	NA	NA	132	218	**1**	2180	**0.1**

TRV = Toxicity Reference Value
NOAEL = No observable adverse effect level
LOAEL = Lowest observable adverse effect level

BAF = Biota-Sediment Accumulation Factor
HQ = Hazard Quotient (Dose/TRV)

Appendix I – pERA Data

Data Set for the SLO Tank Farm
Predictive Ecological Risk Assessment

Data included on attached CD

pERA Datasets:

- **Terrestrial Dataset**: Includes soil and sediment samples collected in the top five feet on site (includes both terrestrial and wetland areas).
- **Riparian Dataset**: Includes soil samples collected in the top ten feet in riparian areas on site.
- **Wetland Dataset**: Includes soil or sediment samples collected in the top six inches within state and/or federal delineated wetlands on site.
- **Surface Water Dataset**: Includes surface water collected from the water column of site water features. *Note that the attached data file includes all surface water data collected for the site but only the data collected during the March 2003 sampling event were quantitatively evaluated in the pERA.*

** See Appendix C for a complete description of the datasets used in the pERA.