ALASKA RAILROAD CORPORATION

Corporate: P.O. Box 107500, Anchorage, AK 99510• 327 Ship Creek Avenue, Anchorage, AK 99501

www.alaskarailroad.com

August 15, 2005

Jacques Gusmano, Project Coordinator
Alaska Operations Office
U.S. Environmental Protection Agency
222 West 7th Avenue, #19
Anchorage, Alaska 99513-7588

Re: Alaska Railroad Corporation, Anchorage Terminal Reserve RI/FS
Administrative Order on Consent EPA Docket No. CERCLA-10-2004-0065
Remedial Investigation/Feasibility Study Work Plan, Revision 1

Dear Mr. Gusmano:

The Alaska Railroad Corporation (ARRC) is pleased to submit the revised Remedial Investigation / Feasibility Study Work Plan (RI/FS) developed under Subtask 2e of the Statement of Work for the above referenced CERCLA/RCRA Administrative Order on Consent (AOC). The RI/FS work Plan was originally submitted on June 23, 2005. A meeting was held on July 21, 2005 between ARRC, EPA, and the Alaska Department of Environmental Conservation to discuss the July 20, 2005 agency comments on the RI/FS Work Plan. The Work Plan was revised to reflect both the meeting discussion and the agency comments. Please replace the appropriate sections of the original June 23, 2005 document with the enclosed revised sections as follows:

- Response to Comments
- Document cover and spine
- RI/FS Work Plan text
- Revised Tables
- Revised Figures
- Appendices, Volume 2 cover and spine
- Appendix C text, table and figures
- Appendix D text

Please do not hesitate to contact me at (907) 265-2410 if you have any questions or concerns.

Sincerely,

Chris Cosentino/for

Ernest W. Piper
Project Coordinator

cc: H. Orlean/EPA
W. Westervelt/CH2M HILL
B. Shephard/EPA
J. Frechione/ADEC

Review of Remedial Investigation/Feasibility Study Work Plan, Alaska Railroad Corporation, Anchorage Terminal Reserve

(Prepared by RETEC, June 23, 2005)

Summary of Report

The Remedial Investigation/Feasibility Study (RI/FS) Work Plan presents the rationale, scope of work, and procedures for data collection at the Anchorage Terminal Reserve in support of the RI. The main goals of the RI/FS are assessment of contaminant transport, receptors, and pathways for protection of Ship Creek; protection of human health and ecological receptors to be evaluated through a risk assessment; identification of relevant sources of chemicals that may pose risk; and identification and screening of potential remedial actions.

EPA Comment No. 1:

Overall, the RI/FS Work Plan is well-written, well-organized, and easy to read. Additionally, most of the previous comments have been incorporated. This is a large, complex site and RETEC and ARRC did a good job putting together the Work Plan.

ARRC Response: We appreciate the comment.

EPA Comment No. 2:

We recommend adding 4 additional surface water and/or sediment sampling locations.

a. One of these should be located in the riparian area downgradient of Arctic Cooperage (LP-991), approximately where the second “A” in “AREA B” is depicted in Figure 3-1. Although sampling is proposed just west of this location in Area B, a sampling point adjacent to the property does not appear to be included in the proposal (i.e., Area B hatching does not include the riparian area adjacent to the property). As this could be a runoff area from Arctic Cooperage, a sediment or soil sample should be collected nearby.

b. A second sediment or soil sampling location in the riparian area downgradient from the Alaska Sheet Metal site (LP-131) would also be useful as PCBs and lead have been detected at this property. We are recommending that an additional sample be taken in the riparian area just north of proposed sampling point S-S-6 (Figure 3-1).

c. A third surface water and sediment sample should be collected on the downgradient side of the KAPP dam near the north bank where the ARRC Storm Water Discharge is shown on Figure 3-1. The most recent historical sample (Sample 145C collected in October 1998) exceeded ecological screening criteria for one or more VOCs, SVOCs, DRO, RRO, PCBs, and metals in sediment, and VOCs in surface water.

d. A fourth sediment sample should be collected adjacent to the Wrightway Auto Carriers site (LP-049). The Appendix D lease property summary in the Site Background Report states that an oil seep was observed at a location 100 feet south of the site in 1986. This location was discussed during the May 19 meeting and it was agreed that a sample would be collected to verify current contamination levels.

ARRC Response:

a. Sample S-B-5 will be moved to the specified location

b. A sample S-E-3 will be added in the specified location

c. A sample S-S-12 will be placed in the channel downgradient of the KAPP dam near the north bank, if practicable.

d. Water sampling from this seep is already planned. If sediment is present we will collect a sample.

EPA Comment No. 3:

Tables 2-1 and 4-2 – Since indoor air is a potential exposure medium, the screening levels used should be low enough to ensure that this pathway is addressed in the screening process.

ARRC Response: The Work Plan will be revised in accordance with this comment.

EPA Comment No. 4:

The basis for deferring subsurface contamination investigation within the railyard is that it is an industrial area and a plan for institutional controls and monitoring during normal O&M activities would prevent worker exposure in the future. Please make reference to this strategy in the Work Plan and consider this Institutional Control Plan in the RI/FS Remedy Selection.

ARRC Response: The Work Plan will be revised to refer to the mechanisms that are in place to prevent current and future worker exposure at the rail yard. ARRC will consider including institutional controls among the alternatives evaluated in the Feasibility Study for any remedial action needed at the Site.

EPA Comment No. 5:

Table 2-3, Disposition of Railyard SWMUs/AOCs:

a. The "perimeter approach" that EPA suggested in the May 19 meeting for evaluating potential contaminant migration from the railyard area was for monitoring groundwater. EPA said in previous meetings that they would expect surface soil sampling to be performed at the railyard SWMUs and AOCs that are identified for further action in the RCRA Facility Assessment (SAIC, 1996) if there could have potentially been an environmental release of hazardous materials. The sampling recommended in Table 2-3 does not appear to include any surface soil sampling at the SWMU/AOC sites (except for sampling boring E20 near SWMU 65).

b. The "Justification for No Further Action" column states for several SWMUs "No indications that releases have occurred." What is this statement based on and how has it been documented and verified?

c. The "Justification for Not Collecting Soil/Groundwater Data" column states for several SWMUs "See ARRC comments regarding RFA and the SWMU." Clarify where the ARRC comments are presented.

d. The "Suggested Investigation" column indicates for several SWMUs "Confirm good housekeeping practices in use, otherwise, no justification for specific investigation." How are "good housekeeping practices" going to be verified and documented?

e. Based on information provided in the RFA, the following sites warrant further investigation to determine if surface soil contamination is present:

   - SWMU -15, Former Oil Storage Containers: This SWMU is in an area which does not have soil or groundwater data.

- SWMU -20, Car Shop, Air Room Hazardous Waste Storage Area: RFA indicated that there was an oil sheen in this area along with detections of benzene.
- SWMU -22, Heavy Equipment Shop Floor Drain: RFA indicated that total petroleum hydrocarbons (TPH) were detected in this area.
- SWMU -23, Heavy Equipment Shop Former Drum Storage Area: The RFA indicated that an oil sheen was found in this area.
- SWMU -26, Engineering Shop Equipment Wash Area: This SWMU is in an area that does not have soil or groundwater data. In addition, it is upgradient of benzene contamination found in groundwater and could be a potential source area.
- SWMU -28, Former Bridges and Buildings Shop Storage Area: If previous sampling results cannot be located then this SWMU should be resampled.
- SWMU -35, Welding Shop Waste Storage: This SWMU does not have soil or groundwater data.
- SWMU -37, Contaminated Soil Stockpiles: Groundwater contamination has been detected in the vicinity of these stockpiles (TPH and volatile organics).
- SWMUs 38 and 39, Former Stockpiles: Ground-water contamination (DRO, VOCs) has been detected in the vicinity of these SWMUs.
- SWMU -43, Boiler Plant: Oil sheens were detected in the vicinity of this SWMU.
- SWMU -73, Former Waste Oil Underground Storage Tank: This SWMU is located upgradient from detected ground-water contamination (TPH).
- AOC-1, Refueling Area: TPH has been detected in groundwater beneath this AOC.
- AOC-2, Former Refueling Area: Oil sheen in soil and TPH in groundwater have been detected at this AOC
- AOC-3, Above ground storage tank: This storage tank had reported spills.
- AOC-6, Former Gasoline Underground Storage Tank: This tank has been reported as being removed with no confirmed sampling.

ARRC Response:

a. Table 2-3 has been significantly updated to reflect proposed locations for sampling associated with a SMWU of potential concern. Locations detailed in 5e. that are not planned for sampling will be visually inspected during the 2005 RI field work with follow-up sampling to be conducted as needed in 2006.

b. Where formal documentation was available, it was cited in the draft Work Plan. ARRC will identify and evaluate in the RI any additional information that may be available to it regarding past operations at these SWMUs, including any information regarding spills, releases or environmental studies at these locations,

c. The table has been refined for the SWMUs that the RFAs identified for further action to more appropriately summarize the RFA findings in this column.

d. Table 2-3 has been updated and revised to further clarify this column. In general, the SWMUs for which the table listed "good housekeeping practices" have been edited to state that a visual site inspection will take place. The inspection will focus on evidence of past releases, as well as current practices regarding material and waste management to evaluate the potential for future releases.

e. Table 2-3 has been updated to more accurately describe the proposed RI evaluations and sampling and relate those to SWMU locations.

EPA Comment No. 6:

Section 2.3.3, Groundwater, p. 2-5, paragraph 2 – Any pumping of the deep artesian aquifer would likely reverse the natural upward groundwater flow component of the gradient. The relatively low permeability and thickness of the Bootlegger might be protective of the deep aquifer, but this hasn't been demonstrated. Moreover, even if the Bootlegger proves protective, contaminants could be drawn into the deep aquifer at wells with poor seals through the Bootlegger. This pathway should be explicitly addressed and explored sufficiently to either rule it out or quantify the potential risk. Consider sampling some existing deep aquifer wells to establish conditions in the lower aquifer beneath the site. Also the effects of tides to reverse the natural vertical groundwater flow component gradient through the Bootlegger should also be addressed.

ARRC Response: As part of the RI, ARRC will continue to evaluate well completion and abandonment information and analytical data (as best available) to determine if potential preferential migration pathways to the deep aquifer exist. The evaluation will be presented in the RI report with recommendations for further investigation if necessary. The information provided below illustrates why, because of the thickness of the Bootlegger Cove Formation (100 to 200 feet thick) and the vertically upward hydraulic gradient, it is reasonable to assume that contaminants have not migrated downward to the deep aquifer.

The combination of the upward hydraulic gradient between the deep and shallow aquifers and the low hydraulic conductivity of the Bootlegger Cove aquitard prevents the transport of contaminants between the two aquifers and eliminates the "shallow aquifer groundwater to deep aquifer groundwater" as a potential exposure pathway under natural gradients (i.e., when the deep aquifer is not being pumped). Pumping from the deep aquifer does occur since it is used as a source of water by the Anchorage Water & Wastewater Utility (AWWU), along with Eklutna Lake and Ship Creek upstream from the Site. The volume of water and the fraction of the AWWU production that is derived from the deep aquifer has varied greatly during the past 40 years. In 2004 about 5 million gallons per day was pumped from 12 deep aquifer AWWU production wells. The AWWU production well nearest the Alaska Railroad Anchorage Terminal Reserve that is routinely pumped is well #4, located on Commercial Drive about 0.5 miles east of the study area (AWWU well #3 is also close to the study site near the corner of Concrete St. and 3rd Avenue). Well #4 is screened in the deep aquifer at a depth of about 270 to 320 below the ground surface. Data from AWWU show that during 2005 pumping from well #4 there was up to about 107 feet of drawdown in the deep aquifer at the well #4 location. This drawdown is sufficient to reverse the natural gradient between the deep and shallow aquifers and to induce flow from the deep aquifer toward the shallow aquifer. To assess if the deep aquifer underlying the Bootlegger Cove formation could be threatened by contaminants from the shallow aquifer two example calculations were preformed as described below:

Example 1 The first example calculation was performed to assess how long it would take contaminants to travel from the shallow aquifer to the deep aquifer through the Bootlegger Cove Formation. The input values and results of the example calculations are shown in Figure 2-3b. The calculations assume the Bootlegger Cove is greater than 120 feet thick at the rail yard location (Updike and Carpenter, 1986) and that the hydraulic conductivity of the Bootlegger Cove formation is in the range of 10^{-7} to 10^{-11} cm/sec (estimated values for marine silts and clays from Freeze and Cherry, 1979). The graph in Figure 2-3b plots groundwater travel time (y-axis) as a function of hydraulic conductivity of the Bootlegger Cove Formation (x-axis) and head difference between the deep and shallow aquifers. Head difference values of 1, 10 and 100 feet are plotted on the figure. Head difference values on the order of 100 feet may be expected near a pumping well, while head difference values between 10 feet and 1 foot could be expected at greater distances from the pumping well. Given that 1) the closest AWWU wells are approximately 0.5 miles from the Site, 2) groundwater pumping from the deep aquifer at high production rates is very unlikely within the Site, and 3) the largest differences in hydraulic head are localized near the pumping wells, the travel times within the 10-foot and 1-foot head difference lines are more relevant to the travel times the AWWU pumping would induce at the Site. As shown on Figure 2-3b, given a hydraulic conductivity of 10^{-7} cm/sec and a head difference of 10 feet it would take contaminants about 10,000 years to travel from the shallow aquifer to the deep aquifer through the Bootlegger Cove formation. These calculations assume that high pumping rates from the deep aquifer would be sustained for the duration of the travel time (10,000 years) and do not include the effects of retardation or biodegradation, which would tend to delay the arrival of the contaminant in the deeper aquifer and reduce the long term contaminant concentration in the deep aquifer. This calculation demonstrates that given a downward gradient during active pumping of the deep aquifer, the Bootlegger Cove formation would protect the water quality in the deep aquifer for the indefinite future and thus protect human health via the deeper aquifer groundwater ingestion route.

Example 2 If a well within the Site penetrated the Bootlegger Cove formation, was located in an area of shallow aquifer groundwater contamination, and had a leaking seal, then contaminants might be able to travel along the well casing and into the deep aquifer much faster than they would travel through the Bootlegger Cove formation. However, the volume of water that could travel along the casing would be limited, resulting in a large degree of dilution in the deep aquifer. The impact of a leaking well seal on water quality in the deep aquifer is evaluated in an example calculation (note that the groundwater in the shallow aquifer at the location of the well with the leaking seal must be contaminated for this potential exposure pathway to be relevant. The example scenario is that a well in the study area has a leaking well seal and the well is within the capture zone of a water production well producing about 1,000,000 gallons per day. The well seal is assumed to have a hydraulic conductivity of a gravel or sand (instead of bentonite clay; installing the piping into the Ship Creek alluvium would tend to plug the annular space with sand and gravel even if the hypothetical well was installed without any seal). All of the water passing through the leaking well seal is assumed to be captured by the pumping well and mixed with uncontaminated water from the deep aquifer. The graph in Figure 2-3c plots the shallow aquifer dilution factor (y-axis) as a function of hydraulic conductivity (x-axis) and head difference between the deep and shallow aquifers. A head difference of 100 feet could be expected near a pumping well, while head differences between 10 feet and 1 foot could be expected at greater distances from the pumping well including areas within the Site. Hence the dilution factor from the 10 foot drawdown line is likely more relevant to the leaking well seal hypothetical example calculation. As shown on Figure 2-3c, a hydraulic conductivity of 10^{-1} cm/sec and a head difference of 10 feet would result in a dilution factor of about 10,000—that is, the contaminant concentration in the water at the deep aquifer production well would be about 1/10,000 of the concentration in the shallow aquifer. These calculations do not include the effects of biodegradation, which would tend to further reduce the concentration of the contaminant in the deep aquifer.

These calculations indicate that shallow groundwater conditions will not threaten water quality in the deep aquifer even if a well with a leaking seal is present in the study area and groundwater production wells in the deep aquifer are pumped at a high rate. As part of the RI, ARRC will continue to evaluate well completion and abandonment information and analytical data (as best available) to determine if potential preferential migration pathways to the deep aquifer exist. The evaluation will be presented in the RI report with recommendations for further investigation if necessary.

EPA Comment No. 7:

Figures 2-6 and 2-7 - The CSMs provided in [these figures] give a general overview of the potential exposure pathways and receptors on a site-wide basis. This is sufficient for the purposes of the RI Work Plan. However, for the Risk Assessment Work Plan, more specificity is needed on a site-specific basis, in order to drive the data needs (e.g., target analytes, soil depths, etc). Please develop a CSM for each of the subareas at a minimum, specifying area-specific sources and release mechanisms, and incorporating area-specific attributes that could affect the completeness of specific exposure pathways (for example, paving that precludes current worker access). Data gathering for soil should focus on whether past releases were subsurface versus surficial.

ARRC Response: The Risk Assessment Scoping Memo will address the additional information requested by this comment.

EPA Comment No. 8:

Section 3, p. 3-1, second bullet – If the wells are tidally influenced, how can we be sure that the measured water levels are representative, especially with only 2 measurements?

ARRC Response: ARRC will complete the tidal study prior to the first RI groundwater gauging event. These data will be used to evaluate tidal influences in selected areas of the Site and determine the appropriate time (relative to the tides) for gauging in these areas.

EPA Comment No. 9:

Section 3.1, p. 3-2, second paragraph –

a. Include analysis/sampling in Area 3 (tank farms) for Ethylene dibromide (EDB) and 1,2-dichlorethane (1,2-DCA).

b. What is the reasoning for placement of A2 and A1 in Area 3. There may be better placement for these in Area 3 (such as west of the Flint Hills facility).

ARRC Response:

a. Based on a request from ADEC, ARRC has added PAHs, Ethylene dibromide (EDB) and 1,2-dichlorethane (1,2, -DCA) to the analyte list for Area 3.

b. Locations A-2 and A-1 were placed to evaluate potential migration to the lowest reach of Ship Creek and adjacent portions of Cook Inlet from sources in NorthStar, Flint Hills and other leases in the southern portion of Area 3. Location A-1 in particular is useful in evaluating migration to Cook Inlet from the southeastern part of Flint Hills. We agree that the area west of Flint Hills is of interest. However, Flint Hills installed groundwater monitoring wells in that area in spring 2005. Data from these wells will be evaluated during the RI. The locations of the existing boundary wells at Flint Hills are shown in Figure 2-10. No specific sampling from the Flint Hills monitoring wells is proposed for as part of the RI investigation.

EPA Comment No. 10:

Section 3.1, p. 3-2, , bottom of page, and page 4-10, Sect 4.3.5, bottom of page -- Recommend using water level data loggers for a period longer than one month (preferably up to one year) to give a more representative picture of seasonal groundwater table fluctuations and changes in flow direction during breakup or high tides.

ARRC Response: Prior to the first RI groundwater elevation gauging event, ARRC will review existing groundwater elevation data and determine if additional continuous data logger gauging would be useful. EPA will be notified of any well locations selected for long term monitoring prior to insertion of data loggers.

EPA Comment No. 11:

Table 3-5, Soil DQOs – Under the decision rule for nature and extent it is stated "Is the nature and extent of COPC sufficiently delineated at known or suspected sources?", but how do you define whether it is sufficiently delineated? Will sampling occur until non-detect? Until levels are below a conservative risk-based level? Or some other method?

ARRC Response: ARRC will revise the DQOs, as discussed with EPA at the July 21, 2005 meeting, to include comparisons to relevant screening levels.

EPA Comment No. 12:

Section 3.3.1, Permitted Point Source Discharges, p. 3-5 – The existence of a permit does not qualify as an exemption unless the contaminant was included in the permitted discharge. In general, sediment sampling is not required at the outfalls at this time. However, if contamination is found within the creek, follow-up sampling will be required.

Please identify all of the outfalls to Ship Creek on Figures 2-8 and 2-9. Also identify if the outfalls are permitted and what constituents the permit includes.

ARRC Response: Text will be added to the RI Work Plan to indicate that existing outfalls were identified in the Ship Creek Habitat Survey. Outfalls will be further discussed in the RI Report.

EPA Comment No. 13:

How are riparian areas that provide favorable habitat for wildlife being addressed? Is collection of soil samples proposed for these areas? Please indicate whether riparian soils are going to be screened as soil and that ecological benchmarks will be used (rather than Industrial PRGs).

ARRC Response: No soil sampling specifically addressing the riparian area is planned. However, some samples will be collected in this area as part of the monitoring well program or as part of the sediment sampling program. Such samples will be compared to relevant ecological soil screening values. No text change required.

EPA Comment No. 14:

Section 3.5 and Tables 3-7 and 3-8 – For some metals (e.g., arsenic) the background level selected is the reporting limit, which are elevated and above potential risk thresholds. The background level in these tables should be listed as less than the reporting limit (e.g., arsenic at <10 µg/L). Additionally, contaminants should not be screened out using these levels. Concentrations below the background levels that are based on reporting limits can be discussed in the risk assessment uncertainty section.

ARRC Response: In cases where the historical data used to derive background values were affected by elevated reporting limits, the background value will be the reporting limit for data collected in fall 2005.

Background values based on reporting limits will be discussed in the risk assessment uncertainty section. No text or table changes made.

EPA Comment No. 15:

Section 3.5, p. 3-16 – What is the basis for using the quality of the north bluff seeps as background for the entire shallow aquifer? The groundwater flowing through the north bluff seeps represents a limited “slice” of groundwater entering the shallow aquifer along with other recharge. Moreover, the seep quality could be disproportionately biased by upgradient EAFB activities. Background quality generally refers to the groundwater quality of a specific aquifer. The seeps are fed by a different aquifer. Background needs to be representative for use everywhere onsite.

ARRC Response: The bluff seeps and springs represent groundwater at the point of entry onto the Site, and in combination with the 10 groundwater sample locations proposed at the base of the bluff is representative of “upgradient” conditions. As discussed with EPA at the July 21 meeting, the text as written otherwise describes current site conditions. Note that anthropogenic background is not used for screening out analytes.

EPA Comment No. 16:

Section 3.5.2, p. 3-18, first bullet – It is stated here that the twice the mean of the background groundwater data set is used for background comparisons with the existing data provided in Appendix D. This is also the approach used for surface water background data. Although this approach is recommended by EPA Region 4, we question the validity of using a value that is twice the mean if it exceeds the maximum detected background concentrations. In these cases, we recommend defaulting to the maximum detected (or non-detected) background concentrations, or performing more detailed statistical analyses of the background data depending on the number of samples and variability.

ARRC Response: This approach seems reasonable and will be applied to groundwater and surface water. The RI Report will be revised to make the recommended change.

EPA Comment No. 17:

Section 3.5.3, p. 3-18, first bullet at bottom of page – Because Ship Creek is a very energetic creek, It would seem unlikely that sediment data collected over 10 years ago would be appropriate for background comparisons.

ARRC Response: Final background values will be derived preferentially from recent sediment data.

EPA Comment No. 18:

Figure 3-6, Sediment and Surface Water Flowchart -- Last decision box "Is there evidence of analytes > SL in Transect 1 or 2 groundwater?" doesn't appear to consider contamination to Ship Creek from site-related outfalls or surface runoff.

ARRC Response: Figure 3-6 will be modified so that Site-related outfalls and surface runoff to Ship Creek also will be considered before determining that an analyte is not Site-related.

EPA Comment No. 19:

Section 3.6 and Figures 3-6 through 3-8 indicate that if concentrations are found below the reporting limit, evaluation will be complete. In accordance with Risk Assessment Guidance with Superfund, page

5-13 (EPA, 1989), detected concentrations below the RL (e.g., J-qualified data) should be used for risk assessment.

ARRC Response: The RI Work Plan will be revised in accordance with this comment.

EPA Comment No. 20:

Section 3.6, p. 3-22 – The groundwater investigation approach assumes that if constituents are absent or below screening levels at a downgradient location, then no investigation of upgradient sources is needed. The truth of this assumption depends on the kinetics of contaminant migration and attenuation, relative to the age of the releases. The underlying premise is that enough time has occurred for the system to be at steady state. This will need further justification during the course of the RI. If there were recent releases present with no current contaminant plume in downgradient wells, could they not still pose indoor air risk?

ARRC Response: It is understood that this approach assumes that downgradient concentrations are not increasing. If a recent and currently unknown release is identified during the RI, additional sampling may be conducted (i.e., in closer proximity to the release area) if it is determined that the release presents a potential risk to human health and the environment.

EPA Comment No. 21:

Section 6, Schedule, p. 6-1 – Add a milestone for a meeting with EPA to discuss the investigation data in early 2006.

ARRC Response: The Work Plan will be revised to add this milestone.

EPA Comment No. 22:

Section 2.3.2, p. 2-3, and Figures 2-2 and 2-3 – The primary flow direction component in the deep artesian aquifer is horizontal to the west with only a minor (but important to the RI/FS) upward component. The up flow arrows in the figure are misleading.

ARRC Response: Figures 2-2 and 2-3 have been revised for clarity.

EPA Comment No. 23:

Figure 2-7 – In previous comments, it was indicated that ponds and backwater areas of the Ship Creek floodplain may provide habitat for wood frogs and that potential risks (especially direct exposure of larvae to water) should be considered in the ecological risk assessment (ERA) and the ecological site conceptual model (ESCM). It is noted that tree frogs were added to the terrestrial receptors in the ESCM; however, tree frogs are not found in the project area, and it is assumed that this should have been the wood frog. Although adult wood frogs would be terrestrial receptors for the riparian areas, data to evaluate this receptor and pathway are not generally available. Instead, evaluation of the larval stages of the wood frog is needed. The pathway from surface water in ponds and backwater areas to wood frog larvae is complete and toxicity data are available for the risk evaluation. Therefore, this receptor and pathway should be added to the ESCM. Please see the hardcopy mark-up of Figure 2-7 for this, as well as a couple minor editorial comments.

ARRC Response: Figure 2-7 has been corrected in accordance with this comment. ARRC meant to refer to wood frogs, not tree frogs. Frog larvae will be added to the surface water exposure pathway for off-channel areas.

EPA Comment No. 24:

Section 2.3.3, p. 2-5 – In addition to the low conductivity of the Bootlegger aquitard and the upper gradient of the deep aquifer, are there any analytical data for the deep zone to support the claim that further study of the confined aquifer is unwarranted?

ARRC Response: See ARRC's response to EPA Comment No. 6 above. Because of the thickness of the Bootlegger Cove Formation (100 to 200 feet thick) and the vertically upward hydraulic gradient it is reasonable to assume that contaminants have not migrated downward to the deep aquifer. ARRC will continue to evaluate well completion and abandonment information and analytical data (as best available) during the RI to determine if potential preferential migration pathways to the deep aquifer exist. This evaluation will be presented in the RI Report with recommendations for any further investigation that may be necessary.

EPA Comment No. 25:

Section 2.4.1, p. 2-6, item 5 – Would someone accessing Ship Creek be considered a trespasser, since this is not private property? A recreational user scenario would likely capture any relevant exposures.

ARRC Response: ARRC agrees that the recreational user scenario will be used to evaluate exposures to surface water and sediment.

EPA Comment No. 26:

Section 2.4.1, p. 2-6, item 6 – Inhalation of volatiles from groundwater to outdoor receptors is not a pathway typically evaluated quantitatively. Is there reason to believe this is a major exposure route?

ARRC Response: The RI Work Plan will be revised to specify that the volatiles in groundwater to outdoor receptors pathway will be evaluated quantitatively only with respect to the groundwater that emerges in springs at the Site.

EPA Comment No. 27:

Section 2.4.3, bullet 1, p. 2-8 – It is assumed that groundwater table elevation maps will be prepared to form the basis for predicting potential upgradient sources.

ARRC Response: This assumption is correct.

EPA Comment No. 28:

Section 2.5, p. 2-8 first bullet under number 1 – Please make it clear in describing the SBR that the detailed evaluation was limited the "Further Action" sites (e.g., "…with special focus on existing analytical data and **detailed evaluation limited to** leased properties and railyard solid waste management units…").

ARRC Response: The Work Plan will be revised in accordance with this comment.

EPA Comment No. 29:

Section 2.5.1, p. 2-11 and Table 2-1 – Please discuss the distinction between the analyte lists in tables 2-1 and 2-2. Also, please footnote screening levels in Table 2-1 that are based on background levels rather than risk levels. In lieu of speciation data, the screening level for chromium in soil should be the PRG value for hexavalent form.

ARRC Response: Table 2-1 shows the analytes included in the standard analyte list. Table 2-2 shows the supplemental analytes that may be added as needed to this list. The requested footnote has been added to Table 2-1. The chromium VI PRG value has been substituted as requested.

EPA Comment No. 30:

Tables 2-1 and 2-2 – These tables do not include the available ecological screening values for soil. Although these values are later presented in Table 4-2, they are also necessary for these Section 2 tables, which demonstrate the acceptability of the reporting limits. The reader should be able to easily compare the ecological benchmarks to the reporting limits in the same way that the values are provided for the human health benchmarks. It is suggested that Table 4-2 be used as the base information for Tables 2-1 and 2-2, with the reporting limits added to this information. The data could then be split up into the two tables to show the investigation analyte list and the supplemental analyte list.

ARRC Response: The Work Plan will be revised in accordance with this comment.

EPA Comment No. 31:

Section 3, p. 3-1, sixth bullet – please make sure that site-specific soil properties needed for the Johnston-Ettinger indoor air model are collected in areas where this pathway may be relevant.

ARRC Response: Comment noted. Random samples were selected to be collected from across the Site to provide an initial site-wide dataset for modeling. If necessary for model input, location specific data will be collected once the initial RI data are evaluated.

EPA Comment No. 32:

Section 3.1, p. 3-2 – Table 2-2 lists EPH and VPH analyses are anticipated, however none of the samples listed in Tables 3-1 or 3-2 list these analyte groups. Under what conditions will EPH and VPH be analyzed?

ARRC Response: The approach to sampling hydrocarbons has been modified in response to this comment. EPH/VPH data is important for potential quantitative risk assessment of hydrocarbon mixtures. Table 3-2 has been revised to add analysis for EPH/VPH.

EPA Comment No. 33:

Section 3.2 and associated Tables 3-3, 3-4, and 3-5 (Data Quality Objectives [DQOs]):

Table 3-3, Surface Water and Sediment DQOs

a. Under “Identify Input to Decision(s)”, please include the human health and ecological risk CSMs as inputs (note: you do not need to include those as figures, but state that they are inputs). Also, please state that the human health and ecological benchmarks to be used for each medium as inputs (you could refer to Table 4-2 as preliminary screening benchmarks, if desired).

b. In the section titled “Develop a Decision Rule(s)”, please include a statement as to what will be done to get at the issue. For example (see italicized statements below that have been added to the first two decision rules):

   1) Are analytical data adequate to develop a list of COPCs for Site characterization? ***Screen data against applicable benchmarks to determine if the reporting limits are adequately low.***

      Yes. Proceed with Site characterization and risk assessment.

      No. Collect additional data as determined upon consultation with U.S. EPA.

   2) Are the data adequate to evaluate the nature and extent of the COPCs that exceed relevant screening levels in riparian zone wetlands and ponds? Determine whether all appropriate portions of the riparian zone wetlands and ponds have been sampled.

      Yes. Proceed to risk assessment.

      No. Collect additional data as determined upon consultation with U.S. EPA.

Table 3-4, Groundwater and LNAPL DQOs

a. This version was missing the first two sections of the DQOs (“State Problem(s)” and “Identify the Decision(s)”). Please make sure these are included in the final versions.

b. Under "Identify Input to Decision" for groundwater, please add the conceptual site hydrogeologic model and screening benchmarks as inputs (as indicated for Table 3-3, could reference Table 4-2 as preliminary screening values, if desired).

c. For both groundwater and surface water, please indicate whether filtered and/or unfiltered samples will be measured.

d. Under “Develop a Decision Rule”, please include a statement on how the question will be addressed (see comment b for Table 3-3). For Decision Rule 1, the text “Screen data … and extent” could be moved up to follow immediately after the questions. A suggestion for Decision Rule 2 is as follows:

   2) Are the nature and extent of dissolved phase COPCs beneath the Site that could migrate to Ship Creek or other receptors adequately delineated? ***Determine whether all portions of the site from which COPCs could migrate have been adequately sampled.***

e. For Groundwater: Development of Decision Rule #5 - this sentence is confusing, as it suggests that vapor intrusion occurs to Ship Creek rather than to indoor air. Suggest changing it to read, "If complete exposure pathways to Ship Creek or upland areas (including vapor intrusion) are identified for groundwater, can human health and ecological risk be calculated based on the existing dataset?"

Table 3-5, Soil DQOs

a. The proposed sampling approach indicates that soil samples will be collected at all or most new groundwater well sites and at known or suspected sources. This is an excellent approach that allows for characterization of unknown as well as known and suspected source areas. These two aspects of the sampling plan are not reflected in the soil DQOs. Steps 2 and 3 seem to focus only on known and suspected source areas. The second question under Step 2 refers only to the known or suspected sources. This could be stated more openly as "Is the nature and extent of COPCs adequately characterized?" or another question could be added to capture the areas lacking historical data (e.g., Have the nature and extent of COPCs been adequately characterized across the entire site?). Under Step 3, please include "analytical results for soil samples taken during groundwater well installation."

b. Please include a statement indicating that the CSMs and the screening benchmarks are inputs in Step 3.

c. See comment b for Table 3-3 and comment d for Table 3-4 above. Similarly, please indicate how the questions will be addressed for the decision rules outlined in Table 3-5.

d. Note that subsurface soil concentrations for volatiles should be screened or modeled for vapor intrusion. Vapor intrusion is only discussed under the groundwater DQOs.

ARRC Response:

Table 3-3

a. The Table will be revised in accordance with this comment.

b. Figure 3-6 provides the requested information. No text change to Table 3-3 is needed.

Table 3-4

a. The Table will be revised in accordance with this comment.

b. The Table will be revised in accordance with this comment.

c. The requested information was added to other parts of the RI Work Plan where this level of detail (metals sampling) is discussed. No text change to Table 3-4 is needed.

d. Figure 3-7 provides the requested information. No text change to Table 3-4 needed.

e. The Table will be revised in accordance with this comment.

Table 3-5

a. The Table will be revised in accordance with this comment.

b. The Table will be revised in accordance with this comment.

d. Figure 3-8 provides the requested information. No text change to Table 3-5 is needed.

e. The Table will be revised in accordance with this comment.

EPA Comment No. 34:

Section 3.3.1, p. 3-5, first paragraph – Delete (1) re: NPDES discharges. Delete the words "non-exempt" in the last sentence.

ARRC Response: The term "non-exempt" has been deleted in accordance with this comment. The clause under heading (1) in this paragraph has been retained as agreed at our July 21, 2005 meeting.

EPA Comment No. 35:

Section 3.3.1, p. 3-6, Area D: Railroad Avenue Marsh Area -- A sentence reads "The habitat survey identified a ditch with evidence of hydrocarbon contamination reaching the marsh." Any idea what the source of the contamination might be?

ARRC Response: Please refer to the Ship Creek Habitat Survey. No text change is needed.

EPA Comment No. 36:

Section 3.3.1, p. 3-7, third bullet – Was any consideration given to using passive diffusion samplers for semivolatile compounds in surface water to get a larger sample averaging period?

ARRC Response: Passive diffusion samplers are not appropriate for this level of investigation.

EPA Comment No. 37:

Section 3.3.1, p. 3-7 – It may be useful to evaluate acid volatile sulfide with simultaneously extracted metals (AVS/SEM) in sediment to assess the potential for uptake and toxicity of divalent metals to aquatic life.

ARRC Response: This method is not appropriate for this level of investigation.

EPA Comment No. 38:

Section 3.3.1, p. 3-7, third bullet – How does a single round of surface water sampling allow temporal evaluation of surface water quality? Is it possible that some transport mechanisms are more prevalent during higher flow conditions?

ARRC Response: ARRC will delete the word “temporal” from the text.

EPA Comment No. 39:

Sections 3.3.1, 3.3.2, and 4.1 – There is no text reference to whether metals analyses will include filtered metals. Please indicate that filtered metals will be collected. The only reference to dissolved metals is in a footnote to Table 3-2.

ARRC Response: The Work Plan will be revised in accordance with this comment.

EPA Comment No. 40:

Section 3.3.3, p. 3-12, fourth paragraph – It is recognized that analysis of VOCs in surface soil may be required for human health vapor intrusion studies; however, measurement of VOCs in soil for areas representing only ecological habitat (e.g., riparian soils) is not necessary.

ARRC Response: Comment noted. No text change is needed.

EPA Comment No. 41:

Section 3.3.4, p. 3-14, item 2 – What is the basis for using only the listed 5 wells? Are they fully representative of the entire shallow aquifer?

ARRC Response: As stated in the Work Plan text, tidal study wells were selected based on where tidal changes are considered to have the greatest potential influence on shallow groundwater elevations. As a result, three wells were selected west of the KAPP where surface water elevations changes are most apparent. Additionally, two wells were selected east of the KAPP dam to evaluate potential tidal influences in areas where there are no observable tidal influences on surface water elevations.

EPA Comment No. 42:

Section 3.3.4, p. 3-14, item 3 – What is the basis for conducting only 3 aquifer tests? Are they fully representative of the entire shallow aquifer?

ARRC Response: Wells will be selected for aquifer testing following review of lithologic logs. A minimum of three wells will be selected. Additional wells may be used for aquifer testing if needed to be representative of the range of lithologic conditions at the Site.

EPA Comment No. 43:

Section 3.5.2, p. 3-18, first para., and Appendix C SAP, Section 2.13, page 2-13, Groundwater Seep Sampling and Flow-Rate Estimation – Groundwater seep samples collected by hand digging the seeps may likely be affected by exposure to the atmosphere. Consider using a temporary drivepoint to sample groundwater at the spring. This approach was recommended in previous comments on the Draft Northern Boundary Assessment Interim Action Work Plan that EPA submitted to the ARRC on September 13, 2004.

ARRC Response: ARRC will revise the Work Plan to substitute the recommended sampling method.

EPA Comment No. 44:

Section 3.5.4, p. 3-19 and 3-20 – The text does not describe the methods used for determining the background value used in the comparisons to existing data. According to Appendix D, the same method used for groundwater is also used for surface water (i.e., twice the mean). Please indicate here the methods used. Also, please see Comment 16 above relating the appropriateness of this method for cases where the "twice the mean value" exceeds the maximum detected background concentration.

ARRC Response: ARRC has modified the background evaluation method for sediment and surface water in response to comment 16.

EPA Comment No. 45:

Section 3.7.1, p. 3-24, item 5 –The 95%UCL based on the arithmetic mean may not apply for all cases. The UCL should be based on the distribution type for each analyte within each exposure area, and could be based on a normal, lognormal, or nonparametric distribution. Statistics such as output from EPA's web-based ProUCL tool are needed.

ARRC Response: Agreed. ARRC has revised the text to state that the UCL will be based on the type of data distribution.

EPA Comment No. 46:

Section 3.7.2, p. 3-26, second bullet under "Additional Data Requirements" – It states here that a "Baseline risk assessment" will be conducted for the Ship Creek Ecological Area. Shouldn't this be a screening-level or refined screening-level assessment?

ARRC Response: Agreed. The Work Plan will be revised in accordance with this comment.

EPA Comment No. 47:

Table 4-1, Laboratory Analytical Methods, Sample Containers, Preservatives, and Hold Time Requirements (and Table 3 in Appendix C SAP) -- Preservation requirements for VOC and GRO solids (methanol, bisulfate, zero-headspace?) and GRO, DRO, and RRO for aqueous samples are not provided. The preservation method selected may effect holding times.

ARRC Response: ARRC will revise Table 4-1 to identify the preservation method that will be used.

EPA Comment No. 48:

Section 4.1, p. 4-1, last paragraph on page – As indicated in a previous comment, measurement of VOCs in surface soils in open-soil areas (i.e., non-industrial use areas) is not needed for the evaluation of risks to ecological receptors.

ARRC Response: Agreed. ARRC will revise the Work Plan in accordance with this comment.

EPA Comment No. 49:

Section 4.2, p. 4-3, last paragraph – Field or laboratory analyses should also measure pH in sediment and pH and water hardness in surface water (because they are needed for evaluation of certain analytes). Also, please indicate whether filtered and unfiltered surface water samples will be used for metals analyses of water.

ARRC Response: ARRC will revise the Work Plan to add water hardness and pH testing for surface water and pH testing for sediments. The Work Plan also will be revised to state that both filtered and unfiltered surface water samples will be analyzed for metals.

EPA Comment No. 50:

Appendix C, Table 1 – This table identifies reporting limits for the listed analytes in aqueous and solid media. It would be very helpful to include a column next to each listing the lowest preliminary screening value for the medium. It would also be useful to identify those reporting limits that exceed preliminary screening values as an early indication of which analyte-medium combinations may have issues with insufficient reporting limits.

ARRC Response: Because the SAP is intended as a procedural document to be used by field personnel in conducting RI field activities, a detailed discussion of preliminary screening levels was not included in the document (Appendix C). However, a full discussion of the selection of preliminary screening levels for the investigation analyte lists is provided in Section 4.1.1 of the RI/FS Work Plan along with a tabular summary of the preliminary screening levels for each analyte by medium (Tables 2-1 and 2-2).

EPA Comment No. 51:

Appendix C, Section 2.7.1, p. 2-7, 3rd para. – Recommend consideration of pre-pack well screens for augered wells.

ARRC Response: Based on the procedures outlined in Section 2.7.1 to ensure adequate placement of a filter pack around the well screen (i.e., determination of the volume of the annular space around the well vs. the volume of the introduced filter or sand pack), the standard approach for well installation and construction proposed in the SAP is considered adequate to ensure the integrity of the proposed new wells. No change is needed to the SAP text.

EPA Comment No. 52:

Appendix C, Section 2.9, p. 2-9, 2nd para. – Clarify the rationale for limiting well development to 10 casing volumes, as opposed to developing the well until water quality parameters stabilize to within a preset criteria. Well development typically includes surging to settle the sand pack.

ARRC Response: ARRC has revised Section 2.9 to state that monitoring wells will be developed until all water quality parameters have stabilized.

EPA Comment No. 53:

Appendix C, Sect 2.12.1, p. 2-11, Bailing Method -- The groundwater purging method appears to be mixing two approaches -- a "parameter stabilization" method and a "well volume" method. Some parameters (DO, redox, conductivity, and turbidity) are not likely to stabilize using a bailer sampling method. It is preferable that a parameter stabilization method and low-flow sampling approach be used at all groundwater monitoring wells and the bailing method be used only for slow recharge wells or as a backup method in case of equipment failure.

ARRC Response: ARRC has revised Section 2.12 to state that low-flow sampling will be performed as the primary means of groundwater sample collection, and that the bailing method will only be used for slow recharge wells or as a backup method.

EPA Comment No. 54:

Appendix C, Section 2.15, p. 2-14, second paragraph – As indicated in comments for the main text, please add pH to the analyses for sediment.

ARRC Response: ARRC has revised Section 2.15 as requested.

EPA Comment No. 55:

Appendix C, Section 2.16, p. 2-14, third paragraph – It says here that pH will be measured at the surface water sampling locations; this should be added to the main text (as indicated in previous comments). Additionally, please add water hardness to the analyses for surface water (may need to add this to the paragraph at the top of p. 2-15).

ARRC Response: ARRC has revised Section 2.16 as requested.

EPA Comment No. 56:

Appendix C, Section 2-18, p. 2-15, Field Quality Assurance Sampling -- Calls for collecting "field blanks" for soil and groundwater. Describe how the field blanks will be collected for each media and how the results will be used.

ARRC Response: ARRC has revised Section 2.18 as requested.

EPA Comment No. 57;

Appendix C, Section 2.24, p. 2-19, Investigation-Derived Waste Management – Describe the procedure and criteria for disposing of groundwater IDW onsite. Note that it is typically allowed by EPA and ADEC to treat most groundwater (without free product) with activated carbon and discharge onsite. This may be less costly than treating and disposing offsite.

ARRC Response: ARRC has revised Section 2.24 as requested.

EPA Comment No. 58:

Appendix D, p. 6, second paragraph on the page – As previously commented, it is recommended that the maximum background concentrations be used in cases where the “twice the mean value” exceeds the maximum detected background concentration. This is the case for aluminum and barium in surface water.

ARRC Response: See ARRC’s response to EPA Comment No. 16 above.

EPA Comment No. 59:

Appendix D, p. 7, first paragraph under “Soil” – Add a note that historical soil sampling did not occur in areas with ecological habitat; therefore, the historical data were not compared to ecological soil screening values. However, ecological soil screening values (as shown in Table 4-2 [and in Tables 2-1 and 2-2 when updated]) will be applied to soil data collected in support of the RI/FS as described in the Work Plan.

ARRC Response: ARRC will revise Appendix D in accordance with this comment.

EPA Editorial Comments

EPA Editorial Comment No. 1:

Additional minor editorial comments will be provided as hardcopy markups.

ARRC Response: ARRC received these hardcopy markups and will incorporate these revisions in the Work Plan.

EPA Editorial Comment No. 2:

Please make a global check for consistency of capitalization when referring to the Site. There are many instances where it is not capitalized.

ARRC Response: ARRC will revise the Work Plan text in accordance with this comment.

EPA Editorial Comment No. 3:

There are several instances in the text where the sample location numbers provided in the text do not exactly match the numbers shown in the figures. Please check these and make the text and figures consistent. One example of this is in Section 3.5.2, p. 3-17, the second paragraph. Two wells location IDs listed in this paragraph (GW6-A and 1S-8-01) do not match the IDs in Figure 3-5 (GW-6A and 1S-8 are shown in the figure). Other similar cases are identified in the hard copy markups.

ARRC Response: ARRC will revise the text designations for the sample locations to match those given in the figures.

EPA Editorial Comment No. 4:

There are also cases where the sample information regarding samples in the text does not agree with the figures. For example, in Section 3.3.3 (page 3-13, Area 4 subheading), the text says soil will be collected at sampling locations B-17 through B-19, whereas Figure 3-2 indicates that soil will be collected only at sampling locations B17 and B19. Similar issues were identified under the Area 5 and Area 6 subheadings. Please refer to the hard copy markups.

ARRC Response: Where sample locations were moved or sample ID's were changed and these were not reflected on the corresponding figures, ARRC will revise and resubmit those figures. The occurrence of a dash in a sample identifier does not alter the meaning or intention of the either the text or the figure. Those comments were not incorporated and no changes were made to figures solely to add a dash to the sample identification.

EPA Editorial Comment No. 5:

Some features identified in the text (e.g., Whitney Road mentioned in the last paragraph on p. 3-5 or Railroad Avenue mentioned on p. 3-6) are not labeled in the figures. Please make sure that all features identified in the text are also depicted on the figures.

ARRC Response: Figure 1-2 has been updated to add the features mentioned in the text.

EPA Editorial Comment No. 6:

Section 2.2, p. 2-1, first paragraph – The last sentence of the paragraph indicates that small commercial operations are located "up-valley (east) of the Site, along the Ship Creek floodplain".

However, the area indicated (i.e., floodplain east of the Site) appears to be part of Elmendorf AFB. Please verify the statement.

ARRC Response: The noted statement was incorrect and will be deleted from the Work Plan.

EPA Editorial Comment No. 7:

Figure 2-2 – Please define the dashed line for soil boring well #4112 (Elmendorf Building 22-001). Also, define TD and AMSL in the notes or legend, or include them in the list of acronyms and abbreviations.

ARRC Response: The dashed line was meant to indicate that the location was not directly on the transect. This has been clarified on the figure. ARRC also has added TD and AMSL to the list of acronyms.

EPA Editorial Comment No. 8:

Figures 2-3 and 2-4 – Please define AMSL in the notes or legend, or include them in the list of acronyms and abbreviations. Also, AMSL is in lower case letters (“amsl”) in Figure 2-4. Please make use of caps consistent among figures. Check for consistent use of caps or lower case in Figure 2-5 as well (either ft or FT).

ARRC Response: ARRC will revise the Work Plan in accordance with this comment.

EPA Editorial Comment No. 9:

1) 2.5.1, p. 2-11, first paragraph after the number list – This paragraph discusses the comparison of existing analytical data to preliminary screening levels, but does not provide the purpose for doing this comparison in the context of the RI/FS. This is later addressed in Section 4.1.1, p. 4-2, third paragraph. Please state the purpose in Section 2.5.1 where this approach to evaluating the existing data is first introduced.

ARRC Response: ARRC will revise the Work Plan in accordance with this comment.

EPA Editorial Comment No. 10:

Table 2-1 – The table notes indicate that the freshwater screening benchmark for bis(2-ethylhexyl)phthalate (32 ug/L) comes from MacDonald et al. (2000). This reference provides sediment benchmarks and is unlikely the source of this information. In Table 4-2 the same screening level is attributed to a different source. Please verify source.

ARRC Response: ARRC will revise the Work Plan to verify the source for this screening benchmark.

EPA Editorial Comment No. 11:

Figures 2-8 through 2-11 – It would be helpful to include the Site ID with the symbol for “no exceedance of a screening level at this location”, though it is acknowledged that this may cause crowding in Figures 2-10 and 2-11 because of the number of sampling locations. However, it would be helpful to be able to match up all data to the sampling locations on the map. Also, for all four maps, one of the notes says “Detection of an compound…” please revise to say “Detection of **a** compound…”.

ARRC Response: ARRC will revise only Figures 2-8 and 2-9in response to this comment. Figures 2-10 and 2-11 would be too busy to read if the requested information were added, since the figures were intended to show exceedances.

EPA Editorial Comment No. 12:

Figures 2-8 and 2-9 – Table Notes indicate that only sampling locations with at least one exceedance are shown in the table; however, both of the inset tables on these maps show the sampling locations with non-exceedances as well. Please either delete the table note or remove these data from the table.

ARRC Response: The Work Plan will be revised to delete the referenced Table Note.

EPA Editorial Comment No. 13:

Figures 2-10 and 2-11 – Map Note 1 says "…on Appendix D…", please change to "…**in** Appendix D…".

ARRC Response: ARRC has not made this requested change since other edits were not necessary to these figures. The requested change would not significantly alter the meaning of the note on the figure.

EPA Editorial Comment No. 14:

Section 3, p. 3-1, third bullet – please change LNAPL to NAPL (to include DNAPL, if this is present).

ARRC Response: ARRC will revise the Work Plan in accordance with this comment.

EPA Editorial Comment No. 15:

Figure 3-1 – Note 3 on Figure 3-1 states that "sample will have a depth component if sediment accumulation **is not significant**." Shouldn't there be a depth component if sediment accumulation **is significant**? Please verify.

ARRC Response: ARRC will revise the referenced text to remove the word "not," which was a typographical error.

EPA Editorial Comment No. 16:

Section 3.3.1, p. 3-5, last sentence that reads "The western pond is actively maintained." Clarify what is meant by this -- does someone actively maintain it and for what purpose?

ARRC Response: ARRC will clarify the referenced text.

EPA Editorial Comment No. 17:

Section 3.3.1, p. 3-7, first bullet – It is questionable whether the sediment sampling strategy actually defines "worst-case" sediment conditions. A worst-case scenario would likely require sampling every depositional area, which would be difficult to verify. Given the energetic nature of Ship Creek, it is understood that it can be difficult finding good sediment sampling locations because there are few areas where sediment accumulates to a significant degree. However, unless all depositional areas are being sampled, the approach should probably be termed "conservative" rather than "worst-case".

ARRC Response: ARRC will revise the Work Plan to substitute "conservative" for "worst-case" in the referenced text.

EPA Editorial Comment No. 18:

Section 3.3.1, pp. 3-7 to 3-8 – The background sediment sampling location (SC-11 [or should this be S-S-11, as indicated in later text?]) is not included in Table 3-1. Please include a description for SC-11 in the table as was done for other sampling locations. Also, please change the last sentence in the partial paragraph at the top of p. 3-8 to "Approximate sample collection locations are shown on **Figures 3-1 and 3-5 (for background sample SC-11)**, and described further in Table 3-1."

ARRC Response: ARRC will revise the Work Plan text and Table 3-1 in accordance with this comment.

EPA Editorial Comment No. 19:

Sections 3.3.2 and 3.3.3, pps. 3-8 to 3-14, identify the types of analytes to be measured during the sampling for groundwater and soil, respectively; however this information is missing from Section 3.3.1 (surface water and sediment).

ARRC Response: ARRC will revise Section 3.3.1 in accordance with this comment.

EPA Editorial Comment No. 20:

Section 3.5.3, p. 3-18, first bullet – Please identify the sample IDs depicted in Figure 3-5 for the six samples collected in June 1994. Are these the TR samples?

ARRC Response: Yes, these were the TR samples, and ARRC will revise Section 3.5.3 to provide this description.

EPA Editorial Comment No. 21:

Section 3.5.3, p. 3-19, first bullet – Station SD-05 is not shown in Figure 3-5.

ARRC Response: ARRC will revise Section 3.5.3 to delete the incorrect reference to SD-05 and change the text so that it refers to HC-05, which is depicted on Figure 3-5.

EPA Editorial Comment No. 22:

Section 3.5.3, p. 3-19, second bullet – Sampling location SC-I1 is said to be from the Elmendorf hatchery; however, in Figure 3-5 it is shown across the creek from the hatchery. Please verify that the sample is depicted in the correct location.

ARRC Response: Sample location was adjusted in Figure 3-5 to the correct location.

EPA Editorial Comment No. 23:

Figure 3-3 -- The seeps at the Northern Bluff are likely caused by clay soils that are above the base of the bluff. The conceptual transect could be improved to more realistically show the elevations of the upper aquifer and bootlegger cove clay at the northern bluff, as was done in Figure 2-3.

ARRC Response: No change to the Work Plan is warranted at this time. ARRC will consider this comment in future deliverables.

EPA Editorial Comment No. 24:

Figure 3-5

- The Anchorage Terminal Reserve Boundary indicated in this figure extends slightly past Reeve Boulevard to the east. The surface water and sediment background sampling location (SC-11) is supposed to lie outside the Site, just east of Reeve Boulevard. However, due to the misplacement of the Site boundary, it appears that the proposed background sampling location is within the Site. Additionally, the sample is depicted at the Reeve

Boulevard bridge, instead of the "reach above Reeve Boulevard" as indicated on p. 3-19 of the text (below the bullets). Please update the figure to show the appropriate extent of the Site boundaries and the appropriate location of SC-11.

- During the Site visit on September 15, 2004, we observed inflow entering the creek from the north, just upstream of the Reeve Boulevard bridge (said to be from the hatchery). Where is EL-SC-8 in relation to that? (It is shown across the creek, outside the creek).
- As indicated above, please verify that SC-I1 is depicted in the correct location.
- Please verify that sample location IDs in this figure match those listed in the text (see editorial comment 2 below).

ARRC Response: ARRC will revise the Work Plan text and Figure 3-5 in accordance with this comment.

EPA Editorial Comment No. 25:

Section 3.6, p. 3-20, second paragraph under "Sediment and Surface Water" – It should be noted here that non-detected constituents with reporting limits (RLs) greater than the screening levels (SLs) will be retained as uncertainties in the risk assessments. This decision from the May 19, 2005 meeting is logged in Section 4.1.1, but it should be included here for sediment and surface water and in the text for each of the other media types (groundwater and soil). This note should also be added to the data evaluation flowcharts (Figures 3-6 to 3-8). It is incomplete to say "Evaluation Complete" if the answer to "Analyte > RL" is "No".

ARRC Response: ARRC will revise appropriate portions of the Work Plan text and figures to make the changes recommended by this comment. ARRC will not revise the text referenced in this comment, however, since this text discusses the general approach for evaluating sediment and surface water and is not directed at providing the specific detail regarding the relationship of reporting limits to screening levels that is provided elsewhere in the document.

EPA Editorial Comment No. 26:

Figures 3-6 through 3-8 – Please add the note indicated in comment 25 above to each figure and see hard copy markups for additional minor comments.

ARRC Response: ARRC will revise these figures to add the requested Note and make the changes noted on the hard copy markups that EPA provided to us at the July 21, 2005 meeting.

EPA Editorial Comment No. 27:

Section 4.1, p. 4-1, second bullet – Rather than using "metals" or "metals and cyanide", please refer to these as "inorganics". This will capture metalloids (e.g., selenium) and other inorganics. This is also a general comment to be applied throughout.

ARRC Response: ARRC will revise Section 4.1 in accordance with this comment.

EPA Editorial Comment No. 28:

Section 4.1.1, p. 4-1, second paragraph – Documentation of meeting decisions (such as included here and elsewhere) is acknowledged, and greatly appreciated.

ARRC Response: Comment noted.

EPA Editorial Comment No. 29:

Section 4.1.1, p. 4-2, first paragraph (and elsewhere) –In the first sentence, information is presented "**in** Table 4-2". In a subsequent sentence within the same paragraph, "levels are shown **on** Table 4-2". Please change the "**on**" in the second sentence to "**in**". This type of usage of "on" was observed throughout the text. Please make a global change (i.e. "…on Table…" to "…in Table…". For figures, it can either be "… on Figure…" or "…in Figure…".

ARRC Response: ARRC has revised the Tables and Figures in accordance with this comment.

EPA Editorial Comment No. 30:

Section 4.1.1, p. 4-2, last sentence of the last paragraph on the page – Please revise this sentence to read: "These are not final screening levels but will contribute to the development of the final levels and required reporting limits."

ARRC Response: ARRC will revise the referenced text in accordance with this comment.

EPA Editorial Comment No. 31:

Section 4.2.1, pg. 4-3 to 4-4, Area A: KAPP Pond – Please rewrite the last sentence under this subsection as follows: "A surface water sample will be collected immediately before (to avoid suspension of sediment into the sample) the sediment sample at the center sample collection location within the pond (Table 3-1)."

ARRC Response: ARRC will revise the referenced text in accordance with this comment.

EPA Editorial Comment No. 32:

Appendix C, Section 2.16, p. 2-14 – It would be good to note in this section that at locations where both sediment and surface water are being collected, that surface water will be collected first to avoid suspension of sediment into the sample. Though this seems obvious, it is always good to state the full protocol.

ARRC Response: ARRC will revise Appendix C to make it explicit that the sampling protocol referenced in this comment will be followed.

EPA Editorial Comment No. 33:

Appendix D - Figure numbers in this appendix are not correct. Additionally, there are many cases of the sample location ID in the text not matching the IDs in the figures. Please see the hard copy markups.

ARRC Response: ARRC will revise Appendix D in accordance with this comment and change the figures as noted in the hard copy markups that EPA provided to us at our July 21, 2005 meeting.

Burt Shepard's Comments

General Comments

1) **Selection of ecological screening levels for various media.** Since the workplan describes a screening level ecological risk assessment, it is important that screening level toxicity reference values (TRVs) for as many chemicals as possible be identified. This serves to both reduce uncertainty in the results of the risk assessment by minimizing the number of chemicals whose hazard cannot be quantified, and helps to ensure that potential risk drivers are not missed due to an absence of TRVs. We note that a large number of chemical analytes in Tables 2-1, 2-2, and 4-2 do not have ecological screening values for many chemicals, including many of the VOCs, SVOCs and TPH fractions with significant numbers of exceedances of screening values as shown in Figures 2-8 through 2-11 of the draft RI/FS workplan. EPA recommends that additional sources of TRVs be reviewed to obtain screening levels TRVs for the large number of chemical analytes in soil, surface water and sediment listed in Tables 2-1, 2-2 and 4-2 currently without screening levels. Consideration should be given to developing a hierarchy of sources for TRVs (e.g. 1. Alaska water quality standards, 2. USEPA ambient water quality criteria, 3. Oak Ridge screening benchmarks, etc.). Potential additional sources of screening levels include the following:

   Canadian Environmental Quality Guidelines (for water, sediment, soil and tissue), found at: www.ec.gc.ca/ceqg-rcqe/English/ceqg/default.com

   Ecological screening values – Savannah River Site (for water, sediment and soil, contains some of the Canadian and Dutch guidelines), found at: www.srs.gov/general/programs/soil/ffa/rdh/p71.PDF

   USEPA soil screening levels (soil), found at: www.epa.gov/ecotox.ecossl/

   Australian and New Zealand Guidelines for Fresh and Marine Water Quality (for water and sediment), found at: www.deh.gov.au/water/quality/nwqms/

   Environment Canada Compendium of Environmental Quality Guidelines (for water, sediment and tissue), found at: www.pyr.ec.gc.ca/georgiabasin/reports/Environmental%20Benchmarks/GB-99-01_E.pdf

Comment Response: We welcome the input and will consider the comments for inclusion in the Risk Assessment Scoping Memo.

2) **Selection of ecological screening values for total petroleum hydrocarbon (TPH) mixtures.** Given the historical and current uses of petroleum products at the site, it is important to have a method by which potential ecological risks from exposure to TPH mixtures can be quantified. While Alaska has no ecological guidelines for GRO, DRO and RRO, we have identified two potential sources of screening level TPH guidelines for water, sediment and soil. One is a series of ecological TRVs for GRO in water and sediment, and for DRO and RRO in sediment developed by URS Corporation, and used during risk assessments of several Alaskan sites including Adak, Barrow Landfill, and Elmendorf AFB. The TRVs are 114 µg/L for GRO in water, and 1200, 9100, and 117,000 mg/kg organic carbon for GRO, DRO and RRO in sediment, respectively. The above values were derived from narcosis theory starting with a critical body burden of each TPH fraction associated with minimal chronic toxicity to aquatic biota, then running a bioaccumulation model backwards to obtain a water column concentration which, if not exceeded, results in bioaccumulation of the critical body residue. The water column TRV was then employed in EPA's equilibrium partitioning approach to

sediment quality guideline development to obtain the organic carbon normalized sediment TRVs. The theory predicts that the maximum water solubility of DRO and RRO would have to be exceeded before toxicity to aquatic species could be elicited, the reason why there are no water column TRVs for DRO and RRO. The Canadian Council of Ministers of the Environment (CCME) and Alberta Environment have been working for a number of years to develop ecological TPH guidelines for soil, based on toxicity tests with terrestrial plants and soil invertebrtes, and have limited information on TPH in water. Unfortunately, the Canadian guidelines have different definitions of TPH fractions than does ADEC (although the Canadian Fraction 1 definition is identical to ADEC's definition of GRO), so the Canadian guidelines may not be directly applicable. The CCME guidelines can be found at: www.ccme.ca/assets/pdf/phcs_in_soil_standard_e.pdf while the Alberta Environment values and supporting documentation are at: http://www3.gov.ab.ca/env/infor/infocentre/publisting.cfm?Keyword=SOIL

Comment Response: See comment response #1.

3) **Data Usability** – The workplan would benefit from one or more data usability tables that would identify the proportion of the existing data whose analytical reporting limits exceed the various human health and ecological screening levels. These tables would be of use in identifying analytes that may need to be analyzed using more sensitive analytical methods, and would also be useful in identifying data gaps where additional sampling may need to be performed. Data usability tables would also provide a good summary of the number of samples available for evaluation in each environmental medium. If a significant number of non-detect values are reported at concentrations above screening levels, EPA recommends that a decision rule be added to Tables 3-3 through 3-5 that specifically states that data whose reporting limits exceed screening levels is inadequate to evaluate risk, and that additional samples be collected. This could be accomplished by modifying the wording of Decision Rule 3 of Table 3-3, and of Decision Rule 3-4 in Table 3.5.

Comment Response: We disagree. As discussed with EPA during the development of the SBR and the RI Work Plan, we already recognize that some chemicals have detection limits higher than screening levels, more sampling will not solve this issue. Therefore, as agreed to with EPA we will track those chemicals and discuss them in the uncertainty analysis of the risk assessment.

Specific Comments

Section 2.4.1, page 2-6, human health conceptual site model. The fourth bullet on the page has a typographical error in its last sentence. The text should read ". . . are contributing to . . ." instead of ". . . are contribute to . . ."

Comment Response: Text has been edited.

Section 2.4.1, page 2-6, and Figure 2-6, human health conceptual site model. The unrestricted use receptor group should be defined in the text. If this group is intended to include either current or future residential receptors in the southwestern portion of the site, there should discussion that current residential receptors is not a complete pathway, and that it is unlikely that a complete exposure pathway will exist for future residential receptors.

Comment Response: Figure and text has been edited.

Section 2.4.2, page 2-7 and Figure 2-7, ecological conceptual site model. The only amphibian native to Alaska is the wood frog, not a tree frog. While the adult wood frog is primarily a terrestrial invertivore, the tadpole stage of the wood frog should also appear as a receptor of concern in the aquatic food web as an invertivore. As it is conceivable that some of the top terrestrial predators such as hawks and foxes can prey on aquatic omnivores and such as ducks and mink, there should be a blue arrow on the CSM linking the aquatic omnivore and piscivore and the terrestrial carnivore boxes.

Comment Response: Figure and text has been edited.

Section 3.3, Site Investigation Approach, Page 3-3. What does "Sediment and surface water samples will be collected authoritatively . . ." mean?

Comment Response: Footnote added with definition.

Section 3.3.3, Soil, Page 3-12. Similar to specific comment 4, what is authoritative soil sampling?

Comment Response: Comment incorporated.

Section 3.5, Determining Background Concentrations, pages 3-16 to 3-19. EPA agrees with the basic approach of identifying both natural and anthropogenic background concentrations for various media. We would expect that the calculated values for the two types of background be clearly identified and separated from each other in all subsequent reports. For example, it is unclear from a reading of Table 3-8 whether the background values listed should be considered natural or anthropogenic, although we are aware that some of this confusion is due to the data sources used to generate the table. Although due to a lack of information we cannot rule out their use at this time, EPA questions the use of groundwater data from monitoring wells GW6-A, NS3-03, SP2/6-01, and 1S-8-01 at Elmendorf AFB as representative of natural background concentrations. The text also does not provide any details regarding the methods that will be used to compare site data to background concentrations, except for a brief mention of the Alaska 2003 background guidance. We recommend that the current EPA Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (EPA 540-R-01-003, September 2002), which uses hypothesis testing methods to identify samples exceeding background, be used as the starting point for the site to background comparisons.

Comment Response: As discussed with EPA on July 21, ARRC will review the CERCLA background document along with ADEC (2003) methods for appropriate use of background data to screen site-data. We agree that anthropogenic and natural background need to be distinguished in future submittals. We will further review the applicability of Elmendorf AFB background data to this site prior to submitting the RI. No changes to the background discussion were done to this Work Plan.

Figure 2-3b   Travel Time through the Bootlegger Cove Formation

travel time = formation thickness / vertical velocity
vertical velocity = k * i
i = vertical gradient = Bootlegger thickness / head difference between deep & shallow aquifers
k values for marine clays = 10^{-7} to 10^{-11} cm/sec, from Freeze & Cherry
Bootlegger thickness = 120 to 200 ft, from Updike & Carpenter, 1986

k,hydraulic conductivity (cm/sec)	travel time (years)	Head difference between deep and shallow aquifer (ft)	travel time (days)	Bootlegger thickness (ft)	velocity (ft/day)	velocity (cm/sec)	i, vertical gradient (ft/ft)
1.E-07	139,178	1	50800000	120	2.E-06	8.E-10	0.008
1.E-08	1,391,781	1	508000000	120	2.E-07	8.E-11	0.008
1.E-09	13,917,808	1	5080000000	120	2.E-08	8.E-12	0.008
1.E-07	13,918	10	5080000	120	2.E-05	8.E-09	0.083
1.E-08	139,178	10	50800000	120	2.E-06	8.E-10	0.083
1.E-09	1,391,781	10	508000000	120	2.E-07	8.E-11	0.083
1.E-07	1,392	100	508000	120	2.E-04	8.E-08	0.833
1.E-08	13,918	100	5080000	120	2.E-05	8.E-09	0.833
1.E-09	139,178	100	50800000	120	2.E-06	8.E-10	0.833

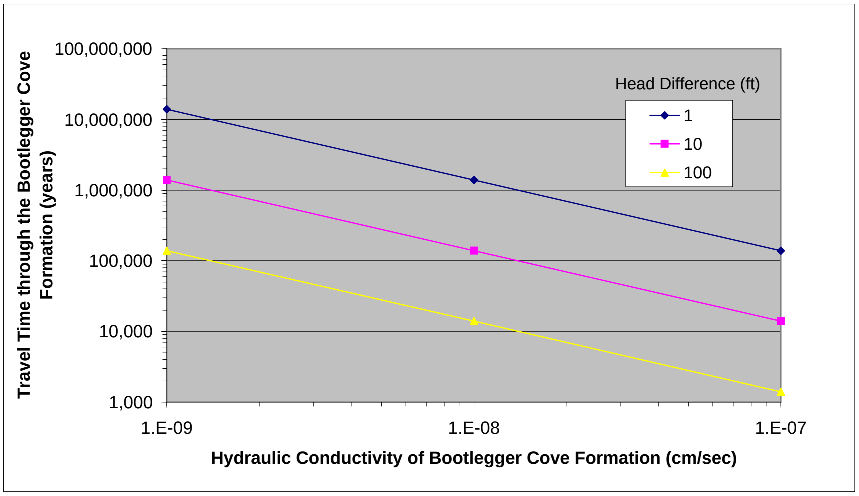


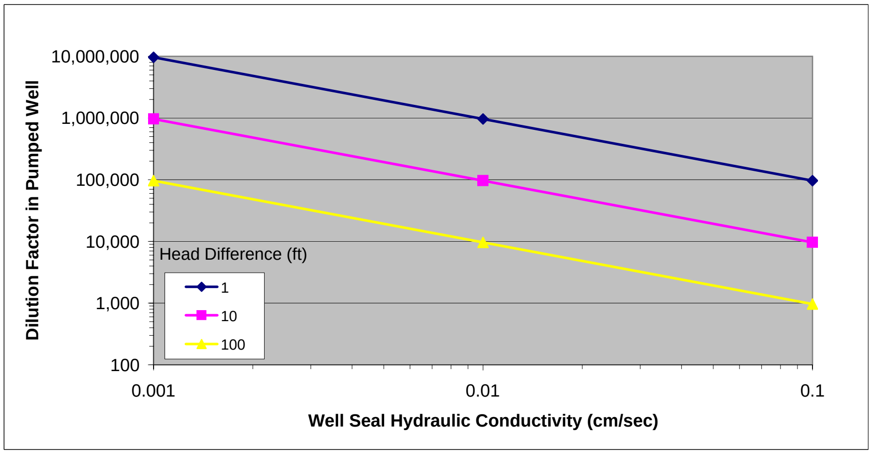
Figure 2-3c   Dilution of Flow though a Leaky Well Seal

Anch population	gal/person/day	Anch water use (gal/day)	production well pumping rate (gal/day)	production well pumping rate (gal/minute)
250,000	120	30,000,000	1,000,000	694

flow though a leaky well seal = Q=kia

casing diameter (in)	screen diameter (in)	annular area (cm^2)
12	6	547
30.48	15.24	547

soil texture suggested by hydraulic conductivity value	k for gravel/sand pack (cm/sec)	Head difference between deep and shallow aquifer (ft)	i, vertical gradient (ft/ft)	area (cm^2)	Q (cc/sec)	Q gal/day)	DF
gravel	0.1	1	0.008	547	0	10	96,062
sand	0.01	1	0.008	547	0	1	960,622
fine sand	0.001	1	0.008	547	0	0	9,606,215
gravel	0.1	10	0.083	547	5	104	9,606
sand	0.01	10	0.083	547	0	10	96,062
fine sand	0.001	10	0.083	547	0	1	960,622
gravel	0.1	100	0.833	547	46	1,041	961
sand	0.01	100	0.833	547	5	104	9,606
fine sand	0.001	100	0.833	547	0	10	96,062



Remedial Investigation / Feasibility Study Work Plan

Revision 1

Volume 1 of 2

Alaska Railroad Corporation
Anchorage Terminal Reserve
U.S. EPA Docket No. CERCLA 10-2004-0065

Prepared by:

The RETEC Group, Inc.
3401 Minnesota Drive, Suite 300
Anchorage, AK 99503

Prepared for:

Alaska Railroad Corporation
327 Ship Creek Avenue
Anchorage, Alaska 99501

Original: June 23, 2005
Revision 1: August 15, 2005

Remedial Investigation / Feasibility Study Work Plan

Alaska Railroad Corporation
Anchorage Terminal Reserve
U.S. EPA Docket No. CERCLA 10-2004-0065

Prepared by:

The RETEC Group, Inc.
c/o HCG
3401 Minnesota Drive, Suite 300
Anchorage, AK 99503

Prepared for:

Alaska Railroad Corporation
327 Ship Creek Avenue
Anchorage, Alaska 99501

Prepared by:

Stan Flagel, Task Manager

Chris Cosentini / for
Amber Murray, Geologist

Reviewed by:

Chris Cosentini
Chris Cosentini, Project Manager

June 23, 2005

Table of Contents

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Acronyms and Abbreviations

ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AMSL	above mean sea level
ANPR	Advance Notice of Proposed Rulemaking
AOC	Administrative Order on Consent
ARAR	applicable or relevant and appropriate requirement
ARRC	Alaska Railroad Corporation
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CERCLA	Comprehensive Environmental Responsibility, Compensation, and Liability Act of 1981
cfs	cubic feet per second
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
CSM	conceptual site model
DQO	data quality objective
DRO	diesel range organics
EAFB	Elmendorf Air Force Base
ECSM	ecological conceptual site model
EPH	extractable petroleum hydrocarbons
GRO	gasoline range organics
KAPP	Knik Arm Power Plant
LNAPL	light non-aqueous phase liquid
ML&P	Municipal Light and Power
MNA	monitored natural attenuation
MOA	Municipality of Anchorage
NAPL	Non-aqueous phase liquid
NPL	National Priorities List
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PC	planned community
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
RAO	remedial action objective
RAO Memo	Remedial Action Objectives Technical Memorandum
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RI/FS	Remedial Investigation and Feasibility Study
RRO	residual range organics
RSLERA	Refined Screening Level Ecological Risk Assessment
SAIC	Science Applications International Corporation
SAP	RI/FS Sampling and Analysis Plan
SBR	Site Background Report
Site	Alaska Railroad Corporation, Anchorage Terminal Reserve
SLERA	Screening Level Ecological Risk Assessment

List of Acronyms and Abbreviations

SMDP	Scientific Management Decision Points
SOW	Statement of Work
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TD	total depth
TOC	total organic carbon
UCL	upper confidence limit
USAF	United States Air Force
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UTL_B	upper tolerance limit
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbons
Work Plan	RI/FS Work Plan

1 Introduction

This *Remedial Investigation and Feasibility Study* (RI/FS) *Work Plan* (Work Plan) was developed under the Comprehensive Environmental Responsibility, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) *Administrative Order on Consent No. 10-2004-0065* (AOC) (U.S. EPA, 2004a) dated June 29, 2004 between the United States Environmental Protection Agency (U.S. EPA) Region 10 and the Alaska Railroad Corporation (ARRC). ARRC agreed under the AOC to conduct a CERCLA- RCRA RI/FS study at its 600-acre Anchorage Terminal Reserve in Anchorage, Alaska (Figures 1-1 and 1-2), hereafter referred to as the Site. This Work Plan is inclusive of the entire Site (i.e., no areas or properties have been excluded).

The purpose of the RI/FS is to meet AOC requirements regarding the following:

- Assessment of contaminant transport, receptors, and pathways for protection of Ship Creek
- Protection of human health and ecological receptors evaluated through a risk assessment
- Identification of relevant sources[1] of chemicals present that may pose a risk
- Identification and screening of potential remedial actions

Upon completion of the RI/FS, ARRC will have satisfied the following specific AOC goals:

1. Investigate the nature and extent of contamination at the Site
2. Assess the potential risk to human health and the environment caused by Site contamination
3. Develop Site-specific remedial action and corrective measures objectives

---

[1] Source has been defined by the U.S. EPA in Section 4.4 of the *Statement of Work* (SOW) (U.S. EPA, 2004b) as follows: Respondent will identify source areas that are contributing to contamination at or from the Site that may cause human or ecological exposures above acceptable risk levels.

4. Identify the need for and the range of potential remedial alternatives, and evaluate those that may encompass both CERCLA remedial actions and RCRA corrective measures

5. Recommend a preferred remedial alternative

The AOC which incorporates a *Statement of Work* (SOW) (U.S. EPA, 2004b) includes specific requirements for ARRC activities through the RI/FS process. This Work Plan is being submitted in fulfillment of Subtask 2e of the SOW. Details of all required RI/FS work activities and submittals, as outlined in the AOC, are provided in the following section.

1.1 Remedial Investigation/Feasibility Study Progress Summary

The ARRC RI/FS is being conducted in accordance with guidelines outlined in the AOC, SOW, and the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (U.S. EPA, 1988). Status of the progress toward completing the ARRC RI/FS is summarized in Table 1-1, which outlines the completed tasks as required by the SOW.

Progress toward completing the RI/FS includes submittal of documents to the U.S. EPA, as outlined in Table 1-1. As of the date of this Work Plan, the following documents have been prepared and submitted to the U.S. EPA as specified in the SOW:

- *North Boundary Assessment Interim Action Work Plan* (RETEC, 2004a) – Submitted August 30, 2004 and approved by the U.S. EPA on September 13, 2004.

- *Ship Creek Initial Habitat Assessment Interim Work Plan* (RETEC, 2004b) – Submitted September 10, 2004 and approved by the U.S. EPA on October 5, 2004.

- *Interim Action Work Plan for Monitoring Well Reconnaissance and Site-Wide Groundwater Elevations* (RETEC, 2004c) – Submitted December 3, 2004 and approved by the U.S. EPA on February 22, 2005.

- *North Boundary Assessment Groundwater and Soil Results* (RETEC, 2004d) – Submitted December 3, 2004.

- *Ship Creek Preliminary Habitat Assessment* (RETEC, 2004e) – Submitted December 6, 2004.

- *Site Background Report* (SBR) (RETEC, 2005a) – Submitted December 15, 2004 and approved (following submittal of responses to U.S. EPA comments) by the U.S. EPA on March 23, 2005.

- *Remedial Action Objectives Technical Memorandum* (RAO Memo) (RETEC, 2005b) – submitted May 16, 2005.
- *Quality Assurance Project Plan* (QAPP), *Alaska Railroad Corporation, Anchorage Terminal Reserve* (RETEC, 2005c) – submitted June 6, 2005.
- *Site-Specific Health and Safety Plan, Alaska Railroad Corporation, Anchorage Terminal Reserve* (RETEC, 2005d) – submitted June 13, 2005.

1.2 Work Plan Objectives

This Work Plan is intended to describe the rationale, scope of work, and procedures for data collection at the Site required to satisfy the goals of the AOC. Because previous investigations were completed on a property-by-property basis and lacked procedural, analytical, or temporal continuity, further data collection will be necessary to evaluate Site-wide impacts to Ship Creek or potential receptors. Although historical data provide a basis for limited source characterization to locate source areas or to determine completeness of source to receptor pathways, further data collection through the RI is needed. As a result, ARRC has developed an investigation strategy that combines systematic and authoritative sampling for a comprehensive analyte list to provide an evaluation of migration pathways to Ship Creek, determination of nature and extent of known and potential sources, human health and ecological risk, and need for potential types of remedial actions.

To implement this investigation strategy, this Work Plan will meet the following objectives:

- Summarize Site conditions and available data
- Develop data quality objectives (DQOs) to guide data collection
- Develop an investigation analyte list for all environmental media (i.e., sediment, surface water, groundwater, and soil) and collect data to define background concentrations for each medium
- Identify sample collection locations, temporal requirements, and specific analyses (chemical and hydrogeologic) required to characterize potential sources, complete human health and ecological risk assessments, and evaluate remedial alternatives, and provide rationale for each

- Describe methods and procedures to be implemented for sample collection and analyses
- Develop criteria for future data collection

1.3 Work Plan Report Organization and Components

The RI/FS Work Plan is organized as follows:

- **Section 1.** Presents an introduction to the ARRC RI/FS process and progress toward achieving the goals outlined in the AOC and SOW. It also defines the objectives of the Work Plan.
- **Section 2.** Provides a discussion of the sources of data used to determine the scope of the RI/FS and a description of the Site background including a summary of the Site history and current and future land use. This section also provides a discussion of the environmental setting and the preliminary human health, ecological, and hydrogeologic conceptual site models (CSMs).
- **Section 3.** Details the RI/FS data collection strategy and rationale for investigative activities at the Site. It includes a discussion of the investigation matrix-specific DQOs defined to ensure data collection of adequate quantity and quality for the purpose of satisfying the RI/FS objectives. This section also presents the requirements for additional data collection including a discussion of background concentration determination, potential source evaluation, and risk evaluation. Remedial action objectives (RAOs), applicable or relevant and appropriate requirements (ARARs), the approach for screening of remedial alternatives, and endpoints are also introduced in Section 3.
- **Section 4.** Summarizes the scope of work proposed to ensure achievement of the DQOs. This includes identification of the RI/FS analyte list and details regarding proposed sediment, surface water, groundwater, light non-aqueous phase liquid (LNAPL), and soil sample collection.
- **Section 5.** Addresses health and safety topics related to conducting the RI/FS.
- **Section 6.** Outlines the schedule for completion of the RI data collection.
- **Section 7.** Provides a listing of the references cited within the text, tables, and figures of this RI/FS Work Plan.

This RI/FS Work Plan also encompasses the following components prepared in accordance with the guidelines summarized in the SOW, AOC, and the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (U.S. EPA, 1988) for preparation of an RI/FS Work Plan:

- **Project Management Plan.** This document identifies the ARRC project team and provides details regarding project goals, the RI/FS schedule, project communication, data management, quality control, document review, and deliverables. The Project Management Plan is provided in Appendix A.

- ***QAPP* (RETEC, 2005c).** This document summarizes the quality assurance objectives (e.g., precision, accuracy, completeness, representativeness, and comparability) for data collection and reporting for Site investigative activities. It covers such topics as sample custody, lab reporting limits, quality assurance/control, investigation/lab personnel roles and responsibilities, field/lab equipment calibration requirements, and data assessment procedures. The QAPP also includes the project Data Management Plan, which was developed to ensure proper procedures for storage of original field and lab data/reports and proper quality assurance procedures for all data input into the ARRC project database. The QAPP was submitted to U.S. EPA under separate cover on June 6, 2005.

  In addition, copies of prospective laboratory QAPPs were submitted to the U.S. EPA in October of 2004 in accordance with Section 2.6.1 of the SOW. Approval of these laboratory QAPPs is still pending as of the date of submittal of this Work Plan.

- ***Site-Specific Health and Safety Plan* (RETEC, 2005d).** This document provides details regarding Site worker health and safety procedures/protocols, on-site physical and chemical hazards, railroad safety protocols, emergency contacts, incident reporting, personal protective equipment (PPE), decontamination, training requirements, and medical surveillance requirements (among other health and safety-related topics). It is intended as a Site health and safety document under which all field investigative activities will be conducted. The *Site-Specific Health and Safety Plan* (RETEC, 2005d) was prepared under separate cover and submitted to U.S. EPA on June 13, 2005.

- **Project-Specific Health and Safety Plan.** This document was prepared as a requirement of the *Site-Specific Health and Safety Plan* (RETEC, 2005d). It includes a Job Hazard Analysis and outlines RI/FS investigation-specific hazards, health and safety procedures/protocols, air monitoring requirements, emergency contact information, and PPE. The Project-Specific Health and Safety Plan is provided in Appendix B.

- **RI/FS Sampling and Analysis Plan (SAP).** This document was prepared in support of the RI/FS investigation scope outlined in this Work Plan. It provides a summary of the methods and procedures outlined for data collection to satisfy the objectives of the RI/FS field investigation. It includes a summary of the investigation objectives, field activity documentation, sample collection methods and procedures, sample collection types and locations, and proposed sample analyses. The SAP is provided in Appendix C.

2 Site Background and Initial Evaluation

This section provides a summary of the Site conditions; specifically what information and data sources were used to form the rationale and strategy for implementation of the RI. The components include extensive Site knowledge regarding the railyard and leased properties, presented through a discussion of the Site history, current and future Site land uses, environmental setting, CSMs, and existing conditions based on historical data.

2.1 Site Description and History

The Alaska Railroad, which began operations in 1914, was owned by various departments of the federal government, including the former War Department, Department of Interior, and, most recently, the Department of Transportation, until its transfer to the State of Alaska in 1985 (Science Applications International Corporation [SAIC], 1996). The Site consists of approximately 600 acres of property in the lower Ship Creek valley. The railyard facility itself occupies approximately 313 of the 600 acres and includes a railroad track system, maintenance and repair buildings, shops, a refueling area, a tank car cleaning area, warehouses, and administrative offices (SAIC, 1996). Railroad ties have not been treated on the ARRC property. Approximately 287 of the 600 acres consist of parcels that are leased to a variety of Anchorage commercial and industrial businesses. The acreage associated with both the railyard and the leased properties includes public streets and rights-of-way, and undeveloped areas. Leasing of most of the 287 acres began during the federal ownership (Booz-Allen Hamilton, 2002).

The railyard and leased properties are depicted on Figure 1-2.

2.2 Current and Reasonable Future Land Use

Currently, ARRC maintains a rail system for freight and passengers from Seward, Alaska to Fairbanks, Alaska, with spur lines to North Pole and Whittier. The railroad system is operated year-round. The central business district of Anchorage is located on the bluff above Ship Creek to the south of the Site; and the Government Hill residential, commercial, and light industrial district is located on the bluff due north of the Site. Elmendorf Air Force Base (EAFB) lies on the bluff north and northeast of the Site and east of the portions of the Site along Ocean Dock Road.

The current and historical use of the Site for commercial/industrial purposes is unlikely to change in the foreseeable future. ARRC will control land uses at the Site since ARRC owns all the Site property. The majority of the Site is zoned for heavy or light industry. ARRC, the State of Alaska, and the Municipality of Anchorage (MOA) have no short- or long-range plans for different land uses at the Site or in the immediately surrounding area. The only potential exception to this relates to the area in the southwestern portion of the Site, which is currently zoned as a “planned community” (PC) district and which includes residential within its permitted uses (RETEC, 2005a). ARRC and the MOA are discussing possible changes to the zoning designation in this area. Regardless of those potential changes, this area is, and will remain, the only area of the Site where a limited amount of future residential housing could possibly be located. Ultimately, as the owner of the property, ARRC will determine the land use in this area, including whether to lease any land for residential purposes.

Areas 2 and 3 (Figure 1-2) of the Site are active industrial areas consisting of the ARRC railyard and fuel terminals, respectively. Because contamination in both these areas is being managed by ARRC in Area 2 and the tenants in Area 3, the latter under Alaska Department of Environmental Conservation (ADEC), this RI Work Plan proposes monitoring at the perimeter of these Areas to determine if contaminants are migrating outside these areas to other portions of the Site, Cook Inlet, or Ship Creek. The perimeter monitoring that is proposed is designed to identify any human health or environmental risks that may be associated with the solid waste management units (SWMUs) and AOCs identified in these Areas.

2.3 Environmental Setting

This section summarizes the environmental setting as discussed in the SBR. Provided below is a summary of the physiographic setting, geology, and hydrogeology of the Site.

2.3.1 Physiography

The Site is located in the Cook Inlet-Susitna lowland physiographic province within a subsection referred to as the Anchorage Lowland (Warhaftag, 1970). Specifically, the Site lies in the Ship Creek valley incised within the Anchorage lowlands adjacent to the Knik Arm of the Cook Inlet. Site topography, shown on Figures 1-1 and 1-2, consists of four primary topographic areas, as follows:

1. The relatively flat floodplain of Ship Creek that contains most of the railyard and many of the light industrial lease lots.

2. The active industrial area on the western portion of the Site is the location of the Port of Anchorage and several of the fuel tank farm facilities. This active area has been covered with fill.

3. The steep slopes north and south of the Ship Creek floodplain and east of the tidal flats that rise approximately 60 to 70 feet above the floodplain and tidal flats, and are largely undeveloped and forested.

4. The relatively flat outwash plain at the top of the north bluff is the location of the Government Hill community and EAFB. The ARRC property on the outwash plain contains several apartment buildings and some commercial properties.

2.3.2 Geology

The geology of the Anchorage railyard area has been described in several reports, including early mapping efforts by Cederstrom et al. (1964), Schmoll and Dobrovolny (1972), and later mapping efforts by Updike and Carpenter (1986) and Schmoll et al. (1996). In addition, engineering studies following the 1964 earthquake, such as that by Hansen (1965), have documented the Site geology. The Site surficial geology is shown on Figure 2-1. Cross-sections A-A' and B-B' (Figures 2-2 and 2-3, respectively) illustrate the current understanding of the hydrogeologic conditions beneath the Site. Site geology was discussed in detail in the SBR. The primary geologic units observed along Ship Creek include:

- The Ship Creek alluvium
- The Bootlegger Cove formation
- Fill materials
- Glacial outwash deposits
- Landslide debris from the 1964 earthquake
- Tidal/estuarine sediments

Glacial outwash sand and gravel deposits flank the Ship Creek valley underlying EAFB to the north and downtown Anchorage to the south. The Bootlegger Cove formation is the oldest geologic unit exposed in the study area and consists predominately of silts and clays deposited in a glacio-marine or glacio-lacustrine environment. The Bootlegger Cove formation underlies the glacial outwash and Ship Creek Alluvium. Down cutting of Ship Creek through the glacial outwash and incision into the Bootlegger Cove formation left fluvial deposits primarily consisting of interbedded sand and gravel across the valley floor. Figure 2-4 shows the upper surface of the Bootlegger Cove formation showing the incision of Ship Creek.

In the area between the railyard and the terminal facilities, the Ship Creek alluvium inter-fingers with fine-grained tidal/estuarine deposits. The tidal deposits are exposed at low tide along the Knik Arm as mud flats consisting of silt and clay (Figures 1-1 and 2-5). As shown on Figure 2-3, across much of the valley floor, the Ship Creek alluvium and tidal sediments are capped with fill material consisting of sand, gravel, and construction debris. Along the edges of the valley are numerous landslide deposits caused by the 1964 earthquake.

2.3.3 Hydrogeology

In and near the study area, there are two shallow water-yielding units (aquifers) and a deep confined aquifer. The relatively shallow water table aquifers exist in the outwash extending south of the Elmendorf moraine and in the Ship Creek alluvium. The sands and gravels beneath the Bootlegger Cove formation constitute the deep confined aquifer. The predominately fine-grained soils of the Bootlegger Cove formation have a low hydraulic conductivity and, consequently, the Bootlegger Cove formation serves as an aquitard separating the deep aquifer from the shallow aquifers.

Groundwater in the outwash within and north of the ARRC study area is from precipitation infiltration on the outwash plain and Elmendorf moraine. The groundwater flow direction is generally southward from the Elmendorf moraine toward Ship Creek, although near the westward facing bluffs above the tank farms, the groundwater flow direction is to the west. This stratigraphy causes the groundwater in the outwash to:

- Emerge as springs in the bluff face just above the contact between the outwash and the Bootlegger Cove formation, and then flow across the surface of the Bootlegger Cove formation to the Ship Creek alluvium where it may re-infiltrate

- Collect in drainage ditches and storm drains leading to Ship Creek

- Flow from the outwash through colluvium or landslide debris at the base of the bluff and into the Ship Creek alluvium

Groundwater

Groundwater in the Ship Creek alluvium is derived from (1) precipitation infiltration on the Ship Creek floodplain, (2) groundwater entering the Ship Creek alluvium from the outwash north and south of Ship Creek, and (3) water that infiltrated through the Ship Creek channel in the "losing section" located upstream of the Site, which flowed westward downgradient through the alluvium (RETEC, 2005a).

Area-wide monitoring of the groundwater flow direction and gradient in the Ship Creek alluvium has not been conducted; however, flow is interpreted to be generally westward toward Knik Arm with convergence toward Ship Creek (i.e., flow north of Ship Creek is toward the southwest and flow south of Ship Creek is toward the northwest). The water table in the Ship Creek alluvium and the fill overlying the alluvium is estimated to be about 5 to 10 feet below ground surface (bgs) and the saturated thickness of the alluvium is estimated to be 5 to 15 feet.

At the western edge of the study area, the Ship Creek alluvium contacts the low permeability tidal and estuarine sediments, and the shape of this contact may influence the groundwater flow pattern and groundwater discharge quantity to both Ship Creek and the inter-tidal zone. For example, if the Ship Creek alluvium pinches-out to the west, the low permeability of the tidal and estuarine soils may force groundwater to enter Ship Creek rather than to discharge as seeps on the tidal flats. Alternatively, if the alluvium maintains its thickness across the tidal flats or is buried beneath inter-tidal sediments, the groundwater may discharge directly to the inter-tidal zone.

Boreholes drilled through the Bootlegger Cove formation and into the confined aquifer in the vicinity of the railyard encountered artesian water with a static head above the elevation of the Ship Creek floodplain, as shown on Figures 2-2 and 2-3 (when active pumping of the confined aquifer was not occurring). The combination of the upward hydraulic gradient between the shallow and deep aquifers and the low hydraulic conductivity of the Bootlegger Cove aquitard suggest that the deep aquifer is isolated from activities in the surficial areas, including the ARRC rail yard.

Surface Water

Most of the Site lies within the Ship Creek drainage, one of several streams running from the Chugach Mountains westward through Anchorage. The portion of the Site that is not in the Ship Creek drainage drains directly into Knik Arm and includes the Port of Anchorage facility, the tank farm areas, and the westward-facing slopes above the tank farms.

The United States Geological Survey (USGS) has maintained a gauging station at the Fort Richardson dam location (station #15276000) from 1946 to the present. Based on gauging data, it is determined that:

- June has the highest average monthly discharge at about 452 cubic feet per second (cfs)
- March has the lowest average monthly discharge at about 17.4 cfs
- The average annual flow rates have ranged from 62.5 cfs in 1996 to 226 cfs in 1980
- The “period of record” maximum flow is 2,100 cfs and occurred in 1989
- Although monthly average flows are highest in June, annual peak flows may occur in any month between May and October

2.4 Conceptual Site Models

This section presents a summary of the human health, ecological, and hydrogeologic CSMs for the Site.

2.4.1 Human Health

Potential human receptors are determined based on current or reasonably foreseeable land use at the Site. The human health CSM (Figure 2-6) provides a summary of Site conditions and potentially impacted media transport pathways, potential exposure pathways, and the proximity of receptors. Per U.S. EPA *Risk Assessment Guidance for Superfund Part A* (U.S. EPA, 1989), the human health CSM is created independent of Site data and is refined as Site conditions and analytical data are better understood.

The human health CSM will be used to focus investigation on the collection of data necessary to meet the requirements of the AOC and, specifically, the RI/FS. In addition, the human health CSM is an important tool used to determine whether more Site data are needed. Data gaps can be identified through the development of a human health CSM. No additional data will be needed where sufficient data have been collected previously, or there is adequate information available to conduct fate and transport modeling to estimate analyte concentrations in media (e.g., indoor air) where direct measurements are not available. In the absence of such existing data and information, additional data will be collected during the RI/FS to evaluate the exposure pathways of concern. All potentially complete exposure pathways will be evaluated either quantitatively or qualitatively in the human health risk assessment.

The human health CSM was introduced in the SBR. The U.S. EPA reviewed the SBR and provided comments to the CSM. Based on those comments, the following edits, or additions, were made to the human health CSM:

1. Groundwater seeping into ditches near the north bluff as a potential source

2. Inhalation of particulates and volatiles from surface soil to outdoor/ambient air for outdoor workers, construction workers, trespassers, and future on-site residents (unrestricted use receptor)

3. Direct contact (including incidental ingestion) by construction workers with emerging groundwater from springs and ditches along the north bluff

4. Trespasser contact with groundwater from springs and ditches along the north bluff (Note: non-site related upgradient sources contribute to these exposure media)

5. Inhalation of volatiles from groundwater emerging in seeps and springs for outdoor workers and trespassers

6. All pathways in the CSM are currently shown as potentially complete (to be discussed at the risk assessment scoping meeting)

The revised human health CSM is shown on Figure 2-6.

2.4.2 Ecological

This section provides a summary of the preliminary ecological conceptual site model (ECSM) in accordance with Section 2.2 of the SOW. The recommended process for evaluating ecological risk at CERCLA sites is described in the *Ecological Risk Assessment Guidance for Superfund* (U.S. EPA, 1997a), commonly referred to as "EcoRAGS," and further clarified in subsequent notices and updates. The ecological risk process is defined as an eight-step process. Each step is iterative and includes Scientific Management Decision Points (SMDP) when the data are evaluated by risk managers in order to focus further evaluation. The first step in the risk assessment process is to develop a problem formulation, which may be graphically presented in the form of an ECSM.

The ECSM was introduced in the SBR. The U.S. EPA reviewed the SBR and provided comments to the ECSM. Based on those comments, the following edits, or additions, were made to the ECSM:

- Added invertivores for direct contact with riparian soil and ingestion of plants, and soil invertebrates
- Added clarification that aquatic wildlife includes piscivorous (e.g., kingfisher and mink) and omnivorous (e.g., ducks) mammals and birds
- Added surface water exposure for wood frog larvae
- Changed piscivorous wildlife to aquatic omnivores and piscivores
- North bluff pathways were removed as the habitat survey indicated that any impacts in this area are not Site related
- Added riparian terrestrial area as an exposure pathway for terrestrial wildlife

The revised ECSM that will form the basis of the problem formulation for the ecological risk assessment for Ship Creek, subject to modifications based on further information, is depicted on Figure 2-7.

2.4.3 Hydrogeologic

A hydrogeologic CSM was presented in the SBR (RETEC, 2005a), which describes the interactions between geology, groundwater, surface water, and tides on fluid flow and potential contaminant migration pathways across the Site (Figures 2-2 and 2-3). Understanding the hydrogeologic system is required in order to achieve the RI/FS goals as stated in Section 1. Therefore, as new data become available during the RI, the hydrogeologic CSM will be revised.

Data needed to revise the hydrogeologic CSM were identified in the SBR and include the following:

- Temporal and spatial shallow groundwater flow in the Ship Creek alluvium and tidal sediment
- Effects of tidal influence to groundwater flow and levels near the mouth of Ship Creek
- Depth to the Bootlegger Cove formation and saturated thickness of the Ship Creek alluvium
- The hydrogeologic relationship of the shallow groundwater between the Ship Creek alluvium and outwash along the eastern end of the north bluff (Operable Unit 5 area)
- Aquifer testing of the Ship Creek alluvium and tidal sediment (slug testing to establish hydraulic conductivity)
- Grain size distribution

The rationale for data collection is further discussed in Section 3.

2.5 Sources of Data

The scope, strategy, and DQOs presented in this Work Plan were developed based on the information presented in the SBR, as well as additional information acquired since the submittal of the SBR. The strategy for the RI is based on review and weight-of-evidence analysis of these data.

The consulted data sources can be grouped into two categories:

1. ARRC RCRA/CERCLA documents, including:
    - **The SBR.** This document preceded this Work Plan as part of the AOC for the Site. The SBR summarized known historical data for the Anchorage Terminal Reserve, with special focus on existing analytical data and detailed evaluation limited to leased properties and railyard solid waste management units (SWMUs) identified as “Further Action” sites in the two *RCRA Facility Assessment* (RFA) reports (SAIC, 1996 and Booz-Allen Hamilton, 2002). The SBR identified:
        a. Applicable historical Site information

        b. Relevant historical environmental studies

        c. Usable information and data of adequate quality and confidence for inclusion in the RI

        d. Preliminary CSMs

        e. Some key data gaps and concerns that would need to be considered in the RI/FS scoping process

    - **RCRA Facility Assessments.** The RFAs (SAIC, 1996 and Booz-Allen Hamilton, 2002) conducted at the Site identified leased properties and railyard SWMUs and areas of concern that may require further action. This information was incorporated into the SBR and further considered for this Work Plan.

2. Other past environmental investigations conducted at the Site

There is a substantial database of environmental investigation data collected by ARRC or individual leaseholders at the Site. This information was reviewed and all relevant analytical data were included in the SBR:

- ADEC monitoring programs, investigations, enforcement actions and reports

- Environmental Site Assessments conducted as part of property and lease transfers

- Other sampling, investigations, and inspections at the leased properties or the railyard conducted to address geotechnical or environmental issues

- Data derived from other documentation, interim actions, and Site visits

As part of conducting the RI/FS process at the Site, the following additional information was also considered:

- Interim actions conducted as part of AOC requirements

- Documentation of environmental investigations conducted by Elmendorf Air Force Base (EAFB) and Fort Richardson

- Information provided by the MOA on storm water systems

- Information provided by ARRC personnel on Site conditions

- Observations made during Site visits

These sources defined the available data to develop the strategy for the systematic and authoritative sampling proposed in this Work Plan. The combined data set defined a "triad" of data sources that guided the analytical data needs (authoritative number and placement of samples) described in this Work Plan. The triad consists of the following:

1. **Existing Analytical Data.** The relational database prepared for the SBR incorporates usable data from all investigations conducted at the Site as a result of actions associated with the activities above. The database is continually being updated as more information is acquired. Existing analytical data guided the definition of analytical data needs and areas where additional data would be useful.

   Analytical data are being collected within Area 3 by the oil companies as part of routine monitoring; these data have been and will continue to be acquired through Alaska Department of Environmental Conservation (ADEC). These data were used to develop this RI Work Plan and will be used, as applicable, in the RI Report.

2. **Leased Property and Railyard SWMU Evaluations.** Additional data from existing reports on environmental investigations, enforcement, remediation, and recommendations were used to identify (1) particular environmental concerns requiring additional investigation, or (2) leased properties where remedial action has eliminated environmental concerns, or where environmental concerns no longer exist. Based on this information, analytical data needs (e.g., sample number, location, and analyte list) were refined.

3. **Areas Identified as Limited in Data.** For portions of the railyard and some leased properties, there is very little information available. Based on current understanding of transport pathways and potential exposures, these areas could present sources of risk. Some analytical data needs are proposed for such areas. However, for other areas, the need for additional data collection is not anticipated as operational history indicates that the area was undeveloped or engaged in activities not likely to result in releases of contaminants.

   Note, a portion of the sample collection is based on systematic placement of groundwater wells in east-west transects in order to address portions of the 600 acres not addressed in the leased property and SWMU evaluation.

All acquired data will be provided in the RI Report and Site database to support an evaluation of the nature and extent of potential sources and to evaluate human health and ecological risk.

2.5.1 Existing Analytical Data

Existing analytical data for the Site are maintained in a project database, and consist of historic data compiled from previous environmental investigations and reports, and data collected during interim investigations related to this RI/FS (as described in Section 1.1). The database provides an overview of existing conditions related to known or suspected sources found in previous investigations, although with some limitations:

1. The existing data set reflects data collected at different times and for different specific purposes. Additional data proposed in this Work Plan will provide more comprehensive temporal and spatial continuity.

2. Previous investigations typically focused on a narrow analyte list of known or suspected contaminants associated with individual purposes of the investigation. Comprehensive evaluation of a wide range of contaminants will assist in the understanding of the nature and extent of contaminants.

3. Existing data are clustered in the areas targeted by specific past investigations. Site-wide evaluation proposed in this Work Plan provides a more comprehensive spatial evaluation of Site conditions or characteristics.

This section provides an evaluation of the existing analytical data, based on comparison of existing data to preliminary screening levels for the respective media. That selection of preliminary screening levels and the subsequent comparison to historical data were completed to facilitate evaluation of existing Site conditions for the purpose of identifying potential source areas to be evaluated in the RI. The screening levels used in this Work Plan are preliminary and may not represent the screening levels to be applied for evaluating human health and ecological risk (Section 3.7). The screening levels applied for comparison are listed in Tables 2-1 (the base investigation analyte list) and 2-2 (supplemental analyte list for specific samples only). Where background levels (defined from preliminary background data sets) exceed the screening levels, the background level was applied as the screening level. Section 4.1.1 provides further discussion of screening levels.

Appendix D presents the existing analytical data for soil, groundwater, sediment and surface water, including summary tables of screening level exceedances. The distribution of existing analytical data is shown on Figures 2-8 through 2-11 for sediment, surface water, groundwater, and soil, respectively. These figures identify historical sample locations for which there was a constituent detected at a concentration that exceeds the respective preliminary screening level, based on the most-recent data collected at each location. The summary table provided on the bottom of each figure indicates the class of analytes for which there was a detection, or detections, in excess of respective preliminary screening levels. The following should be considered when interpreting the data presented on Figures 2-8 through 2-11:

1. Not all sample locations have been sampled for the RI analyte list (or the same list of analytes)

2. A conservative approach was taken for analytes lacking preliminary screening values and any detections of these analytes are shown as exceedances

3. Exceedances may not necessarily represent current conditions at the location

4. The data set includes exceedances of screening levels in areas where remedial goals and action levels have already been met based on ADEC determinations and no further action is required

Existing analytical data collected within the ARRC Terminal Reserve are a major component of the data sources to be used to meet the project objectives. The data is used for two primary purposes:

- Existing data were used to determine the specific placement of sample locations along the proposed transects, and to determine Site-specific infill sample locations.

- Existing data will be incorporated into the evaluation of transect and infill data collected according to this Work Plan, as further discussed in Section 3.6. Because existing data do not necessarily represent current conditions, the primary function of existing data will be to supplement the evaluation of upgradient sources of risk and downgradient exposures suggested by the results of transect and infill sampling.

2.6 Site Summary

The evaluation of Site data, Site history, land use, and CSMs contribute to the Site knowledge and were used to formulate the approach and strategy for the RI and RI Work Plan. Sampling is proposed and designed to evaluate known or potential (e.g., authoritative sampling – leased property or SWMU-specific) and unknown (e.g., systematic sampling – downgradient groundwater well transects) sources. Note, the SOW defines “sources” as sources of risk and this has been confirmed in March and May 2005 meetings with U.S. EPA.

Specifically, the approach for sampling includes:

1. Review and consideration of all railyard SWMUs (Table 2-3) and leased property RFA (Table 2-4) findings.

2. Review and consideration of all available environmental related operational history and documentation for the railyard and leased properties (as seen in the SBR and post-SBR internal detailed review of Site files).

3. Site-wide sampling, which may include even those areas and leased properties with previous “no further action” designations. No area has been excluded from evaluation for sampling (i.e., confirmation of Site conditions will be completed prior to any exclusion).

4. Source determination through groundwater evaluation. The existing Site data lack continuity (they were collected for a variety of purposes with respect to specific leaseholds of other specific locations at the Site). Therefore, groundwater migration and plume identification is proposed to complete a comprehensive Site-wide evaluation and guide source of risk identification. The sampling program is designed to provide continuity to data spatially (i.e., more systematic distribution of samples), analytically (i.e., all samples in Areas 1, 2, 4, 5, and 6 will be analyzed for the same analyte list), and procedurally (i.e., all samples will be collected with similar purpose and method). Area 3 will be sampled for a list of analytes consistent with the fact that it has only been used for fuel terminal operations.

5. Specific additional concerns or questions related to individual lease properties and railyard SWMUs and AOCs are outlined in Tables 2-3 and 2-4. To address such concerns, this work plan may propose (a) focused soil and or groundwater sampling at these locations, (b) a visual site inspection to verify current conditions and identify any ongoing issues, or (c) review of documentation to verify that concerns have been property addressed.

The rationale for Site sampling is further detailed in Section 3.

3 Rationale for Data Collection

This section provides a summary of the investigation strategy and rationale for the proposed RI/FS scope of data collection. The data collection proposed is intended to satisfy the goals of the AOC.

Data collection activities are designed to provide information adequate to evaluate the following: nature and extent sources in different environmental media (i.e., surface water, sediment, groundwater, surface soil, and subsurface soil); potential migration pathways for contaminants; human health and ecological risk associated with contaminants; and potential remedial action alternatives as necessary. As a result, the following general categories of data collection are proposed for the investigation:

- Analytical data will include volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and inorganics for all samples, and petroleum hydrocarbons, polychlorinated biphenyls (PCBs), pesticides, and herbicides for specific samples.

- Fluid-level elevation data will be collected twice across the Site to determine groundwater flow directions. Additionally, the influences of daily tides and seasonal stream flow fluctuations in Ship Creek on groundwater gradients will be evaluated. These data will be used to locate potential upgradient sources, evaluate migration pathways (e.g., groundwater to Ship Creek) as sources of risk, and identify the need for and range of potential remedial actions.

- NAPL occurrences will be identified and evaluated as potential sources of risk.

- Aquifer properties will be evaluated in order to calculate hydraulic conductivity. Hydraulic conductivity will be used to evaluate flow velocities, migration pathways, and applicability of remedial technologies.

- Monitored natural attenuation (MNA) parameters will be collected to evaluate current natural attenuation processes as well as potentially applicable remedial technologies.

- Geologic data will be collected at each borehole completed to evaluate soil type and physical properties. The data will be used to evaluate fate and transport, migration pathways, and applicability of potential remedial technologies.

- Field-testing data will be collected to evaluate water and soil quality. These data will be used to evaluate nature and extent of contamination and applicability of potential remedial technologies.

Specific sample analyses, number of samples to be collected, and sample locations are discussed in detail in Section 4.

All proposed sample locations are shown on Figures 3-1 and 3-2 and listed in Tables 3-1 and 3-2. For ease of presentation in this Work Plan, soil and groundwater well and/or sample locations will be identified with a letter prefix followed by a number. The letter prefix corresponds with a specific transect (e.g., “A” with Transect 1, “B” with Transect 2, etc.) and the number indicates numerical order. Transects are described in Section 3.1. The letter prefix “E” indicates an infill sample not specifically associated with one of the four proposed transects. Locations designated for surface soil sampling only are given a prefix of “SS” in this Work Plan. Sample nomenclature is discussed in the SAP (Appendix C). Sediment and surface water samples are shown in Table 3-1 with an “S” prefix. In addition, sampling of established groundwater seep sampling locations are shown with the prefix “SP”.

3.1 Remedial Investigation Strategy and Rationale

The data collection strategy for the RI is designed to evaluate the entire 600 acres of the Site. To do so, ARRC proposes a Site-wide sampling strategy which combines both authoritative and systematic sampling using a comprehensive analyte list to provide for an evaluation of the migration pathways particularly but not limited to Ship Creek, the nature and extent of known and potential sources of risk, and the applicability of potential remedial action.

Sampling will be conducted in accordance with the procedures described in this Work Plan and the SAP (Appendix C). All soil, groundwater, sediment, and surface water samples collected during the RI/FS will be analyzed for the complete list of constituents summarized in Table 2-1, with the exception of those samples proposed for collection within Area 3. At the May 19, 2005 Work Plan preparation meeting between U.S. EPA, ADEC, and ARRC, it was agreed, based on the operation history of Area 3 (i.e., oil company fuel terminals) (Figure 1-2), that a modified RI analyte list was appropriate for that area. Groundwater samples collected from within Area 3 will be analyzed for the following analytes on the investigation analyte list (Table 2-1): benzene, toluene, ethylbenzene, and total xylenes (BTEX), ethylene dibromide (EDB), 1,2-dichloroethane (1,2-DCA), lead, and PAHs.. Fuel hydrocarbons will be evaluated by fractionation into aromatic and aliphatic hydrocarbon ranges using the method of the Massachusetts Department of Environmental Protection. This step is proposed in order to provide fuel hydrocarbon data suitable for risk assessment purposes.

In addition, some samples collected during the investigation will be analyzed for all or a subset of the constituents summarized in Table 2-2. All proposed sample locations are identified in Tables 3-1 and 3-2, along with the respective proposed analyses. Approximate sample locations are shown on Figures 3-1 (sediment and surface water) and Figure 3-2 (soil and ground water).

Two groundwater sampling and fluid-level gauging events are proposed for fall 2005 and spring 2006 to evaluate seasonal and temporal changes in contaminant concentrations in groundwater. Prior to the first RI groundwater gauging event, ARRC will complete a month long tidal influence study using data loggers located at selected wells. The objective of the tidal study will be to consider the short-term effects (across one entire lunar cycle) of the diurnal tide cycle on groundwater behavior near lower Ship Creek and Cook Inlet. Additionally, ARRC will review groundwater elevation data to determine if continuous data logger gauging would be useful in selected wells to further evaluate the influence of seasonal fluctuations of flow in Ship Creek on groundwater gradients. Data quality for all investigation activities will be assessed in accordance with the project QAPP.

The following subsections describe the investigation strategy and rationale for RI data collection.

3.2 Data Quality Objectives

In accordance with the *Advance Notice of Proposed Rulemaking* (ANPR) (U.S. EPA, 1996a), data gathering strategies should be tailored to reflect Site-specific DQOs. The DQO process is a seven-step, iterative planning approach used to guide environmental data collection. DQOs are developed to define the decision to which the data will contribute and specify the overall degree of data quality or uncertainty that the decision maker is willing to accept during the decision making process. DQOs are intended to provide "…a systematic approach for defining criteria that a data collection design should satisfy, including: when, where, and how to collect samples or measurements…" (U.S. EPA, 2000a).

The seven steps in the DQO process are as follows:

1. State the Problem
2. Identify the Decision
3. Identify Inputs to the Decision
4. Define Boundaries for the Study
5. Develop Decision Rules
6. Specify Tolerable Limits of Decision Error
7. Optimize the Design for Obtaining Data

The *Guidance for the Data Quality Objectives Process* (U.S. EPA, 2000a) was used to develop RI/FS Work Plan DQOs for sediment and surface water, groundwater and LNAPL, and soil investigations. The respective RI/FS DQOs are presented in Tables 3-3, 3-4, and 3-5.

3.3 Site Investigation Approach

This section describes the investigative approach for collecting surface water, sediment, groundwater, and soil data. Sediment and surface water samples will be collected authoritatively[2] at selected locations in the Ship Creek channel and at off-channel locations such as ponds and marshes. Soil and groundwater sampling will be conducted along four east-west transects that cross the Site. The four transect locations are illustrated on Figure 3-3. The transects are designed to identify potential upgradient sources of risk, as illustrated in Figure 3-3.

3.3.1 Surface Water and Sediment

The proposed sediment and surface water investigation is based on the results of the *Ship Creek Preliminary Habitat Assessment* (RETEC, 2004e). The survey investigated overall habitat conditions and features in the Ship Creek riparian corridor, and identified areas that would benefit from further investigation. The key findings of the habitat survey and literature surveys (Hart Crowser, 2004a) and a generalized recommended approach for sediment and surface water investigation at the Site were presented at meetings with the U.S. EPA in March and May 2005.

This section expands on the investigation strategy and rationale for the proposed sediment and surface water investigation. Details regarding the scope of work proposed are provided in Section 4.

Key Investigation Issues

The Ship Creek habitat survey recommended that the RI incorporate the following tasks:

1. Additional investigation of the abandoned pumping facility located south of Dean’s Auto (LP-069). This area is located within the riparian area, but is not in contact with surface water. It will be evaluated as part of the upland soil investigation and not further discussed in this section.

2. Focused investigation of sediment and water quality in two off-channel areas of potentially affected marshland on the north side of the creek. Additional areas were subsequently identified for inclusion in this investigation.

---

[2] Authoritative-specific sample locations selected on the basis of prior Site knowledge.

3. Additional sediment (and surface water) analysis in the limited areas of Ship Creek where substantial deposition may have occurred.

Biological sampling (e.g., benthic community structure, tissue analysis, or toxicity bioassays) is not proposed at this time. The absence at this time of confirmed sources and transport pathways from the Site to Ship Creek, and the presence of several non-ARRC related sources, indicate that such studies would not easily differentiate between the effects of on-site and off-site sources. Biological sampling, if necessary, will be considered based on the outcome of this investigation.

All proposed surface water and sediment sample locations are identified in Table 3-1 and depicted on Figure 3-1.

Permitted Point Source Discharges

Ship Creek is the designated receiving water for a number of permitted point source storm water and other effluent outfalls. These outfalls were detailed in the *Ship Creek Preliminary Habitat Assessment* (RETEC, 2004e) and are associated with several sources, including the MOA, the Alaska Department of Transportation, EAFB, and Elmendorf Hatchery, in addition to ARRC. This investigation does not include any specific sampling of discharges from these outfalls or of sediment adjacent to the outfalls, for two reasons, (1) the storm water discharges are permitted under the NPDES program and are outside the scope of the RI/FS, and (2) the proposed sediment investigation will evaluate the cumulative sediment contamination from all sources and then if sediment contamination is found above screening levels, will determine which portion may be attributable to sources originating at the Site. The outfalls are identified in the Ship Creek Preliminary Habitat Survey (RETEC, 2005). These outfalls will be further considered in the RI Report.

The Ship Creek investigation detailed below is designed to identify the presence of sediment contamination in Ship Creek attributable to Site sources by targeting downstream depositional areas which would integrate contaminated sediment from all upstream sources. It is likely that the permitted point sources (as well as upstream sources) contribute to any contamination present in these areas. If surface water and/or sediment concentrations are found to be elevated, additional investigation to assess the contribution from permitted discharges may be required.

Investigation Strategy and Rationale: Off-channel Areas

The objective of the proposed off-channel sediment and surface water sampling is to collect Site investigation data for residual contamination in areas potentially affected by contaminant migration from on-site sources, for which little or no analytical data exist. The analytical data used to develop the sediment and surface water strategy are summarized in Appendix D. The following subsections provide a summary of the off-channel areas from which data collection is proposed in Section 4.

Area A: KAPP Pond

The KAPP (LP-120) pond (Figures 1-2 and 3-1) was created concurrently with the KAPP dam in the early 1950's to provide cooling water for the power plant. The pond sediment and water have been sampled several times in the past. Although low levels (i.e., below screening levels) of organic contaminants (primarily polyaromatic hydrocarbons [PAHs]) have been noted, it is likely that concentrations have further decreased in recent years. However, because the pond attracts wildlife (e.g., a beaver lodge is present) , surface water and sediment sampling is proposed in the pond to confirm the attenuation of any residual contamination. Area A sample locations are shown on Figure 3-1.

Area B: Wastewater Pond

This area includes ponds and marshes south of Whitney Road. The pond is the receiving water for an ARRC/MOA joint storm water discharge. The area is located downgradient of a known source area (i.e., Arctic Cooperage [LP-991]). Originally this area included two excavated ponds predating the 1940s. The original use of the ponds is unknown. The eastern pond has filled in and currently is a marshy area southeast of the main pond. The western pond receives storm water runoff and has a drainpipe installed to prevent flooding of neighboring leases. East of the pond and marshy area is a riparian zone with several dry channels. The habitat survey reported possible sheens in the main pond. Relict channels connect the pond to the area immediately downgradient of Arctic Cooperage (LP-991).

No historical data exist for this area except for the eastern end, where several sediment samples were collected in a now dried up channel below Arctic Cooperage (LP-991) in 1997. These samples showed no significant contamination. Area B sample locations are shown on Figure 3-1.

Area C: Railroad Ditch

The ditch along the railroad track was noted in the habitat survey but not identified for further sampling. The ditch is not a valuable habitat; however, it is a conveyance of run-off and storm water that may transport contaminants to Ship Creek. The ditch is maintained as part of the storm water outfall near the intersection of Post Road and Whitney Road; however, runoff from several leased properties may reach it. There are no historical data available for this area. Area C sample locations are shown on Figure 3-1.

Area D: Railroad Avenue Marsh Area

The habitat survey identified a marshy area impounded behind a gravel bar separating it from the creek located just west of the end of Railroad Avenue and south of Post Road. Part of the area is permanently wet, and forms a marsh with emergent aquatic vegetation. The marsh appears to drain only via seepage through the gravel bar. This marshy area may have received discharges from surrounding lease properties. The habitat survey identified a ditch with evidence of hydrocarbon contamination reaching the marsh. No previous sampling has been conducted in this area. Area D sample locations are shown on Figure 3-1.

Area E: Other Areas of Concern

Based on further review of historical data, two additional areas were identified for sample collection (locations S-E-1 and S-E-2 as identified on Figure 3-1). These areas are associated with past remedial actions in neighboring properties, and the sampling is intended to confirm the absence of residual contaminants downgradient from these locations that could impact Ship Creek.

Location S-E-1 (Figure 3-1) is the old drainage ditch from the closed Standard Steel National Priorities List (NPL) site. This ditch, described in the habitat survey, is largely filled with silt and seems to function only as a conveyance of runoff in the riparian area. However, one sediment sample is proposed to confirm the absence of residual contamination. Surface water is not expected to be present at this location, thus surface water sampling is not proposed.

Location S-E-2 (Figure 3-1) is located in a relict channel immediately below the Post Road Co-Tenancy site (LP-127). The channel appears to frequently contain standing water, and is likely scoured by creek flows during high water levels in the creek. Sediment accumulation is minimal. Historical records for the adjoining lease property show past PCB contamination. The contaminated soil has been removed. To confirm removal of contamination a sediment sample (S-E-2) (Figure 3-1) will be collected in the relict channel below the area where PCBs were excavated. If surface water is present, a water sample will be collected.

Investigation Strategy and Rationale: Ship Creek Sediment and Surface Water

Sediment and surface water data were collected from the main channel of Ship Creek as part of several historical investigations. The most recent effort was conducted by Hart Crowser (2004a). Five samples from the tidal area to upstream of the Site boundary were sampled for surface water and sediment and analyzed for the complete target compound list. Evidence of elevated contaminant concentrations was not found, although some chemicals reported elevated detection limits, which is consistent with the historical investigations detailed in the *Ship Creek Literature Review* (Hart Crowser, 2004b).

However, the exact conditions under which the historical investigations carried out sampling are unknown. Physical characteristics affecting mobility and bioavailability of sediment contaminants, such as total organic carbon (TOC) and grain-size distribution, were seldom collected. Neither is it known if past sampling focused on fine-grained, depositional material. It is generally accepted that most contaminants in fluvial systems end up in depositional areas associated with the fine-grained fraction of the bed sediment.

The objectives of the proposed sediment and surface water sampling for Ship Creek are to:

- Further define "conservative" sediment conditions through a sampling effort focusing on depositional zones of fine-grained sediment accumulation.
- Collect physical sediment parameters (TOC and grain-size distribution) for evaluation of bioavailability and transport of contaminants.
- Provide one round of surface water sampling to allow evaluation of surface water quality.

Sediment Sample Collection

Sediment samples will be collected from Ship Creek within the Site. In addition, one upstream sample will be collected to complement the historical background sediment data. Approximate sample collection locations are shown on Figures 3-1 and 3-5 (for background location SC-11, and described further in Tables 3-1 and 3-7 (for background location).

Ship Creek is a high-energy stream, and depositional areas are few and shallow. Locating sediment for sample collection is anticipated to be difficult. Thus, the following steps will be applied to collect adequate sediment samples:

- Locate the nearest depositional area to the preliminary sample location located within the channel
- Avoid bank soils that are not ordinarily submerged
- Select a sample location based on best professional judgment that the selected location contains >15% fines (silt and clay, fractions passing through a No. 200 sieve)

Surface Water Sample Collection

One round of surface water samples will be collected from Ship Creek at the Site to complement existing data. These samples will be collected during low-flow conditions within Ship Creek, as determined from historical stream flow data (presented in Section 2.3). The proposed surface water sampling will be conducted concurrently with sediment sampling.

Only a subset of the sediment sample collection locations are also designated as surface water sample collection locations, as the creek is well mixed with rapid flow, and significant spatial variability is not expected. Both filtered and unfiltered inorganics will be collected and analyzed.

The groundwater, sediment, and surface water data collected during this sampling event will be used to determine if there are additional surface water data needs.

Data Analysis

All sediment samples will be analyzed for the investigation analyte list (Table 2-1), i.e. VOCs, SVOCs and inorganics. In addition all sediment samples will be evaluated for several supplemental analytes (Table 2-2): Total organic carbon (TOC) and grain size distribution (in order to evaluate bioavailability of contaminants), pH, and PCBs. Surface water samples will also be analyzed for the investigation analyte list as well as selected supplemental analytes: hardness (to evaluate bioavailability of some metals), PCBs, and several field-measured parameters (pH, conductivity, dissolved oxygen, temperature, pH, and oxidation-reduction potential).

3.3.2 Groundwater

The RI groundwater investigation is intended to provide the data necessary to evaluate potential sources of risk to human health and the environment. Because the Site is large and encompasses different flow regimes, the groundwater investigation has been subdivided into three areas. For the purpose of this Work Plan, the study areas are only intended as convenient geographic divisions used to help identify sample locations. These areas are consistent with the following study areas described in Section 3.1 of the SBR:

- **North of Ship Creek.** Area consists of all railyard and leased properties on north side of Ship Creek; groundwater flow is generally to the south-southwest.

- **South of Ship Creek.** Area consists of all leased properties on the south side of Ship Creek; groundwater flow is generally to the north-northwest.

- **Oil Company Terminals.** Area northwest of railyard immediately adjacent to Cook Inlet and dominated by oil company terminals; groundwater flow is generally to the northwest.

The strategy for the groundwater investigation is to establish transects of groundwater monitoring wells across the Site in order to evaluate groundwater flow patterns, aquifer properties, and distribution of dissolved-phase constituents. In addition to the wells proposed along transects, monitoring wells will also be located to infill existing data gaps identified in Section 4.2 of the SBR.

A combination of new and existing monitoring wells will be used to complete four east-west trending transects across the Site (Figures 3-2 and 3-3). Well locations will be based on a hybrid of systematic (i.e., wells spaced out along each transect for maximum coverage) and authoritative (i.e., well locations and spacing along transects based on historical information) sampling strategies. Although the monitoring well transects are intended to be roughly linear, specific well locations are based on Site data and historic land use, as presented in Section 2. If no data are available for an area, the wells will be evenly spaced along the trend of the transect. Final well locations will be marked in the field and will ultimately depend on equipment access, underground and overhead utilities, and worker safety.

The rationale for the four transects and infill monitoring wells is described in the following subsections.

Transect 1

Transect 1 is designed to evaluate potential analyte migration to Ship Creek from potential sources located north of Ship Creek, including leased properties and the west side of the railyard (RY-065) (Figure 3-3). It consists of 29 proposed monitoring wells (A-1 through A-29) (Figure 3-2) oriented roughly parallel to the north bank of Ship Creek extending from the North Star Terminal (LP-060) to just west of Reeve Boulevard. Wells will be located parallel to Ship Creek downgradient of these potential sources.

Transect 1 wells located west of C Street (A-1 though A-3) are intended to evaluate potential migration of analytes from the oil terminals area (LP-060, LP-005, LP-019, LP-025, and LP-004). Note that the Flint Hills (LP-003/005) lessee maintains and monitors additional groundwater wells along the flow boundary towards Cook Inlet north of the mouth of Ship Creek. ARRC will review data from these monitoring wells as needed to further evaluate this potential transport pathway. Historical groundwater analytical (Appendix D) and flow data from these properties (Figures 2-3, 2-4, and 2-10) do not suggest groundwater contaminant migration to Ship Creek. Therefore, wells along this part of the transect are systematically located. On the east side of C Street, wells are systematically and authoritatively located to reflect historical groundwater and soil analytical results reported in Appendix D (Figures 2-10 and 2-11), indicating multiple locations where VOC, SVOC, and petroleum hydrocarbon concentrations exceed screening levels within 500 feet of Ship Creek (e.g., Dean's Automotive [LP-049], KAPP [LP-120], Arctic Cooperage [LP-991], Laidlaw [LP-137], CBS Equipment [LP-085], and HW Alaska [LP-134]). Groundwater flow, discussed in Section 2.3 and illustrated on Figures 2-3 and 2-4, is to the south-southwest on the north side of Ship Creek. The rationale for placement of each Transect 1 well is provided in Table 3-2.

Transect 2

Transect 2 is designed to evaluate potential analyte migration to Ship Creek from potential sources located south of Ship Creek (Figure 3-3). It consists of 20 monitoring wells (B-1 through B-20) (Figure 3-2) oriented roughly parallel to the south bank of Ship Creek extending from ARRC Administration Building (LP-057) east to Reeve Boulevard. Like Transect 1, wells are located parallel to Ship Creek downgradient of potential sources.

Groundwater and soil analytical data from the south side of Ship Creek and presented in Appendix D are not as numerous as data from the north side. Sample collection locations on the south side are clustered near Municipal Light and Power (ML&P) (LP-022) (Figures 2-10 and 2-11) and to the south of ML&P property. Spacing of sample locations on the east end of Transect 2 increases, as the Site information does not indicate sources of risk. The rationale for placement of each Transect 2 well is provided in Table 3-2.

Transect 3

Transect 3 is designed to evaluate potential analyte migration from the railyard (RY-065) to the south (Figure 3-3). It consists of 13 monitoring wells (C-1 through C-13) (Figure 3-2) oriented along the southern boundary of the railyard (RY-065) extending from just east of C Street to Reeve Boulevard.

Groundwater and soil data presented in Appendix D is limited to the southeast area of the railyard and along the bluff on the north boundary. Because of the limited analytical data, and few constituent concentrations exceeding screening levels (Figures 2-10 and 2-11), the spacing of wells was based primarily on identified SWMUs, as reported in the RFA (SAIC, 1996) and the SBR. Because the greatest density of SWMUs is found on the west end of railyard property, well spacing is densest on the west end of Transect 3 (Figure 3-2). The rationale for placement of each Transect 3 well is provided in Table 3-2.

Transect 4

Transect 4 is designed to evaluate potential migration of analytes from upgradient sources to the railyard, background concentrations (i.e., those not affected by any releases originating on the Site), and interaction between springs and groundwater along the north bluff (Figure 3-3). It consists of 13 monitoring wells (D-1 through D-13) (Figure 3-2) oriented along the northern boundary of the railyard extending from C Street to just west of Reeve Boulevard.

In addition to the monitoring wells located along Transect 4, five spring locations (SP-01, SP-24, SP-35, SP-40, and SP-48) will also be sampled. Each of the spring locations was previously sampled and reported in the *North Boundary Assessment Groundwater and Soil Results* (RETEC, 2004d). The RI spring locations (Figure 3-2) were selected to be in close proximity to one or more of the Transect 4 wells and represent a range of groundwater concentrations. The spring sampling is designed to provide additional background concentration data (Section 3.5) and evaluate the interaction between springs and groundwater beneath the north boundary of the Site. The rationale for placement of each Transect 4 well and spring is provided in Table 3-2.

Infill Wells

Infill sample locations consist of 25 monitoring wells (E-1 through E-25) (Figure 3-2) located authoritatively off the transect lines (Figure 3-3) to provide greater analytical distribution. These locations are based on Site information and analytical results. Infill well locations are not restricted to any particular property (Figures 2-10 and 2-11). Infill well locations were selected to evaluate potential sources of risk in areas where limited or no data has previously been generated. The rationale for placement of each infill well is provided in Table 3-2.

Data Collection

Groundwater samples will be collected from all transect and infill well locations and analyzed for VOCs, SVOCs, total metals , and petroleum hydrocarbons by fractionation into aromatic and aliphatic hydrocarbon ranges using the method of the Washington Department of Ecology. As described in Section 3.1, monitoring wells located within Area 3 (A-1, A-2, A-3, E-17, and E-18) will be analyzed for BTEX, EDB, 1,2-DCA, PAHs, lead, and fuel hydrocarbons and fractionation analysis {“EPH/VPH”). Select samples will be analyzed for additional analytes such as PCBs, dioxins, furans, pesticides, and herbicides. Sample selection for additional analyses is based on historical information and analytical data. If particular compounds, such as PCBs, were known to have been handled at a particular property or analytical data indicates detections, then groundwater from wells located at that property or downgradient of that property will be sampled for that specific compound. Existing groundwater and soil analytical data presented in Section 2.5 and Appendix D were used to determine locations for additional analyses. Analytical sampling to be conducted at each well location is provided in Table 3-2. Further details regarding the proposed scope of groundwater sample collection are provided in Section 4.3.

Upon evaluation of initial groundwater sampling and delineation of any groundwater plumes, MNA parameters will be analyzed from a select set of wells representative of various levels of contaminant impact, as further discussed in Section 4.3. These data will be used to determine if natural attenuation of constituents is occurring at the Site and to support an evaluation of MNA as a potential remedial technology for the Site.

Groundwater results will be used to identify potential upgradient sources. If a source is identified and exposure pathways are determined to be complete, additional evaluation (e.g., soil sample collection, plume tracking, etc.) may be required. The process for determining additional data collection needs is described in Section 3.6.

3.3.3 Soil

Soil analytical data (surface and subsurface) will be collected authoritatively[3], based on historical information and Site analytical data presented in the SBR and Section 2.5. The purpose of the RI soil investigation is to identify potential sources of risk and provide a Site-wide distribution of soil data (analytical and physical) for evaluating nature and extent of contamination, revising CSMs, calculating risk, and evaluating remedial action technologies as necessary.

Because of the large size of the Site, the area has been subdivided into six study areas. The study areas used in this Work Plan are the same as those described in Section 3.1 of the SBR. For the purpose of this Work Plan the study areas are only intended as convenient geographic divisions to aid in identifying sample locations. The soil study areas are shown on Figure 3-2.

Additionally, soil samples will be collected, logged, and submitted for laboratory analyses, as described in Section 4, at all well bore locations drilled using hollow stem auger techniques along all four transects and infill locations discussed in the previous section. Because existing soil data are clustered on just a few properties (e.g., Arctic Cooperage [LP-991], Laidlaw [LP-137], KAPP [LP-120], southwest area of railyard, Prescott [LP-024], Area 3, etc.), as described in the SBR and shown on Figures 2-10 and 2-11, soil sample locations were identified in areas with limited data or where additional data were deemed necessary for evaluating potential sources (Figure 3-2). Surface (0 to 0.5 feet bgs) and subsurface (between 0.5 feet bgs and the water table) soil samples will be collected from the proposed drilling locations discussed below. An additional seven surface soil samples have also been proposed from non-drilling locations (Figure 3-2). The proposed scope of soil sample collection and sample collection depth intervals are discussed further in Section 4.

Soil samples will be analyzed for VOCs, SVOCs, inorganics, and fuel hydrocarbons. Select samples will be analyzed for additional analytes such as PCBs, pesticides, and herbicides. Sample selection for additional analyses is based on historical information and analytical data.

The following is the rationale for proposed soil sampling by study area.

Area 1

No samples are proposed for this area. Existing Site analytical data do not indicate concentrations exceeding screening levels for VOCs, SVOCs, or inorganics (Figures 2-10 and 2-11).

---

[3] Authoritative-specific sample locations selected on the basis of prior Site knowledge.

Area 2

Soil sample collection is proposed within Area 2 at select locations along Transects 3 and 4 and infill wells at select SWMUs. Soil samples are located in areas with limited existing data such as in the western area of the railyard and along the southern boundary. Proposed soil sample collection locations are shown on Figure 3-2, and the rationale for specific sample locations is provided in Table 3-2.

Because Area 2 consists exclusively of the railyard, this area will be treated as an active industrial site in which on-site contamination is actively managed to protect current workers. Excavation within the rail yard is controlled by ARRC policies for ground disturbance and safety practices. Within the rail yard excavation activities require approval of a hot work permit and an approved work plan for excavation. The excavation contractor must be an ARRC approved contractor with the required railroad safety training. In addition to utility and clearance of potential subsurface structures, the excavation work plan details procedures for handling soil and groundwater, the potential for encountering impacted media and the appropriate monitoring for worker protection. As such, the primary focus of investigation in Area 2 will be identifying potential sources (e.g., SWMUs) of migration from Area 2 and potential migration into Area 2 of contaminants from upgradient that takes into account the worker protection practices in place at Area 2. Transects 3 and 4, discussed above, are designed for these specific purposes.

Area 3

Soil sample collection is proposed within Area 3 at two borings (A-1 and A-2) along the south and west boundary in an area of limited existing data. Soil sample collection is also proposed just west of the Tesoro and Chevron (LP-019 and LP-025) facility (E-17 and E-18, and SS-1 through SS-4). Although the interior of the oil terminal leasehold area is well characterized and managed by ADEC, only limited existing data are available at the perimeter of these properties. Proposed soil sample collection locations are shown on Figure 3-2, and the rationale for specific sample locations is provided in Table 3-2.

Area 3 is within a 24-hour security controlled access heavy industrial area. Area 3 consists of an active industrial area where contamination is currently managed to protect current workers. Extensive soil and groundwater data have been collected within this area. The historical data set for Area 3 contains over 1,000 soil and groundwater samples. As such, the primary focus of investigation will be identifying potential migration of contaminants from Area 3. Transect 1 and infill wells, discussed above, are designed for this specific purpose.

Area 4

Soil sample collection is proposed along Transects 1 and 2 (A-22 through A-28, and B-17 and B-19) to provide better soil data coverage within Area 4. Infill borings are proposed at LH Construction (LP-018) and Keystone Distribution (LP-031) to provide data in an area south of the railyard boundary. Proposed soil sample collection locations are shown on Figure 3-2, and the rationale for specific sample locations is provided in Table 3-2.

Area 5

Soil sampling is proposed along Transects 1 and 2 (A-12, A-13, A-16 through A-21, B-11, B-12 and B-14) and infill locations (E-7 to E-11) to provide additional soil data downgradient of Arctic Cooperage (LP-991) and in the vicinity of Dean's Automotive (LP-069). Infill borings are also proposed at Alaska Teamsters (LP-026) and Whitney Enterprises (LP-112) to evaluate potential source areas. Proposed soil sample collection locations are shown on Figure 3-2, and the rationale for specific sample locations is provided in Table 3-2.

Area 6

Soil sample collection is proposed within Area 6 along Transects 1 and 2 (A-5, A-7 through A-10, and B-6 through B-8) to provide additional soil data at Wrightway Auto (LP-049) and KAPP (LP-120) on the north side of Ship Creek, and additional soil data coverage on the south side of Ship Creek. Infill surface samples (SS-05 through SS-07) are proposed for KAPP. Proposed soil sample collection locations are shown on Figure 3-2, and the rationale for specific sample locations is provided in Table 3-2.

If initial RI surface water and groundwater data indicate a potential upgradient source, additional soil samples may be proposed. Specific locations would be selected based on historical Site information, presence of a potentially complete exposure pathway, new and existing soil data, and fate and transport calculations (i.e., calculated upgradient concentrations). The process for determining additional data collection needs is described in Section 3.6.

3.3.4 Hydrogeologic Data

Hydrogeologic data will be collected and used to revise the CSMs and evaluate the applicability of potential remedial alternatives. With the exception of the wells selected for the proposed tidal influence study, all wells were selected randomly for hydrogeologic evaluation.

Hydrogeologic data will consist of:

1. Fluid-level gauging at all RI monitoring wells to evaluate groundwater flow gradients and potential occurrences of LNAPL (Figure 3-2). An understanding of the flow directions is needed to evaluate potential upgradient source locations. LNAPL

distribution is required to determine if LNAPL at the Site is a potential source of contamination to groundwater.

2. Tidal influence study using five wells (A-2, A-4, B-6, C-45, and C-9) (Figure 3-4) to determine the influence of tides on shallow aquifer groundwater flow directions and gradients. The tidal influence study will be three wells on the far west side of the Site (A-2, A-4, and B-6) where tidal influences are anticipated to be greatest and two wells farther east (C-4 and C-9) to evaluate the eastern extent of influence in the shallow aquifer. These data will be used to evaluate the tidal influence on groundwater flow direction to help delineate migration pathways of potential sources.

3. Aquifer testing to evaluate aquifer hydraulic conductivity to determine seepage velocity and contaminant migration rates will be completed at a minimum of three wells screened in the shallow aquifer. Wells will be selected based on field observations and lithologic logs after all wells are installed. Wells will be selected to be representative of lithologic conditions at the Site.

4. Soil descriptions (i.e., soil type and physical properties) will be completed for all soil cores collected during borehole drilling activities. These data will be used for evaluation of migration pathways and remedial action alternatives.

All wells selected for hydrogeologic data collection identified in Table 3-4.

3.4 Additional Investigation Activities

In addition to the collection of analytical and hydrogeologic data, the RI/FS will also include a groundwater supply well survey, surface cover evaluation, and property inspection.

The groundwater supply well survey will be conducted at the Site in an attempt to identify those properties containing existing groundwater wells that may be used for drinking water or other purposes (e.g., irrigation or dust control). This information will be used to identify and evaluate potential exposure pathways and assess any related potential risk to human or ecological receptors. In addition, during the RI the wells at the Site that penetrate the Bootlegger Cove formation into the deep aquifer will be verified and if possible sampled. The RI Report will present whatever information will have been collected regarding the Site wells that have been installed into the deep aquifer, and also will present information regarding the nearest deep wells that are located off Site.

An evaluation of the surface cover at the Site (e.g., parking lots, buildings, soil cover, vegetative cover) will be conducted to estimate the size and distribution of areas of potential surface water runoff, areas of industrialized development, and areas of natural vegetative cover. This information will be used to support both the human health and ecological risk assessments.

Lastly, visual inspection of six leased properties and 17 railyard SWMUs and AOCs is proposed for the RI, in accordance with the recommendation outlined in the SBR. The SBR stated that six specific leased properties being proposed for exclusion as potential source areas would require a property inspection to determine if any U.S. EPA-identified issues are still of concern, and to visually determine if other environmental issues exist. These six referenced leased properties include the following:

- LP-002 Consolidated Freightways
- LP-042 York Steel
- LP-072 Karen’s RV
- LP-115 Technic Services
- LP-124 Alma Corporation
- LP-128 Seamless Flooring Systems

A detailed summary of each of these leased properties was provided in Appendix D of the SBR. These summaries will be used during the physical inspection of the leased properties to assess any U.S. EPA-identified issues of concern and to aid in the identification of any other potential environmental issues that may be present.

Within the railyard the following SWMUs and AOCs will undergo a visual site inspection: AOC 6 and SWMUs 3, 13, 14, 15, 20, 22, 23, 24, 26, 35, 39, 43, 63, 66, and 67. Another 15 SWMUs and AOCs (with some overlap) reportedly have been addressed in site documentation. For these SWMUs and AOCs, this documentation will be reviewed to determine if concerns have been addressed.

Further details regarding the completion of these additional investigation activities are provided in Section 4.

3.5 Determining Background Concentrations

Background concentration for this project is defined as the concentration of a hazardous substance that is consistently present and naturally occurring, or that is a result of human activities such as a release not originating on the Site (ADEC, 2003a). There are, therefore, two classes of background to consider for the RI: (1) naturally occurring background and (2) anthropogenic background. In this RI Work Plan “Site-related” is defined as originating on site.

For the Site, both classes of background are relevant. For mobile media (sediment, surface water, and groundwater), the upgradient area is occupied by known (EAFB and Fort Richardson) or potential (urban and industrial areas) sources of contaminants. It will be necessary to consider anthropogenic background when evaluating Site contaminants in these media. For soil, the natural background for inorganics is the appropriate endpoint, although anthropogenic sources of organics (e.g., aerial deposition) are a potential concern.

Background concentrations will be applied to Site-related contaminants for (1) Site characterization to identify releases that may have originated at the Site, (2) remedial goal derivation to ensure that remedial goals are not stricter than background concentrations for the area, and (3) risk assessment to screen constituents of potential concern (COPCs) or to use for risk characterization.

Background values are calculated for naturally occurring inorganics and, where appropriate, for upgradient sources of organic substances.

The background concentrations to be used for the RI/FS are provided in Tables 3-6 through 3-8 for soil, groundwater, and surface water and sediment, respectively.

3.5.1 Soil

Soil background will be calculated in accordance with *Determining Background Concentrations in Soil* (ADEC, 2003a). The recommended statistic for background is the upper tolerance limit (UTL_B), corresponding to Method 1 of the ADEC guidance and consistent with the G*uidance for Comparing Background and Chemical Concentrations in Soil at CERCLA Sites* (U.S. EPA, 2002a).

Soil sampling to determine background soil concentrations is not proposed for this investigation. EAFB developed natural soil background data, as reported in the *EAFB, Alaska Environmental Restoration Program: Basewide Background Sampling Report* (USAF, 1993). This document identified suitable background soil locations and developed natural background values for the two main soil types at the base (morainal and alluvial) and for three depths (surface, root zone, and deep). Based on probability plot analysis of the data showing that morainal and alluvial soil did not differ significantly, the final background UTL_B was defined based on pooled alluvial and morainal data for each depth interval. These values, as summarized in Table 3-6, will be applied as soil background concentrations throughout the RI/FS process.

3.5.2 Groundwater

Background groundwater concentrations are based on upgradient contributions to Site groundwater. The known presence of contaminants in groundwater at the EAFB suggests the need to not only determine natural background for inorganics, but also anthropogenic background from off-site sources for organic contaminants, primarily VOCs.

USAF (1993) identified a set of monitoring wells suitable for monitoring in order to develop a natural background value in the area adjacent to Ship Creek. Most of the wells are located in distant parts of the EAFB. However, four wells identified as suitable by USAF (1993) were located upgradient of the Site. These four wells are preliminarily identified as natural background locations for this RI. The wells are identified as GW-6A, NS3-03, SP2/6-01 (located just northeast of the ARRC boundary, north of the fish hatchery), and 1S-8 (located approximately 3,000 feet north of the ARRC boundary). The USAF (1993) document does not contain results of monitoring for these wells. As part of the RI, data from these wells will be acquired from EAFB and evaluated.

Anthropogenic background for groundwater will be defined based on monitoring data from the EAFB/ARRC boundary. Numerous groundwater springs along the bluff, on the north boundary of the Site, can serve as sources of groundwater anthropogenic background. The bluff springs represent groundwater as it enters the Site. Recent sampling, as reported in the *North Boundary Assessment Groundwater and Soil Results* (RETEC, 2004d), confirms the presence of VOCs in some springs. The samples from the groundwater springs were collected by excavating the spring location by hand and sampling water as it emerged. Per EPA request, additional sampling from these springs will utilize drive points to minimize effects of contact with the atmosphere. These samples are considered representative of groundwater and have not been affected by exposure to the atmosphere.

Metals and VOC data from springs will be used to derive background values. In addition, 14 monitoring wells and five north bluff seep locations (SP-01, SP-24, SP-35, SP-40, and SP-48) along the north boundary are proposed for sampling as part of the groundwater investigation and can be used to define background concentrations (Figure 3-2).

Background groundwater analysis will follow the *Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action* (U.S. EPA, 2004c). A provisional background value can be adapted from the *Supplemental Guidance to RAGS: Region 4 Bulletins: Human Health Risk Assessment Bulletins* (U.S. EPA, 2000b), where background is:

- Twice the mean of the data set for the existing upgradient wells, or the maximum detected background concentration, whichever is lower, and

- The maximum background reporting limit for any inorganics that were not detected in the background data set (i.e., any detection would be considered in excess of background)

Appropriate methods for comparing Site data to background data from the sources listed above will be developed.

3.5.3 Sediment

Concentrations of hazardous constituents in sediments may not be the same as soil background levels. Sediment in Ship Creek is, in part, derived from sediment transport from upstream locations, which include EAFB, Fort Richardson, several highways, and other urban sources including storm water outfalls. Both natural and anthropogenic background values, therefore, need to be considered.

Definition of background for sediment will be based, in part, on existing data and, in part, on additional data collection during the RI. The method for evaluating background will be determined at that time. Sediment background will be calculated for sediment in Ship Creek itself. Sediment background in the isolated wetlands and ponds in the riparian zone cannot easily be defined due to the absence of suitable reference locations. In these areas, background will be estimated based on soil background and Ship Creek sediment data.

Existing data available to derive sediment background include (Figure 3-5):

- Up to six samples (TR-1 through TR-6) collected in June 1994 in Ship Creek from upstream of Davis Highway to the Elmendorf hatchery, and analyzed for VOCs, inorganics, DRO/GRO, and biological parameters (Cushing et al., 1994)

- Station HC-05 collected in 2004 near the Alaska Department of Fish and Game (ADF&G) hatchery upstream of Reeve Boulevard analyzed for VOCs, SVOCs, and inorganics (Hart Crowser, 2004a)

- Station SC-I1 collected in 1997 at the Elmendorf hatchery and analyzed for selected inorganics and organics (Boden, 1997)

- Samples collected near the Fort Richardson outfall as part of the Fort Richardson Operable Unit D investigation

Background sediment sample location is shown on Figure 3-5.

In addition to the existing data, one additional sediment sample (SC-11) will be collected in the reach above Reeve Boulevard to complement the existing data (actually obtaining a sediment sample in this reach or any other reach of Ship Creek will depend on whether sediment accumulations are present). Final background values will be derived preferentially from recent sediment data.

No specific method is defined for sediment evaluation. A method similar to that used for soil (ADEC, 2003a and U.S. EPA, 2002a), with proper attention to sediment characteristics affecting concentrations (e.g., particle size and TOC), or another suitable and agreed upon method will be used to derive representative background values in the RI Report

3.5.4 Surface Water

Surface water quality in the freshwater portions of Ship Creek is affected by upstream contributions; that is, by permitted discharges to the creek from off-site sources. In the lower creek (below the KAPP dam) tidal influence is also relevant. This Work Plan will not specifically address the impact of permitted storm water or other wastewater discharges to Ship Creek. Such discharges originating from off site contribute to the anthropogenic background, but will not be specifically addressed. However, if impacts to Ship Creek surface water quality are noted, further evaluation may be done to distinguish the impacts from off-site sources that would constitute part of the anthropogenic background. The method for evaluating background will be determined at that time.

Existing data will be used for determining natural surface water background. EAFB collected monthly samples for two years between 1994 and 1997 from at least six locations in Ship Creek upstream of ARRC, as reported in the *EAFB Environmental Restoration Program: Sampling and Analysis of Ship Creek: Eighth Quarterly Report of Results and Overall Water Quality Assessment* (USAF, 1996). Samples were analyzed for selected inorganics, nutrients, and VOCs. These stations have also been sampled as part of the environmental monitoring program for EAFB and several rounds of data are available from 2001 and 2002, as reported in the *EAFB Environmental Restoration Program: Basewide Environmental Monitoring Program, Groundwater and Surface Water Analytical Results for OU 5* (USAF, 2001). These data provide a temporal series for developing background values.

In addition to the EAFB data, Hart Crowser (2004a) sample SW-05 (Figure 3-5) provides a recent background value from a location near the Elmendorf hatchery.

This Work Plan proposes to collect samples from one additional location (SC-11) upstream of Reeve Boulevard to complement the existing data. A surface water sample will be collected from this location, concurrent with the proposed sampling of surface water within Ship Creek. Representative background concentrations will be presented in the RI report.

3.6 Data Evaluation

Figures 3-6 through 3-8 present the conceptual approach (flowcharts) for evaluating the RI/FS data, following analysis and data validation, by media. The flowcharts define a process to determine (1) if data are adequate to meet the DQOs outlined in Section 3.2, to proceed with the risk assessment, and to delineate the nature and extent of contaminants, or (2) if additional data collection will be necessary to meet those objectives. Additional refinement of the decision process related to how to incorporate existing data and information into the decision process will be presented in the RI Report. This conceptual approach indicates how the overall objectives of the RI will be met based on the sampling strategy presented in this Work Plan.

Sediment and Surface Water

Figure 3-6 presents the decision flowchart for sediment and surface water data. The goal of the sediment and surface water data collection (off-channel and Ship Creek) is the protection of human health and the environment, and to identify those sources of risk attributable to release originating at the Site. If sediment or surface water contamination is not Site-related, it is not of further concern in this RI/FS. Site-related releases to Ship Creek that may affect human health or the environment are a primary focus of this RI/FS.

Only detected constituents exceeding an applicable screening level are considered further[4]. If such constituents are identified, the primary mechanism for identifying if they are Site-related is via an evaluation of groundwater data from Transects 1 and 2. The primary objective of these two transects is to evaluate potential groundwater contaminant transport to Ship Creek. Groundwater transport from industrial areas is considered the most likely source of Site-related contamination to Ship Creek, as source areas generally are absent in the riparian areas near the creek, and runoff appears insignificant except locally in some of the off-channel areas. The impact of storm water outfalls was discussed previously.

If contaminants are determined to be Site-related, and are otherwise adequate for risk assessment, the investigation proceeds to the risk assessment phase. If inadequate, additional data collection may be needed. Additional data collection needs may entail additional sediment and surface water sampling to define sources, or additional types of data collection that may provide further information on impacts due to site-related contaminants (e.g., toxicity testing or population and community testing).

Groundwater

Figure 3-7 presents the decision flowchart for evaluating groundwater analytical data. The flowchart reflects the fundamental approach for this RI of identifying sources of risk to receptors by evaluation of transport and exposure pathways based on groundwater transport. The four east-west groundwater well transects are intended to meet these objectives:

1. Transect 1 (immediately north of Ship Creek) and Transect 2 (immediately south of Ship Creek) define a zone where the data collection goals are focused on the protection of human health and the environment (primarily Ship Creek) and identification of Site-related sources to Ship Creek. Groundwater data from Transects 1 and 2 will be used as source data.

---

[4] The need and process for further consideration of detected constituents lacking screening levels will be discussed in the risk assessment scoping memorandum .

2. Transect 3 and Transect 1 define a zone primarily occupied by leased properties north of Ship Creek. The data collection goals within this zone are protection of human health from direct contact, vapor intrusion, and potentially from potable water ingestion, and identification of sources to Ship Creek. Groundwater data from Transect 3 (upgradient) and Transect 1 (downgradient) define sources of risk within the zone and exposures within the zone from upgradient sources of risk. Infill groundwater data focus on specific sources of risk.

3. Transect 4 and Transect 3 define a zone primarily occupied by the ARRC railyard. The data collection goals are protection of human health from direct contact or vapor intrusion, and identification of sources of risk to downgradient receptors. Groundwater data from Transect 4 (background or upgradient) and Transect 3 (downgradient) will define sources of risk within the zone and exposures within the zone from background sources of risk. Infill groundwater data focus on specific sources of risk.

4. Transect 4 (background or upgradient) defines the upgradient boundary of Site-related impacts. The goal of this data evaluation is the identification of contaminants from off-site sources that may contribute to Site risk. Contributions from off-site sources will be included in the risk assessment, but attributed to off-site sources.

No further evaluation is considered for non-detected constituents. Note that J-qualified data (estimated detections) will be evaluated in the risk assessment. For constituents detected above the applicable screening level in a transect location, there exists an upgradient potential source of risk[5]. If there are potential downgradient exposures the constituent will be further considered. If the constituent is detected but does not exceed a screening level, there may still be a potential upgradient exposure to higher concentrations, although downgradient exposures are not of further concern.

Upgradient sources of risk will then be evaluated by review of existing information (e.g., existing analytical data, hydrogeology, information on known or suspected upgradient source areas, or fate and transport modeling). Downgradient exposures will be evaluated by review of existing information, land use, or fate and transport modeling. If data are adequate to evaluate potential exposures (including indoor air) and sources of risk to human health and Ship Creek, the risk assessment will be completed. If data are not sufficient for this purpose, additional data collection will be considered. These data may include additional soil and groundwater analytical results as

---

[5] The management of detected constituents lacking screening levels will be discussed in the risk assessment scoping memorandum.

well as source specific data to support the Johnson and Ettinger (1991) indoor air model.

Finally, it is understood that this approach for eliminating downgradient areas from further concern assumes that concentrations are not increasing. If a recent and currently unknown release is identified during the RI, additional sampling may be conducted (i.e., in closer proximity to the release) if it is determined that the release presents a potential risk to human health and the environment.

Soil

Figure 3-8 presents the decision flowchart for evaluation of soil analytical data. Soil data will be collected separately for surface and subsurface soil. There will be two groups of soil data: (1) soil data collected systematically concurrent with the installation of monitoring wells on transects, which are not necessarily related to a specific suspected source, and (2) infill soil samples collected at known or suspected sources, particularly where non-mobile analytes are suspected. The goals are protection of human health and the environment from direct contact with surface soil, protection of Ship Creek from runoff from the Site, and protection of human health from direct contact with subsurface soil and vapor intrusion, as well as protection of groundwater and Ship Creek from leaching of contaminants from soil.

Detected surface and subsurface soil constituents that exceed applicable screening levels will be considered further. If an analyte exceeds its screening level, existing data, land use, and analytical data will be evaluated to determine if the data are adequate to define the nature and extent of a potential source of risk and complete the risk assessment. If data are deemed inadequate, further data collection to delineate sources of risk may be needed. Infill soil samples are generally placed at locations representing worst-case conditions related to a known or suspected source and may be adequate to fully define worst-case risk.

In a further step, subsurface soil data will be evaluated as to leaching potential to groundwater (and thence to Ship Creek). Detected analytes that exceed the soil leaching screening level will be further evaluated by comparing them to nearby groundwater data. If nearby groundwater data (including groundwater data from the same location, and existing and recent data from nearby wells) exceed the screening levels for groundwater for the affected constituents, further evaluation of leaching potential using fate and transport modeling or leachability tests (e.g., synthetic precipitation leaching procedures) will be considered before proceeding with the risk assessment.

3.7 Evaluating Risk

This section presents a description of the general approach for conducting the baseline human health and ecological risk assessments in accordance with

Section 2.6 of the SOW. The detailed approach and procedures will be developed following scoping meetings with the U.S. EPA and the results will be presented in a Risk Assessment Work Plan for U.S. EPA review and approval. Additional interim deliverables also may be agreed upon with U.S. EPA (per Section 4.7.2 of the SOW). This summary, therefore, presents a general preliminary approach, and is subject to refinement based upon data and feedback from the risk assessment scoping meeting with U.S. EPA. The risk assessments for the Site will be conducted per U.S. EPA guidance for CERCLA sites. The key U.S. EPA documents for the baseline risk assessments are listed below. Additional U.S. EPA guidance documents, as well as applicable ADEC guidance, will be presented in the Risk Assessment Work Plan.

For the human health risk assessment, the following guidance documents will be used:

- *Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual* (Parts A, B, C, and E) (U.S. EPA, 1989; U.S. EPA, 1991a; U.S. EPA 1991b; and U.S. EPA, 2001a)

For the ecological risk assessment, the following guidance documents will be used:

- *Ecological Risk Assessment Guidance for Superfund, Interim Final* (U.S. EPA, 1997a)

- *Guidelines for Ecological Risk Assessment* (U.S. EPA, 1998)

The preliminary DQOs defined for this RI/FS, as detailed in Section 3.2, include the objective of collecting adequate data to complete human health and ecological risk calculations for the Site. Historical data review presented in the SBR and the results of the *Ship Creek Preliminary Habitat Assessment* (RETEC, 2004e) identified specific data gaps related to data quality for the purpose of risk assessment. The data collection proposed in this Work Plan will support the baseline risk assessment. However, there are provisions for additional data collection for under-represented areas, if data review in consultation with U.S. EPA determines additional data collection is necessary.

3.7.1 Human Health Risk Assessment Approach

The scope of work to complete the baseline risk assessment includes the following tasks.

1. **Site Characterization Summary.** Soil, groundwater, surface water, and sediment data collected during the RI will be evaluated for data adequacy for risk assessment.

2. **Human Health CSM.** The CSM identifies the potential sources, chemical migration routes, receptors, and complete exposure pathways for the Site.

3. **COPC.** Chemicals detected in soil, groundwater, surface water, and sediment, that exceed relevant screening criteria will be retained as COPC for the quantitative, Site-specific risk assessment for potentially complete exposure pathways.

4. **Exposure Assessment.** For all complete exposure pathways, intake assumptions for each receptor will be identified. The intake assumptions will be based on Site-specific information (if available) and default exposure factors from the U.S. EPA including the *Exposure Factors Handbook* (U.S. EPA, 1997b), *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (U.S. EPA, 2001b), and *Risk Assessment Guidance for Superfund* (U.S. EPA, 2001a).

5. **Exposure Point Concentrations and Fate and Transport Modeling.** U.S. EPA guidance indicates that the exposure point concentrations should be based on the 95% upper confidence limit (95% UCL) of the arithmetic mean (based on appropriate statistical distribution), or the maximum, whichever is lower, for all exposure media with measured, adequate analytical data. For media that lack measured data (such as outdoor and indoor air and leaching of soil to groundwater), fate and transport models will be used to calculate the exposure point concentrations.

   Specific details of the exposure assessment will be agreed to with U.S. EPA prior to implementation and will be discussed in the risk assessment scoping meeting.

6. **Toxicity Assessment.** U.S. EPA-acceptable and peer-reviewed toxicity data will be used for COPC identified in the risk assessment.

7. **Risk Characterization and Uncertainty Analysis.** Potential cancer risks and hazard indices will be calculated for all receptors and complete exposure pathways. Evaluation of lead will be assessed using the appropriate U.S. EPA methodologies. The resulting cancer risks hazard indices will be compared to the target risk level benchmarks established through discussion with U.S. EPA. A qualitative evaluation of the uncertainties inherent in the risk assessment will also be included.

3.7.2 Ecological Risk Assessment Approach

The *Guidelines for Ecological Risk Assessment* (U.S. EPA, 1998) define an iterative, tiered approach to ecological risk assessment. Initial tiers serve to screen out pathways and receptors of less significance to ecological risk, allowing more intense focus on evaluation of Site-specific ecological risk for the key pathways and receptors at the Site. The eight-step, tiered approach in the *Ecological Risk Assessment Guidance for Superfund* (U.S. EPA, 1997a) is a more prescriptive process to be applied at CERCLA sites.

Current Site understanding was presented in the ECSM in Section 2.4.2. Available data suggest that a screening-level risk assessment (Steps 1 and 2 of the eight-step process defined in U.S. EPA [1997a]) may be sufficient risk characterization to allow risk management decisions without proceeding to additional steps. If the screening-level assessment determines that further ecological risk assessment is necessary, additional data requirements will be defined.

A summary of the steps of the ecological risk assessment process is presented below. A more complete discussion of methods, calculations, assumptions and inputs to the ecological risk assessment will be presented in the Risk Assessment Work Plan.

- **Step 1: Screening-Level Problem Formulation.** In this step, the preliminary CSM is refined, assessment endpoints and measures of effect set up, and key receptors identified.

- **Step 2: Screening Level Ecological Risk Assessment (SLERA).** In this step, Site chemical data will be screened against conservative screening levels to determine constituents of potential ecological concern (COPEC). The screening levels and process will be discussed with U.S. EPA in the risk assessment scoping meeting.

- **Step 3.** In 2001, U.S. EPA issued a clarification to the guidelines in the *Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (U.S. EPA, 2001c). It was noted that Steps 1 and 2 seldom resulted in screening out of insignificant endpoints because of the use of deliberately conservative generic assumptions. To allow Site-specific screening, U.S. EPA introduced a Refined SLERA (RSLERA) sub-tier as part of Step 3, where Site-specific considerations related to area use factors, toxicity reference values, average exposures, background values, and other factors could be applied. The RSLERA allows more realistic Site-specific decisions on the need to proceed to additional steps of the process.

- **Steps 4 through 8.** In the event that the screening level assessment cannot discount the potential for ecological risk, additional steps of the baseline risk assessment may be needed, unless proceeding directly to remedial action is preferred. In these steps of the process, additional data needs are identified, which may involve biological studies or *in situ* investigations. These steps will not be scoped until the need has been determined following the completion of the screening level risk assessment portion of the RI.

Additional Data Requirements

The *Ship Creek Preliminary Habitat Assessment* (RETEC, 2004e) for the Site identified data needs for purposes of ecological risk assessment. Two ecological zones were identified:

- **North Bluff Ecological Area**. The north bluff area contains ecological habitat. However, no pathways from Site sources to ecological receptors in this area were identified or are likely to exist. Further ecological evaluation as part of the RI/FS was not recommended.

- **Ship Creek Ecological Area (Includes Adjacent Knik Arm Marine Areas)**. Ship Creek and its associated riparian area are the principal recipients of releases from the Site. Potential risk was identified from releases of contaminants to the creek and its valuable recreational fishery, and to riparian habitat and off-channel aquatic habitats in the riparian zone. A Screening Level and Refined Screening Level Ecological Risk Assessment (SLERA and RSLERA), therefore, will be conducted for this area.

The remainder of the Site, including most of the railyard and the leased properties, is actively used for industrial, commercial, or transportation operations. These areas currently lack significant ecological habitat and do not have the potential for providing for future ecological habitat under anticipated future land use. Data needs for the ecological evaluation are detailed in Section 3.7.2.

3.8 Remedial Action Objectives

The RAO Memo (RETEC, 2005b) was submitted to the U.S. EPA on May 16, 2005 in fulfillment of Subtask 2c of the SOW. The RAO Memo identified preliminary location-specific, constituent-specific, and action-specific ARARs and potential remedial action objectives (RAOs) for the Site. Preliminary ARARs were developed as part of the planning process to assist in selecting appropriate analytical methods and setting analytical DQOs in this Work Plan. ARARs for the Site will be further updated during implementation of the RI/FS process as Site conditions, contaminants of concern, and RAOs become better defined.

The objectives of the RAO Memo were to:

- Outline preliminary RAOs for the Site that specify general goals for protecting human health and the environment
- Summarize constituents of potential concern for the Site
- Identify preliminary ARARs for the Site
- Describe remedial technologies that may be applicable at the Site, and identify data requirements that would be needed to evaluate these technologies. These data requirements may be considered data gaps which will be addressed in the RI Work Plan.

The potential remedial technologies encompass, where appropriate, alternatives in which treatment significantly reduces the toxicity, mobility, or volume of the waste; alternatives that involve containment with little or no treatment; alternatives that include removal of waste, and a no-action alternative. Excavation, capping, in-situ treatment, monitored and enhanced natural attenuation, and other alternatives (as well as combinations of each where called for) are also included in the range of remedial action alternatives.

Based on the identification of preliminary remedial action alternatives, the RAO Memo identified data requirements needed to evaluate each alternative during future stages of the RI process and data gaps for this Work Plan. The RAO Memo included MNA as a potential remedial action, and recommends collection of data to evaluate the applicability of MNA at the Site. These data gaps are addressed via the scope of data collection proposed in this Work Plan. The results will be used to evaluate remedial action alternatives for each area at the Site that may be found to present an unacceptable level of risk to human health or the environment.

3.9 Endpoints

As part of the evaluation of remedial action alternatives, Site-specific endpoints will be developed for each environmental medium that is determined to present unacceptable risk to human health and/or the environment. The endpoint objectives will be commensurate with existing regulations and guidance, endpoint objectives applied at other similar sites, and the outcome of the Site-specific human health and ecological risk assessments.

The screening levels applied in the RI are not equivalent to endpoint criteria. Screening levels are deliberately conservative values used to focus on analytes of concern for further consideration in the RI and are, therefore, inappropriate as endpoint criteria.

Endpoint criteria may include, but are not limited to:

- ARARs
- Media concentrations within acceptable level of risk to human health and the environment under reasonably anticipated current and future land use, and are technically and economically feasible given Site conditions

Establishing an endpoint methodology early in the investigation and remediation process is important for several reasons:

- They are protective of human health and the environment
- They quantify the remediation objective
- They affect the selection and design of feasible remediation technologies
- They provide a gauge for measuring remedial system performance

Additionally, due to asymptotic decline behavior, the endpoints establish a practical limit for suspending remediation system operations, and transitioning from active (e.g., sparging) to passive (e.g., MNA) remediation at a site.

4 Investigation Scope of Work

This section summarizes the RI/FS scope of work proposed to satisfy the DQOs, as outlined in Section 3.2. It provides a summary of the RI/FS analyte lists and proposed scope of data collection (i.e., matrix-specific sample collection, well installation, groundwater well survey, fluid-level data collection, tidal influence study, and slug testing). All proposed investigation activities summarized in this section will be conducted in accordance with the field methods and procedures (e.g., field activity documentation, matrix-specific sample collection, borehole drilling, well installation, and equipment decontamination) outlined in the SAP (Appendix C), and with the data quality assurance and quality control procedures outlined in the QAPP (RETEC, 2005c).

The proposed investigation scope of work for sediment and surface water is summarized in Table 3-1 and the proposed investigation scope of work for soil and groundwater is summarized in Table 3-2. The rationale for the RI/FS proposed scope of work, including number of samples and sample/well placement, is discussed in detail in Section 3.

4.1 Investigation Analyte List

The RI/FS investigation analyte list and supplemental analyte list (to be used on a sample-specific basis) are provided in Tables 2-1 and 2-2, respectively. These analyte lists reflect the current hazardous substance list of target analytes for Superfund sites as defined in the following documents:

- **VOCs, SVOCs, Pesticides, and PCBs.** *U.S. EPA Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, and Multi-Concentration* (U.S. EPA, 2004d)

- **Inorganics.** *U.S. EPA Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, and Multi-Concentration* (U.S. EPA, 2005a)

- **Dioxins and Furans.** *U.S. EPA Analytical Operations/Data Quality Center Statement of Work for Analysis of Chlorinated Dibenzo-p-dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs), Multi-Media, Multi-Concentration* (U.S. EPA, 2002b)

All soil, groundwater, sediment, and surface water samples collected during the RI/FS will be analyzed for the complete list of constituents summarized in Table 2-1, with the exception of those samples proposed for collection within Area 3. At the May 19, 2005 Work Plan presentation meeting between U.S. EPA, ADEC, and ARRC, it was agreed that samples collected within Area 3 would be analyzed for a modified group of analytes based on the fact that Area 3 has been used only for oil terminal operations and the oil company lessees have done a considerable amount of sampling and analysis under ADEC oversight that identifies the constituents of concern for that area. The Area 3 analyte list for groundwater will consist of BTEX, ethylene dibromide (EDB), 1,2-dichloroethane, lead, Polynuclear aromatic hydrocarbons (PAHs), and fuel hydrocarbons by the Massachusetts fractionation method. In addition, some samples collected during the investigation will be analyzed for all, or a subset of, the constituents summarized in Table 2-2. All samples proposed for collection during this investigation are identified in Tables 3-1 and 3-2, along with the respective proposed analyses.

A list of the laboratory analytical methods, sample containers, sample preservation, and holding time requirements for the constituents on the investigation analyte lists is provided in Table 4-1. Details regarding laboratory reporting procedures are provided in the QAPP (RETEC, 2005c), along with reporting limit requirements for the investigation analyte lists (Table 1-2; RETEC, 2005c).

4.1.1 Preliminary Human Health and Ecological Screening Levels

The preliminary human health and ecological screening levels for the Site are presented in Table 4-2. This table was adapted from the compilation of available screening levels presented in the SBR, and updated per U.S. EPA comments. The preliminary screening levels are shown in Table 4-2. As screening levels, they are not intended as ARARs for the Site. The selection of appropriate screening levels for data evaluation to meet the specific DQOs for the RI will be conducted in consultation with U.S. EPA during the risk assessment scoping meeting.

The final selection of applicable screening levels for the Site will include an evaluation of available laboratory reporting limits to assess analytes for which reporting limits exceed screening levels. Available laboratory reporting limits for the investigation analyte list and supplemental analyte list are presented in Tables 2-1 and 2-2, respectively, along with the medium-specific screening level selected for each analyte. As agreed to with the U.S. EPA in a meeting held May 19, 2005, if the reporting limit for a given constituent is greater than the screening level for that particular constituent, it will be addressed in the uncertainty analysis section of the risk assessment, and the reporting limit will become the screening level.

The media-specific screening levels used to summarize the Site historical data in Section 2.5 were selected from the set of human health and ecological screening levels presented in Table 4-2. That selection of preliminary screening levels and the subsequent comparison to historical data were completed to facilitate evaluation of existing Site conditions for the purpose of identifying potential source areas to be evaluated in the RI. These are not final screening levels but will contribute to the development of the final levels and required reporting limits.

4.2 Sediment and Surface Water Investigation

As summarized in the sediment and surface water DQOs (Table 3-3), the proposed sediment and surface water investigation was designed to collect data of the appropriate quantity and quality to:

- Delineate the nature and extent of contaminants of concern that exceed relevant screening levels in wetland sediment and surface water of the riparian zones adjacent to Ship Creek
- Evaluate the accumulation or downstream transport of contaminants of concern that exceed relevant screening levels in Ship Creek sediment and surface water
- Determine the potential for on-site and off-site upgradient sources if contaminants of concern in surface water or sediment that exceed relevant screening levels
- Calculate human health and ecological risk for contaminants of concern present in sediment and surface water
- Evaluate alternatives for any sediment and surface water remedial action that may be determined necessary

The following subsections outline the scope of the proposed sediment and surface water investigation designed to meet the RI/FS sediment and surface water DQOs.

All proposed sediment samples will be analyzed for the investigation analyte list (Table 2-1), PCBs (Table 2-2), pH, TOC, and grain-size distribution. The proposed surface water samples will be analyzed for the investigation analyte list (Table 2-1) and PCBs (Table 2-2), water hardness, and field measured parameters including pH. Note that surface water inorganics analysis will include both filtered and unfiltered samples.

4.2.1 Off-Channel Areas

This section provides a summary of the proposed scope of sediment and surface water sample collection from the off-channel areas, as identified in Section 3.3.1. All proposed sample locations within the off-channel areas are identified in Table 3-1 and depicted on Figure 3-1.

Area A: KAPP Pond

The KAPP (LP-120) pond is quiescent and appears to have accumulated a fair amount of silty sediment. For this reason, sediment sample collection is proposed from three locations within the pond (Figure 3-1). Sediment samples will be collected at these three locations from 0 to 4 inches below the surface of the sediments and from 4 to 12 inches below the surface of the sediments (Table 3-1). A surface water sample will be collected immediately before (to avoid suspension of sediment into the sample) the sediment sampling at the center sample collection location within the pond (Table 3-1).

Area B: Wastewater Pond

To evaluate the nature and extent of residual contamination, sediment sample collection is proposed at six locations and surface water sample collection is proposed at three corresponding locations (Figure 3-1). Silty sediment accumulation is extensive in this area, exceeding 1 foot in the marshy area. Thus, sediment samples will be collected at these six locations at two different depths: from 0 to 4 inches below the surface of the sediments and from 4 to 12 inches below the surface of the sediments (Table 3-1).

Three of the proposed sample locations are within the main body of the pond (Table 3-1 and Figure 3-1), as follows:

- S-B-1 (surface water and sediment sample collection) located in the center deepest point of the northern lobe. The pond appears to be over 6 feet deep in this area.

- S-B-2 (sediment sample collection only) located in the narrow channel that historically connected the pond to Ship Creek. Beaver activity blocked this channel; however, the pond is now drained via a gravity fed pipe from the western end of the pond. Water depth is approximately 2 feet in this area.

- S-B-3 (sediment sample collection only) located in the eastern lobe of the pond. If any flow from Arctic Cooperage has reached the ponds, the flow would have arrived in the vicinity of this location. Water depth at this location is approximately 2 to 3 feet.

Two samples will be collected in or near the old pond (currently marsh) area (Table 3-1 and Figure 3-1), as follows:

- S-B-4 (surface water and sediment sample collection) located in the western part of the marsh. In this area, there are several narrow channels with permanent water separated by hummocks of vegetation.

- S-B-5 (sediment sample collection only) located east of the marsh . In this area, soil is only intermittently saturated.

Sediment and surface water sample collection is proposed from one location northeast of the pond (i.e., S-B-6). In this area, surface water flow in the ditch from the ARRC/MOA storm water outfall forms a marshy area before joining the pond at its northeast corner.

Area C: Railroad Ditch

Three sediment sample locations spaced along the railroad ditch are proposed for this area (Table 3-1 and Figure 3-1). Sediment samples will be collected at these three locations from two different depths: 0 to 4 inches below the surface of the sediments and 4 to 12 inches below the surface of the sediments (Table 3-1).

Surface water sample collection is also proposed at the sediment sample location nearest Ship Creek (Table 3-1).

Area D: Railroad Avenue Marsh Area

Sediment sample collection is proposed in this area from four locations and surface water sample collection is proposed at two of those corresponding locations, if standing water is present (Table 3-1 and Figure 3-1). The depth of silty sediment is approximately 1 foot in this area. Sediment samples will be collected at the following four locations at two different depths (0 to 4 inches below the surface of the sediments and 4 to 12 inches below the surface of the sediments) (Table 3-1):

- S-D-1 located at western end of marshy area, where relict channels are present
- S-D-2 located within the main body of open marsh area
- S-D-3 located at the southeastern end of the open marsh area (in the area where seeps to the creek were noted)
- S-D-4 located at the mouth of the ditch into the marsh. This ditch has evidence of hydrocarbon contamination

Area E: Other Areas of Concern

Sediment sample collection locations are also proposed in two additional areas identified as Area E on Figure 3-1. Proposed sediment sample location S-E-1 (Table 3-1) is located within the old drainage ditch from the closed Standard Steel NPL site. This ditch, described in the habitat survey, is largely filled with silt and seems to function only as a conveyance of runoff in the riparian area. However, sediment samples will be collected at this location from 0 to 4 inches and from 4 to 12 inches below the surface of the sediments to confirm the absence of residual contamination. Surface water is not expected at this location; thus, no sampling is proposed.

Sediment sample location S-E-2 is located in a relict channel immediately below the Post Road Co-Tenancy site (LP-127) (Figure 3-1). The channel appears to frequently contain standing water, and is likely scoured by creek flows during high water levels in the creek. Sediment accumulation is minimal. Historical records for the adjoining lease property show past PCB contamination. The contaminated soil has been removed. To confirm the absence of residual contamination, sediment samples will be collected at S-E-2 from 0 to 4 inches and from 4 to 12 inches below the surface of the sediments (Table 3-1). If surface water is present, a sample will be collected (Table 3-1).

Sample S-E-3 will be taken in the riparian are downgradient of LP-131 to address EPA concerns.

4.2.2 Ship Creek Sediment

Sediment sample collection is proposed at 10 locations within Ship Creek (Table 3-1 and Figure 3-1). It is anticipated that the sediment accumulation within Ship Creek will be minor in most areas. Therefore, sediment sample collection from within Ship Creek is only proposed from 0 to 4 inches below the surface of the sediments (Table 3-1). Collection may require compositing small amounts of sediment accumulated within a coarser gravel or cobble matrix. If a depositional zone is encountered at one of the 10 proposed sediment sample locations, a deeper sample (i.e., from 4 to 12 inches below the surface of the sediments) may be collected opportunistically. Only one location is expected to contain substantial fine-grained sediment accumulation, location SS-4 (Table 3-1 and Figure 3-1).

The following are the proposed sediment sample locations:

- **S-S-1.** Located in the scoured creek channel in the lower intertidal area. This sample will be collected from sediment in the channel, not from the marine clay formations adjacent to the channel.

- **S-S-2.** Located in the lower zone downstream of all Site-related discharge points.

- **S-S-3.** Located in the upper tidal zone below the KAPP (LP-120) dam. This sample will not be collected adjacent to the storm water outfalls, but at some distance away.

- **S-S-4.** This location is a depositional eddy formed behind the KAPP (LP-120) dam, and is the only significant depositional environment in Ship Creek. This is the only location where a deeper sediment sample (to 1 foot) is anticipated to be feasible.

- **S-S-5.** Located in the sandy area behind the KAPP (LP-120) dam. Medium to coarse sand deposits in this area.

- **S-S-6.** Located within the main stem of Ship Creek downstream of potential contaminant migration from the wastewater pond area and associated leased properties. It is anticipated that locating sediment accumulation in this area may be difficult.

- **S-S-7.** Located within the main stem of Ship Creek upstream of potential contaminant migration from the wastewater pond area, but downgradient of the railroad ditch and the former PCB contaminated area in the Post Road Co-Tenancy lease site (LP-127).

- **S-S-8.** Located within the main stem of Ship Creek upstream of Post Road Bridge. This location was selected because there appears to be some depositional features present.

- **S-S-9.** Located within the main stem of Ship Creek, downstream of potential contaminant migration from the Railroad Avenue marsh area and the former Standard Steel NPL site.

- **S-S-10.** Located within the main stem of Ship Creek, upstream of potential contaminant migration from the Railroad Avenue marsh area and the former Standard Steel NPL site.

- **S-S-12.** Located within the channel downgradient of the KAPP dam near the north bank to the extent possible.

One additional sediment sample location (SC-11) will serve as the investigation background sample location (Figure 3-5) complementing the historical background sample set. This sediment sample will be collected upstream of Reeve Boulevard if a suitable depositional area is located. If not, the sample may need to be collected above the hatchery dam, ¼ mile upstream of Reeve Boulevard.

4.2.3 Ship Creek Surface Water

Surface water sample collection is proposed at four locations within Ship Creek (Table 3-1 and Figure 3-1). One round of surface water samples will be collected from these locations during low-flow conditions within Ship Creek. This sampling will be conducted concurrently with the sediment sampling proposed in the previous section.

Only a subset of the sediment sample collection locations are also designated as surface water sample collection locations, as the creek is well mixed with rapid flow and significant spatial variability is not expected. These locations are identified in Table 3-1 and depicted on Figure 3-1.

One additional surface water sample location (SC-11) will serve as the investigation background sample location (Figure 3-5) complementing the historical background sample set.

4.3 Groundwater and Light Non-Aqueous Phase Liquid Investigation

As summarized in the groundwater and LNAPL DQOs (Table 3-4), the proposed groundwater and LNAPL investigation is designed to collect groundwater data of the appropriate quantity and quality to:

- Delineate the nature and extent of dissolved-phase contaminants of concern at the Site that could migrate to Ship Creek or contribute to vapor intrusion to structures
- Assess the relative contribution of upgradient and background dissolved-phase contaminants of concern to groundwater beneath the railyard and leased properties
- Evaluate groundwater flow and tidal influences beneath the railyard and leased properties to identify potential exposure pathways of contaminants of concern to Ship Creek or potential vapor intrusion exposure pathways
- Calculate human health and ecological risk for dissolved-phase contaminants of concern at the Site
- Delineate and characterize LNAPL present in the subsurface which may act as a source of dissolved-phase contaminants of concern
- Evaluate alternatives for any remedial action that may be determined necessary for groundwater and LNAPL

The following sections outline the scope of the proposed groundwater investigation designed to meet the RI/FS groundwater and LNAPL DQOs.

4.3.1 Groundwater Well Survey

A groundwater well survey will be conducted at the Site to identify those properties having existing groundwater wells that may be used for drinking water or other purposes (e.g., irrigation or dust control). Some existing groundwater wells have already been identified for the leased properties, as reported in the SBR. However, to ensure a complete inventory of groundwater wells present at the Site, a survey of the leased properties will be conducted either by mail or by visits to those properties. This survey will be used to verify the existence or absence of groundwater wells present at the Site. The survey results will be provided in the RI Report. In addition, information regarding the deep wells located at the Site and nearby deep wells located off Site will be presented in the RI Report.

4.3.2 New Monitoring Wells and Drive-Point Wells

A total of 62 new monitoring wells and 22 new drive-point wells are proposed for installation, as summarized in Table 3-2 and shown on Figure 3-2. These wells are proposed in areas north and south of Ship Creek and within the terminal area of the Site (Figure 3-2). The proposed new wells will be used for groundwater and LNAPL sample collection, fluid-level gauging, slug testing, and a tidal influence study, each of which is described further in the following sections. A brief rationale for placement of the proposed new monitoring wells and drive-point wells is provided in Table 3-2.

The new monitoring wells will be installed by hollow-stem auger drilling techniques and the new drive-point wells are proposed for direct-push installation, as described in the SAP (Appendix C). All proposed wells will be installed in the unconsolidated materials overlying the Bootlegger Cove formation in the uppermost unconfined aquifer. They will be screened across the water table to allow for seasonal and tidal-influenced groundwater fluctuations.

Lithologic data, headspace data, ultraviolet fluorescence data, and blow counts are proposed for collection during borehole drilling activities at locations proposed for monitoring well installation. The proposed new monitoring and drive-point wells will be installed, constructed, and developed in accordance with the procedures outlined in the SAP. Management of investigation derived waste (e.g., soil generated during borehole drilling activities) will be conducted in accordance with the procedures outlined in the SAP.

Following installation, all new wells will be surveyed to establish horizontal and vertical control.

4.3.3 Groundwater, Spring, and Light Non-Aqueous Phase Liquid Sampling

Groundwater sampling is proposed at the 62 new monitoring wells, 22 drive-point wells, 15 existing monitoring wells, and 5 groundwater springs, as summarized in Table 3-2 and shown on Figure 3-2. Groundwater sample collection events are proposed for fall 2005 and spring 2006 from this set of new wells, existing wells, and groundwater springs. This will allow for an evaluation of seasonal influences (if any) on groundwater concentrations, and will also provide a temporal data set for evaluating groundwater concentrations over time at the Site. The flow-rate of each groundwater spring will also be estimated and documented at the time of sample collection to evaluate potential seasonal changes in flow-rates. Upon completion of the first proposed groundwater sampling event (fall 2005), the results will be evaluated to determine if the current list of wells to be sampled requires modification (e.g., continued monitoring at some wells may be deemed unnecessary for the spring 2006 event due to non-detections). All groundwater sample collection will be performed during low-tide stages to provide a conservative data set for evaluating groundwater concentrations. The proposed groundwater samples will be analyzed as detailed in Table 3-2.

If LNAPL is present in a well, a sample may be collected for characterization via gas chromatography analysis and for physical properties analyses (i.e., viscosity, specific gravity, surface tension, and interfacial tension).

All of the wells proposed for groundwater sampling will be purged prior to sample collection. Water quality parameters, including pH, temperature, and conductivity, will be collected and documented during well purging activities. Groundwater samples will be collected by either the bailing method or low-flow sample collection method. LNAPL samples will be collected using disposable bailers. Groundwater will be collected from the groundwater springs using decontaminated or laboratory-supplied disposable transfer-bottles to fill the sample containers. Investigation-derived waste management (e.g., purge water), groundwater/LNAPL sample handling and shipping, and groundwater quality assurance sampling will be conducted in accordance with the procedures outlined in the SAP.

Monitored Natural Attenuation

Groundwater sample collection is also proposed for natural attenuation monitoring. The scope of this data collection will be assessed upon receipt and review of the groundwater analytical results. As such, data collection details (e.g., number of samples and locations) proposed for evaluating natural attenuation will be outlined in the *Preliminary Site Characterization RI Data Compilation Summary* to be submitted to the U.S. EPA upon completion of the RI/FS field investigation and receipt of the groundwater analytical results. The list of proposed natural attenuation parameters and respective analytical methods, sample preservation requirements, and holding times is provided in Table 4-3. The low-flow groundwater sample collection method is necessary for natural attenuation monitoring.

4.3.4 Fluid-Level Gauging

Fluid-level gauging is proposed to confirm groundwater flow patterns in the unconsolidated sediments overlying the Bootlegger Cove formation and to determine the thickness and extent of LNAPL, if present. A total of 15 existing monitoring wells, 62 new monitoring wells, and 22 new drive-point wells are proposed for fluid-level gauging for the RI/FS, as shown on Figure 3-4. Two fluid-level gauging events are proposed (i.e., fall 2005 and spring 2006) from this set of new and existing wells. This will allow for an evaluation of seasonal influences on groundwater flow patterns at the Site. Upon completion of the first fluid-level gauging event in fall 2005, the current list of wells to be gauged will be evaluated to determine if modifications are necessary for the spring 2006 event (e.g., addition or subtraction of wells from the list to ensure adequate coverage).

The proposed fluid-level gauging will be conducted following installation and development of the proposed new monitoring wells and drive-point wells. Care will be taken to collect the fluid-level data during consistent tidal stages (e.g., all data collection during low- or high-tide) to provide a data set adequate for assessing groundwater flow.

All fluid-level gauging activities and respective management of investigation-derived waste (e.g., PPE and paper towels) will be conducted in accordance with the procedures outlined in the SAP.

4.3.5 Tidal Influence Study

A tidal influence study is proposed to investigate the influence of daily tidal fluctuations on groundwater elevations, potential LNAPL thickness, and vertical gradients within the unconsolidated sediments. The 30-day test is designed to capture tidal influences over a one-month period (i.e., one complete lunar cycle). Understanding tidal influences in the unconsolidated sediments is necessary to evaluate groundwater elevation data. The wells selected for the tidal influence study are identified in Table 3-2 and shown on Figure 3-4. Drilling and installing this set of wells will be given priority to ensure adequate time for data collection during the RI/FS.

The tidal influence study will be conducted using water level data loggers installed in the wells. The tidal influence study will be conducted before completing groundwater sample collection activities.

4.3.6 Slug Testing

To determine the hydraulic conductivity in the unconsolidated material overlying the Bootlegger Cove clay, slug testing will be performed at a set of wells to be selected upon review of the field data collected during the investigation (e.g., boring logs). These locations will be selected to test representative upper-aquifer conditions.

The procedures for conducting the proposed slug tests are provided in the SAP.

4.4 Soil Investigation

The proposed scope of work for the soil investigation is based on an authoritative (i.e., sample locations based on known or suspected source areas) and systematic (i.e., samples along the transects) approach. As summarized in the soil DQOs (Table 3-5), the soil investigation is designed to collect soil data of the appropriate quantity and quality to:

- Delineate the nature and extent of contaminants of concern in soil within known or suspected source areas
- Calculate human health and ecological risk for contaminants of concern in soil at the Site
- Evaluate potential fate and transport of contaminants of concern

- Evaluate alternatives for any soil remedial action that may be determined necessary

The following sections outline the scope of the proposed soil investigation designed to meet the RI/FS soil DQOs. However, additional soil sample collection may be conducted based on the results of the groundwater sampling. The groundwater analytical results will be used to assess the nature and extent of dissolved-phase contaminants and identify potential source areas where additional soil sample collection may be conducted. This determination will be made based on the decision flow charts provided on Figures 3-7 and 3-8. If additional soil sample collection is determined necessary to meet the soil DQOs (Table 3-5), a proposed scope of work will be submitted to the U.S. EPA for review and approval prior to data collection.

4.4.1 Surface Soil

Surface soil sample collection is proposed at the 62 new monitoring well locations, along with 7 surface-soil-only sample locations, as identified in Table 3-2 and shown on Figure 3-2. Surface soil samples are proposed for collection at these locations from 0 to 6 inches below the ground surface. At the proposed monitoring well locations, the samples will be collected using split-spoon samplers during hollow-stem auger drilling. At the surface-soil-only sample locations, the samples will be collected using a decontaminated spade or shovel and a stainless steel mixing bowl. All soil samples will be analyzed as detailed in Table 3-2.

Investigation-derived waste management (e.g., soil cuttings generated from borehole drilling activities), equipment decontamination, soil sample handling and shipping, and soil quality assurance sampling will be conducted in accordance with the procedures outlined in the SAP. Upon completion of sample collection from the surface-soil-only locations, each location will be surveyed. Surveying will also be conducted at each new monitoring well location, as previously described.

4.4.2 Subsurface Soil

Subsurface soil sampling is proposed at the 62 new monitoring well locations, as identified in Table 3-2 and shown on Figure 3-2. Subsurface soil samples will be collected during hollow-stem auger drilling using split-spoon samplers. One subsurface soil sample will be collected from the 2-foot split spoon sampler with the highest headspace measurement for all samples retrieved between 6 inches below ground surface and the water table. Thus, the subsurface soil sample collection depth will vary from one sample location to the next as it is dependent on headspace measurements and the depth to the water table at each location. All soil samples will be analyzed as detailed in Table 3-2. Additional soil samples may be collected at the discretion of the field geologist.

In addition, a total of 11 subsurface soil samples will be analyzed for a set of geotechnical parameters (i.e., air-filled porosity, water-filled porosity, grain size, permeability, and soil dry-bulk density) to support an evaluation of potential vapor intrusion exposure pathways. These samples will be collected using acetate sleeves or brass liners. The locations selected for geotechnical analyses are identified in Table 3-2.

Investigation-derived waste management (e.g., soil cuttings generated from borehole drilling activities), equipment decontamination, soil sample handling and shipping, and soil quality assurance sampling will be conducted in accordance with the procedures outlined in the SAP.

4.5 Property Inspection

As described in Section 3.4, an inspection is proposed as part of the RI for the following six leased properties and 17 railyard SWMUs and AOCs:

- LP-002 Consolidated Freightways
- LP-042 York Steel
- LP-072 Karen’s RV
- LP-115 Technic Services
- LP-124 Alma Corporation
- LP-128 Seamless Flooring Systems

The proposed inspections will include the following:

- **Site Information Review.** This will include a review of available existing information for the property (e.g., aerial photographs, historical spill records, analytical data, property maps, etc.). This information is already summarized in Appendix D of the SBR.

- **Site Visit/Reconnaissance.** This will be conducted to verify the results of the Site information review and to collect any additional relevant information regarding the property (e.g., currently unknown drum storage on the property, areas of surface soil impacts not previously identified, etc.). The proposed Site reconnaissance involves a Site visit to visually and/or physically observe and identify any relevant environmental conditions.

- **Interview.** An interview with the property lessees will be conducted to provide additional information for the property (if available) and to verify the results of the Site information review. The results of the interview will be used to determine the potential existence of relevant environmental conditions on the subject property.

- **Reporting.** The results of the property inspections will be recorded, documented, and summarized in the RI Report.

4.6 Surface Cover Evaluation

An evaluation of the surface cover at the Site (e.g., parking lots, buildings, soil cover, vegetative cover) will be conducted to estimate the size and distribution of areas of potential surface water runoff, areas of industrialized development, and areas of natural vegetative cover. To estimate the size and distribution of these areas, a review of existing aerial photographs of the Site will be completed. The results of the evaluation will be depicted on a surface cover figure to be included in the RI Report upon completion of the investigation.

5 Health and Safety

The field activities associated with the RI/FS will be conducted in accordance with the guidelines outlined in the *Site-Specific Health and Safety Plan* (RETEC, 2005d) and the *Project-Specific Health and Safety Plan* provided in Appendix B. All personnel involved in the investigation (including any subcontractors to RETEC) will be required to review and adhere to the *Site-Specific Health and Safety Plan* (RETEC, 2005d) and the Project-Specific Health and Safety Plan.

Prior to conducting any field activities at the Site, all RETEC investigation personnel and contractors will be required to (1) complete the RETEC On-Track Safety Training, (2) complete the ARRC Railroad Safety Training, (3) comply with all Site health and safety requirements and protocols, and (4) attend a preliminary Site safety orientation to identify the hazards specific to working at the Site. In addition, all field personnel will attend daily safety meetings or project-specific tailgate safety meetings to discuss safety topics specific to the fieldwork being performed that day.

6 Schedule

The anticipated schedule for implementation and completion of the RI/FS investigative activities is as follows (contingent upon U.S. EPA approval of the RI/FS Work Plan):

- July 2005: ARRC procurement of materials and equipment needed for scheduled 2005 RI/FS field activities
- August 2005: U.S. EPA approval of the RI/FS Work Plan needed in order to complete field work scheduled for 2005
- August 2005: Commencement of the RI/FS field investigation activities
- November – December 2005: Receipt of investigation analytical data
- January – June 2006: Review of investigation data adequacy and time frame for additional data collection as necessary
- Early 2006: Meeting with EPA to discuss investigation data
- Spring 2006: Completion of proposed groundwater monitoring
- Monthly progress reports will continue to be submitted to U.S. EPA in accordance with Paragraph 64 of the AOC

The Preliminary Site Characterization RI Data Compilation Summary will be submitted upon completion of the RI/FS investigative activities conducted through 2005. All investigative results, including any additional data collected in 2006, will be submitted in the RI Report (scheduled for submittal following the Preliminary Site Characterization RI Data Compilation Summary).

7 References

ADEC, 2003a. *Determining Background Concentrations in Soil*. Alaska. Department of Environmental Conservation. June 13, 2003.

ADEC, 2003b. *Alaska Water Quality Criteria Manual*. Drinking Water Primary Maximum Contaminant Levels, Table I. May 15, 2003.

ADEC, 2004a. *Sediment Quality Guidelines*. 2004.

ADEC, 2004b. *Groundwater Cleanup Levels.* Table C of 18 AAC 75, as amended May, 26, 2004.

ADEC, 2004c. *Method 2 Soil Cleanup Levels, under 40-inch Zone.* Table B1 of 18 AAC 75. As amended May 26, 2004.

Boden, 1997. "Ship Creek Water Quality Assessment, Phase II". M.S. Thesis. December 1997.

Booz-Allen Hamilton, 2002. *RCRA Facility Assessment Report*. Alaska Railroad Corporation Leased Properties. Prepared for U.S. EPA by Booz-Allen Hamilton. EPA Id No. AKD 98176-7403. July 16, 2002.

Canadian Environmental Quality, 2002. Canadian Environmental Quality Guidelines for Tissue Residue protective of Wildlife. Update 2002.

Cederstrom, D.J., Frank Trainer & Roger Waller, 1964. *Geology and Ground-Water Resources of the Anchorage Area, Alaska*. USGS Water-Supply Paper 1773.

CH2M Hill, 1996. *Summary of Information on the Natural Occurrence (Background) of Select Metals in Surface Soil and Stream Sediments: Ship Creek and Throughout Alaska.* September 20, 1996.

Cushing et al., 1994. *Draft Ship Creek Bioassessment Investigations.* Prepared for EAFB. December 2004.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants. ES/ER/TM-85/R3. Revision 1997.

ENSR, 1995. *Preliminary Source Evaluation 2, Operable Unit D, Fort Richardson.* Prepared for the U.S. Army Corps of Engineers, Fort Richardson, Alaska. August 1995.

Hansen, W.R., 1965. Effects of the Earthquake of March 27, 1964 at Anchorage, Alaska. USGS Professional Paper 542-A.

Hart Crowser, 2004a. *Ship Creek Water and Sediment Assessment Report, Anchorage, Alaska*. May 2004.

Hart Crowser, 2004b. *Ship Creek Literature Review, Alaska Railroad Corporation, April 2004*. Document 8877. July 2004.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger, 2000. *Development and Evaluation of Consensus based Sediment Quality Guidelines for Freshwater Ecosystems.* Archives of Environmental Contamination and Toxicology 39:20-31.

MWH, 2001. *North Ship Creek Railyard Expansion Surface Water Study Data Report.* November, 2001.

RETEC, 2004a. *North Boundary Assessment Interim Action Work Plan, Alaska Railroad Corporation, Anchorage Terminal Reserve.* RETEC: Ft. Collins, Colorado Office. August 30, 2004.

RETEC, 2004b. *Ship Creek Initial Habitat Assessment Interim Work Plan, Alaska Railroad Corporation, Anchorage Terminal Reserve.* RETEC: Ft. Collins, Colorado Office. September 10, 2004.

RETEC, 2004c. *Interim Action Work Plan for Monitoring Well Reconnaissance and Site-Wide Groundwater Elevations, Alaska Railroad Corporation, Anchorage Terminal Reserve.* RETEC: Ft. Collins, Colorado Office. December 3, 2004.

RETEC, 2004d. *North Boundary Assessment Groundwater and Soil Results, Alaska Railroad Corporation, Anchorage Terminal Reserve.* RETEC: Ft. Collins, Colorado Office. December 3, 2004.

RETEC, 2004e. *Ship Creek Preliminary Habitat Assessment, Alaska Railroad Corporation, Anchorage Terminal Reserve.* RETEC: Ft. Collins, Colorado Office. December 6, 2004.

RETEC, 2005a. *Site Background Report, Alaska Railroad Corporation, Anchorage Terminal Reserve.* RETEC: Ft. Collins, Colorado Office. December 15, 2004. Revisions: February 1, 2005 and March 21, 2005.

RETEC, 2005b. *Remedial Action Objectives Technical Memorandum, Alaska Railroad Corporation, Anchorage Terminal Reserve.* RETEC: Golden, Colorado Office. May 16, 2005.

RETEC, 2005c. *Quality Assurance Project Plan, Alaska Railroad Corporation, Anchorage Terminal Reserve.* RETEC: Golden, Colorado Office. June 6, 2005.

RETEC, 2005d. *Site-Specific Health and Safety Plan, Alaska Railroad Corporation, Anchorage Terminal Reserve*. RETEC: Golden, Colorado Office. June 13, 2005.

SAIC, 1996. *RCRA Facility Assessment Report*. Alaska Railroad Corporation. Prepared for U.S. Environmental Protection Agency by Science Applications International Corporation. EPA I.D. No. AKD 98176 7403. March 1996.

Schmoll, Henry and Ernest Dobrovolny, 1972. Generalized Geologic Map of Anchorage and Vicinity, Alaska. USGS Map I-787-A.

Schmoll, Henry, Lynn Yehle, and Ernest Dobrovolny, 1996. Surficial Geology of the Anchorage A8 NE Quadrangle, Alaska. USGS Open File Report 96-003.

Suter, G. and C. Tsao, 1996. *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects of Aquatic Biota.* U.S. Department of Energy, Oak Ridge Laboratory, ES/ER/TM-96/R2. June 1996.

Updike, Randall and B. Carpenter, 1986. Engineering Geology of the Government Hill Area, Anchorage, Alaska. USGS Bulletin 1588.

USAF, 1993. *Elmendorf AFB, Alaska Environmental Restoration Program: Basewide Background Sampling Report*. January 1993.

USAF, 1996. *Elmendorf Air Force Base Environmental Restoration Program: Sampling and Analysis of Ship Creek: Eighth Quarterly Report of Results and Overall Water Quality Assessment.* November 1996.

USAF, 2001. *Elmendorf Air Force Base Environmental Restoration Program: Basewide Environmental Monitoring Program, Groundwater and Surface Water Analytical Results for OU 5.* August 2001.

U.S. EPA, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA.* EPA/540/G-89/004. OSWER Directive 9355.3-01. October 1988.

U.S. EPA, 1989. *Risk Assessment Guidance for Superfund, Volume I—Human Health Evaluation Manual (Part A).* U.S. EPA/540/1-89/002. Washington D.C.: Office of Emergency and Remedial Response. December 1989.

U.S. EPA, 1991a. *Risk Assessment Guidance for Superfund, Volume I—Human Health Evaluation Manual* Part B, Development of Risk-based Preliminary Remediation Goals, OSWER Directive 9285.7-01B. December 1991.

U.S. EPA, 1991b. *Risk Assessment Guidance for Superfund, Volume I—Human Health Evaluation Manual* Part C, Risk Evaluation of Remedial Alternatives, Interim OSEWR Directive 9285.7-01C. October 1991.

U.S. EPA, 1996a. *Advance Notice of Proposed Rulemaking for Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities,* 85 FR 19431. May 1, 1996.

U.S. EPA, 1996b. U.S. EPA Office of Solid Waste and Emergency Response Ecotox Threshold Values. 1996.

U.S. EPA, 1996c. U.S. EPA Office of Solid Waste Sediment Quality Benchmark. Region IV. 1996.

U.S. EPA, 1996d. *Guidance for Data Quality Assessment, Practical Methods for Data Analysis,* EPA QA/G-9. QA96 Version. Washington, D.C.: U.S. Environmental Protection Agency, Office of Research and Development. July 1996.

U.S. EPA, 1997a. *Ecological Risk Assessment Guidance for Superfund*: Process for Designing and Conducting Ecological Risk Assessment. Interim Final. Office of Solid Waste and Emergency Response. EPA 540-R-97-006. June 1997.

U.S. EPA, 1997b. *Exposure Factors Handbook,* Vols. I–III, EPA/600/P-95/002Fa-c. Washington, D.C.: Office of Research and Development. August 1997.

U.S. EPA, 1998. *Guidelines for Ecological Risk Assessment*, EPA/630/R95/002-F. 1998.

U.S. EPA, 2000a. *Guidance for the Data Quality Objectives Process*. EPA QA/G-4, U.S. EPA, Office of Environmental Information. EPA/600/R-96/055. August 2000.

U.S. EPA, 2000b. Supplemental Guidance to RAGS: Region 4 Bulletins: Human Health Risk Assessment Bulletins.

U.S. EPA, 2001a. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual*. Part E Supplemental Guidance for Dermal Risk Assessment. Interim. Review Draft. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R/99/00.

U.S. EPA, 2001b. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*. 2001.

U.S. EPA, 2001c. *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments.* EPA 540/F-01/014. June 2001.

U.S. EPA, 2002a. *Guidance for Comparing Background and Chemical Concentrations in Soil at CERCLA Sites*, EPA 540-R-01-003.

U.S. EPA, 2002b. *USEPA Analytical Operations/Data Quality Center Statement of Work for Analysis of Chlorinated Dibenzo-p-dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs), Multi-Media, Multi-Concentration.* Document DLM01.4. January 2002.

U.S. EPA, 2002c. *Human Health Fact Sheet*: Revised National Recommended Water Quality Criteria. EPA822F03012. November 2002.

U.S. EPA, 2004a. *Administrative Order on Consent*. U.S. EPA CERCLA Docket No. 10-2004-0065. June 29, 2004.

U.S. EPA, 2004b. *Statement of Work* – Administrative Order on Consent No. CERCLA 10-2004-0065, Alaska Railroad Corporation, Anchorage Terminal Reserve. May 17, 2004.

U.S. EPA, 2004c. Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action (for Facilities Subject to Corrective Action under Subtitle C of the Resource Conservation and Recovery Act).

U.S. EPA, 2004d. *USEPA Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration.* Document SOM01.0. October 2004.

U.S. EPA, 2004e. Region IX Preliminary Remediation Goals for Tap Water. Available at: www.epa.gov/region 09/waste/sfund/prg/intro.htm. October 2004.

U.S. EPA, 2004f. *2004 Edition of the Drinking Water Standards and Health Advisories.* EPA 822R02038. Office of Water. Winter 2004.

U.S. EPA, 2005a. *USEPA Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration.* Document ILM06.X, 1st Draft. March 2005.

U.S. EPA, 2005b. Guidance for Developing Ecological Soil Screening Levels. Office of Emergency and Remedial Response. Washington D.C. November, 2003. Revised: February 2005.

Warhaftag, 1970. Physiographic Provinces of Alaska. USGS Paper.

Washington Department of Ecology, 2001. Terrestrial Ecological Evaluation Process: Interactive User's Guide. Washington State Department of Ecology. Toxics Cleanup Program. 2001.

Washington Ecology, 1995. Sediment Management Standards. Chapter 173-204. Washington Administrative Code. 1995.

Tables

Table 1-1
Statement of Work[1] Compliance

Task or Subtask Identifier	Statement of Work Task Title	Further Details / Description	Status	Notes
2a	Data Compilation/ Site Background Report	- Conduct Project meeting - Initial Interim Actions - Ship Creek Assessment, Potential Sediment Sampling, Analysis/Biological Testing - Soil and/or Groundwater Sampling at Northern Boundary	Completed	▪ Existing data were reviewed, compiled, and input into an ARRC project GIS-database for storage, evaluation, and reproduction. ▪ The North Boundary Assessment Interim Action Work Plan (RETEC, 2004a) was submitted to the U.S. EPA Aug. 30, 2004 and approved Sept. 13, 2004. ▪ The Ship Creek Initial Habitat Interim Work Plan (RETEC, 2004b) was submitted to the U.S. EPA Sept. 10, 2004 and approved October 5, 2004. ▪ Historical site data/info. were compiled/provided in the Site Background Report (RETEC, 2005a) submitted to the U.S. EPA Oct. 15, 2004. ▪ U.S. EPA reviewed the Site Background Report (RETEC, 2005a) and provided comments dated Dec. 1, 2004 and Feb. 23, 2005. ARRC submitted responses to comments to the U.S. EPA dated Feb. 1, 2005 and March 21, 2005. ▪ The North Boundary Assessment was conducted - the results were submitted to the U.S. EPA in the North Boundary Assessment Groundwater and Soil Results dated Dec. 3, 2004. ▪ The initial habitat survey was conducted - the results were submitted to the U.S. EPA in the Ship Creek Preliminary Habitat Assessment dated Dec. 6, 2004. ▪ ARRC received U.S. EPA approval of the *Site Background Report* (RETEC, 2005a) dated March 23, 2005.
2b	Data Review and RI Planning	- Preliminary Conceptual Site Models - Preliminary Analytical Concentration Goals - Preliminary Field Sampling	Completed	▪ Historical or existing data were reviewed prior to the preparation of the RI/FS Work Plan to identify data gaps, develop preliminary conceptual site models, analytical concentration goals, and define the scope of investigative activities. ▪ The results, including human health, ecological, and hydrogeologic conceptual site models, are provided in the RI/FS Work Plan.
2c	Preliminary FS Planning Tasks	- RAO Technical Memorandum - Natural Attenuation Data Gaps	Submitted	▪ The RAO Technical Memorandum (RETEC, 2005b) was submitted to the U.S. EPA on May 16, 2005 and included a presentation of potential ARARs and an assessment of the data needed to evaluate potential remedial alternatives and natural attenuation options.
2d	Propose and Carry Out Additional Interim Actions Consistent with the AOC	- Submit Draft Work Plan for Proposed Additional Interim Actions	Completed	▪ The Interim Action Work Plan for Monitoring Well Reconnaissance and Site-Wide Groundwater Elevations (Interim Action Work Plan) (RETEC, 2004c) was submitted to the U.S. EPA on Dec. 3, 2004 and approved Feb. 22, 2005. ▪ The plan proposed data collection efforts designed to assess groundwater flow characteristics in the shallow unconfined aquifer and refine the hydrogeological conceptual site model.
2e	Development of RI/FS Work Plan	- Project Management Plan - Sampling and Analysis Plan - Quality Assurance Project Plan - Site Health and Safety Plan	Submitted (Awaiting Approval)	▪ The Project Management Plan and the Sampling and Analysis Plan are included in appendices to the RI/FS Work Plan. ▪ The Quality Assurance Project Plan (RETEC, 2005c) and Site-Specific Health and Safety Plan (RETEC, 2005d) were submitted to the U.S. EPA under separate cover on June 6, 2005 and June 13, 2005, respectively.

Note:

1. U.S. EPA, 2004b

AOC = Administrative Order on Consent (U.S. EPA, 2004a)
FS = feasibility study
GIS = geographic information systems
RAO = remedial action objective
RI/FS = remedial investigaiton/feasibility study

Table 2-1
Investigation Analyte List and Preliminary Screening Levels

		Human Health				Ecological Aquatic Life Criteria					Ecological Sediment Criteria				Human Health		Ecological	
	Reporting	Groundwater		Target Groundwater Concentration Protective of Indoor Air		Surface Water (Freshwater)		Surface Water (Marine)		Reporting	Sediment (Freshwater)		Sediment (Marine)		Soil		Soil[5]	
List of Constituents and Respective Analytical Methods	Limit for Aqueous Samples (µg/L)	Screening Level (µg/L)	Screening Level Source[1]	Screening Level (µg/L)	Screening Level Source[7]	Screening Level (µg/L)	Screening Level Source[2]	Screening Level (µg/L)	Screening Level Source[2]	Limit for Solid Samples (mg/kg)	Screening Level (mg/kg)	Screening Level Source[3]	Screening Level (mg/kg)	Screening Level Source[3]	Screening Level (mg/kg)	Screening Level Source[4]	Screening Level (mg/kg)	Screening Level Source[6]
Volatile Organic Compounds (8260B)																		
1,1,1-Trichloroethane	1	3171.7	1	3100	7	62	2B	NA	-	0.025	0.17	3B	NA	-	1200	4	NA	-
1,1,2,2-Tetrachloroethane	0.5	0.1	1	30	7	420	2B	NA	-	0.05	0.94	3B	NA	-	0.93	4	NA	-
1,1,2-Trichloroethane	1	0.2	1	41	7	1200	2A	NA	-	0.025	NA	-	NA	-	1.6	4	NA	-
1,1-Dichloroethane	1	811.0	1	2200	7	47	2A	NA	-	0.025	NA	-	NA	-	1700	4	NA	-
1,1-Dichloroethene	1	339.0	1	190	7	25	2A	NA	-	0.025	NA	-	NA	-	410	4	NA	-
1,2,3-Trichlorobenzene	1	NA	-	NA	7	NA	-	NA	-	0.05	NA	-	NA	-	NA	-	20	6B
1,2,4-Trichlorobenzene	1	7.2	1	3400	7	NA	-	NA	-	0.05	9.2	3B	NA	-	220	4	20	6B
1,2-Dibromo-3-chloropropane	2	0.05	1	33	7	NA	-	NA	-	0.1	NA	-	NA	-	2	4	NA	-
1,2-Dibromoethane	1	0.01	1	3.6	7	NA	-	NA	-	0.025	NA	-	NA	-	0.073	4	NA	-
1,2-Dichlorobenzene	1	370.1	1	2600	7	14	2B	NA	-	0.025	0.34	3B	0.023	3C	600	4	NA	-
1,2-Dichloroethane	0.5	0.1	1	23	7	910	2A	NA	-	0.025	NA	-	NA	-	0.6	4	NA	-
1,2-Dichloropropane	1	0.2	1	35	7	NA	-	NA	-	0.025	NA	-	NA	-	360	4	700	6A
1,3-Dichlorobenzene	1	183.0	1	830	7	71	2B	NA	-	0.025	1.7	3B	NA	-	600	4	NA	-
1,4-Dichlorobenzene	0.5	0.5	1	8200	7	15	2B	NA	-	0.025	0.35	3B	0.031	3C	7.9	4	20	6A
2-Butanone	10	6968.1	1	440000	7	NA	-	NA	-	0.25	NA	-	NA	-	110000	4	NA	-
2-Hexanone	10	NA	-	NA	7	99	2A	NA	-	0.25	NA	-	NA	-	NA	-	NA	-
4-Methyl-2-pentanone	10	1993.0	1	14000	7	NA	-	NA	-	0.25	NA	-	NA	-	47000	4	NA	-
Acetone	10	5475.0	1	220000	7	1500	2A	NA	-	0.25	NA	-	NA	-	54000	4	NA	-
Benzene	0.4	0.4	1	14	7	46	2B	NA	-	0.013	NA	-	NA	-	1.4	4	NA	-
Bromochloromethane	1	NA	-	0.84	7	NA	-	NA	-	0.025	NA	-	NA	-	NA	-	NA	-
Bromodichloromethane	0.5	0.2	1	21	7	NA	-	NA	-	0.025	NA	-	NA	-	1.8	4	NA	-
Bromoform	1	8.5	1	0.083	7	NA	-	NA	-	0.025	NA	-	NA	-	218.2	4	NA	-
Bromomethane	3	8.7	1	14	7	19	2B	NA	-	0.1	NA	-	NA	-	13.1	4	NA	-
Carbon Disulfide	2	1000.0	1	560	7	0.92	2A	NA	-	0.1	NA	-	NA	-	720	4	NA	-
Carbon Tetrachloride	1	0.2	1	5	7	240	2B	NA	-	0.025	NA	-	NA	-	0.5	4	1000	6A
Chlorobenzene	0.5	110.0	1	390	7	130	2B	NA	-	0.025	0.82	3B	NA	-	530.5	4	40	6A
Chloroethane	1	4.6	1	28000	7	NA	-	NA	-	0.01	NA	-	NA	-	6.5	4	NA	-
Chloroform	1	0.2	1	80	7	28	2A	NA	-	0.025	NA	-	NA	-	0.47	4	NA	-
Chloromethane	1	160.0	1	67	7	NA	-	NA	-	0.025	NA	-	NA	-	160	4	NA	-
cis-1,2-Dichloroethene	1	61.0	1	180	7	NA	-	NA	-	0.025	NA	-	NA	-	150	4	NA	-
cis-1,3-Dichloropropene	0.5	0.4	1	8.4	7	23	2A	NA	-	0.025	NA	-	NA	-	1.8	4	NA	-
Dibromochloromethane	0.5	0.1	1	32	7	NA	-	NA	-	0.025	NA	-	NA	-	2.6	4	NA	-
Dichlorodifluoromethane	1	390.0	1	14	7	NA	-	NA	-	0.025	NA	-	NA	-	308.1	4	NA	-
Ethylbenzene	1	1300.0	1	700	7	290	2B	NA	-	0.025	3.6	3B	NA	-	400	4	NA	-
Isopropylbenzene	1	660.0	1	33000	7	NA	-	NA	-	0.025	NA	-	NA	-	2000	4	NA	-
m,p-Xylene	2	NA	-	22000	7	1.8	2B	NA	-	0.05	NA	-	NA	-	NA	-	NA	-
Methyl tert-Butyl Ether	5	11.0	1	120000	7	NA	-	NA	-	0.04	NA	-	NA	-	70	4	NA	-
Methylene Chloride	5	4.3	1	3300	7	2200	2A	NA	-	0.1	NA	-	NA	-	20.5	4	NA	-
o-Xylene	1	NA	-	33000	7	NA	-	NA	-	0.025	NA	-	NA	-	NA	-	NA	-
Styrene	1	1600.0	1	8900	7	NA	-	NA	-	0.025	NA	-	NA	-	1700	4	300	6A
Tetrachloroethene	1	0.1	1	11	7	120	2B	NA	-	0.025	0.53	3B	NA	-	1.3	4	NA	-
Toluene	1	720.0	1	1500	7	130	2B	NA	-	0.05	0.67	3B	NA	-	520	4	200	6A
trans-1,2-Dichloroethene	1	120.0	1	180	7	NA	-	NA	-	0.025	NA	-	NA	-	230	4	NA	-
trans-1,3-Dichloropropene	1	0.4	1	8.4	7	NA	-	NA	-	0.025	NA	-	NA	-	1.8	4	NA	-
Trichloroethene	1	0.028	1	5	7	NA	-	NA	-	0.025	1.6	3B	0.041	3	0.11	4	NA	-
Trichlorofluoromethane	1	1300.0	1	180	7	NA	-	NA	-	0.025	NA	-	NA	-	2000	4	NA	-
Vinyl Chloride	1	0.02	1	2.5	7	NA	-	NA	-	0.025	NA	-	NA	-	0.75	4	NA	-
Semivolatile Organic Compounds (8270C)																		-
2,4,5-Trichlorophenol	10	3600.0	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	62000	4	4	6B
2,4,6-Trichlorophenol	10	3.6	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	61.6	4	10	6A
2,4-Dichlorophenol	10	110.0	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	1800	4	20	6A
2,4-Dimethylphenol	10	730.0	1	NA	-	NA	-	NA	-	0.25	NA	-	0.029	3C	12000	4	NA	-
2,4-Dinitrophenol	70	73.0	1	NA	-	NA	-	NA	-	2	NA	-	NA	-	1200	4	20	6A
2,4-Dinitrotoluene	10	73.0	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	1200	4	NA	-
2,6-Dinitrotoluene	10	36.5	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	620	4	NA	-
2-Chloronapthalene	10	490.0	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	23000	4	NA	-
2-Chlorophenol	10	30.4	1	1000	7	NA	-	NA	-	0.25	NA	-	NA	-	240	4	10	6A
2-Methylnaphthalene	10	NA	-	3300	7	NA	-	NA	-	0.25	NA	-	0.0202	3	NA	-	NA	-
2-Methylphenol	10	1800.0	1	NA	-	13	2A	NA	-	0.25	NA	-	0.063	3C	31000	4	NA	-
2-Nitroaniline	10	110.0	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	1800	4	NA	-
2-Nitrophenol	10	NA	-	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	NA	-	NA	-

Table 2-1
Investigation Analyte List and Preliminary Screening Levels

		Human Health				Ecological Aquatic Life Criteria					Ecological Sediment Criteria				Human Health		Ecological	
	Reporting	Groundwater		Target Groundwater Concentration Protective of Indoor Air		Surface Water (Freshwater)		Surface Water (Marine)		Reporting	Sediment (Freshwater)		Sediment (Marine)		Soil		Soil[5]	
List of Constituents and Respective Analytical Methods	**Limit for Aqueous Samples (µg/L)**	**Screening Level (µg/L)**	**Screening Level Source[1]**	**Screening Level (µg/L)**	**Screening Level Source[7]**	**Screening Level (µg/L)**	**Screening Level Source[2]**	**Screening Level (µg/L)**	**Screening Level Source[2]**	**Limit for Solid Samples (mg/kg)**	**Screening Level (mg/kg)**	**Screening Level Source[3]**	**Screening Level (mg/kg)**	**Screening Level Source[3]**	**Screening Level (mg/kg)**	**Screening Level Source[4]**	**Screening Level (mg/kg)**	**Screening Level Source[6]**
3,3'-Dichlorobenzidine	10	0.1	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	3.8	4	NA	-
3-Nitroaniline	10	3.2	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	NA	-	NA	-
4,6-Dinitro-2-methylphenol	50	3.6	1	NA	-	NA	-	NA	-	2	NA	-	NA	-	NA	-	NA	-
4-Bromophenyl-phenylether	10	NA	-	NA	-	1.5	2B	NA	-	0.25	NA	-	NA	-	NA	-	NA	-
4-Chloro-3-methylphenol	10	NA	-	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	NA	-	NA	-
4-Chloroaniline	10	150.0	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	2500	4	NA	-
4-Chlorophenyl-phenylether	10	NA	-	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	NA	-	NA	-
4-Methylphenol	20	180.0	1	NA	-	NA	-	NA	-	0.3	NA	-	NA	-	3100	4	NA	-
4-Nitroaniline	10	3.2	1	NA	-	NA	-	NA	-	0.5	NA	-	NA	-	NA	-	NA	-
4-Nitrophenol	50	NA	-	NA	-	NA	-	NA	-	1	NA	-	NA	-	NA	-	7	6A
Acenaphthene	10	370.0	1	NA	-	23	2B	40	2B	0.25	NA	-	0.00671	3	29000	4	20	6A
Acenaphthylene	10	NA	-	NA	-	NA	-	NA	-	0.25	NA	-	0.00587	3	NA	-	NA	-
Anthracene	10	1800.0	1	NA	-	0.73	2A	NA	-	0.25	0.01	3A	0.0468	3	100000	4	NA	-
Benzo(a)anthracene	10	0.1	1	NA	-	0.027	2A	NA	-	0.25	0.0317	3	0.0748	3	2.1	4	NA	-
Benzo(a)pyrene	10	0.01	1	NA	-	0.014	2B	NA	-	0.25	0.0319	3	0.0888	3	0.2	4	12	6B
Benzo(b)fluoranthene	10	0.1	1	NA	-	NA	-	NA	-	0.25	NA	-	2.3	3C	2.1	4	NA	-
Benzo(g,h,i)perylene	10	NA	-	NA	-	NA	-	NA	-	0.25	NA	-	0.31	3C	NA	-	NA	-
Benzo(k)fluoranthene	10	0.9	1	NA	-	NA	-	NA	-	0.25	0.0272	3A	2.3	3C	21.1	4	NA	-
bis(2-Chloroethoxy) methane	10	NA	-	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	NA	-	NA	-
bis(2-Chloroethyl) ether	10	0.01	1	100	7	NA	-	NA	-	0.25	NA	-	NA	-	0.58	4	NA	-
bis-(2-Ethylhexyl)phthalate	10	4.8	1	NA	-	32	2B	NA	-	0.25	NA	-	0.182	3	120	4	NA	-
Butylbenzylphthalate	10	7299.9	1	NA	-	NA	-	NA	-	0.25	11	3B	0.049	3C	100000	4	NA	-
Chrysene	10	9.2	1	NA	-	NA	-	NA	-	0.25	0.0571	3	0.108	3	210	4	NA	-
Dibenzo(a,h)anthracene	10	0.01	1	NA	-	NA	-	NA	-	0.25	0.01	3	0.00622	3	0.21	4	NA	-
Dibenzofuran	10	12.0	1	NA	-	NA	-	NA	-	0.25	2	3B	0.15	3C	1600	4	NA	-
Diethylphthalate	10	29000.0	1	NA	-	220	2B	NA	-	0.25	0.63	3B	0.61	3C	100000	4	100	6A
Dimethylphthalate	10	360000.0	1	NA	-	NA	-	NA	-	0.25	NA	-	0.53	3C	100000	4	200	6A
Di-n-butylphthalate	10	3600.0	1	NA	-	NA	-	NA	-	0.25	11	3B	2.2	3C	62000	4	200	6A
Di-n-octylphthalate	10	1500.0	1	NA	-	NA	-	NA	-	0.25	NA	-	0.58	3C	25000	4	NA	-
Fluoranthene	10	1500.0	1	NA	-	8.1	2B	11	2B	0.25	0.111	3	0.113	3	22000	4	NA	-
Fluorene	10	240.0	1	NA	-	3.9	2B	NA	-	0.25	0.01	3	0.0212	3	26000	4	NA	-
Hexachlorobenzene	10	0.04	1	1	7	NA	-	NA	-	0.25	NA	-	0.0038	3C	1.1	4	1000	6A
Hexachlorobutadiene	10	0.9	1	3.3	7	NA	-	NA	-	0.25	NA	-	0.039	3C	22.1	4	NA	-
Hexachlorocyclopentadiene	30	220.0	1	50	7	NA	-	NA	-	1	NA	-	NA	-	3700	4	10	6B
Hexachloroethane	10	4.8	1	38	7	12	2B	NA	-	0.25	1	3B	NA	-	120	4	NA	-
Indeno(1,2,3-cd)pyrene	10	0.1	1	NA	-	NA	-	NA	-	0.25	0.0173	3A	0.34	3C	2.1	4	NA	-
Isophorone	10	71.0	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	510	4	NA	-
Naphthalene	10	6.2	1	150	7	24	2B	NA	-	0.25	0.0146	3A	0.0346	3	190	4	NA	-
Nitrobenzene	10	3.4	1	2000	7	NA	-	NA	-	0.25	NA	-	NA	-	100	4	40	6A
N-Nitroso-di-n-propylamine	10	0.01	1	NA	-	NA	-	NA	-	0.25	NA	-	NA	-	0.25	4	NA	-
N-Nitrosodiphenylamine	10	13.7	1	NA	-	210	2A	NA	-	0.25	NA	-	0.11	3C	350	4	20	6A
Pentachlorophenol	50	0.6	1	NA	-	6.7	2	7.9	2	1	NA	-	0.36	3C	9.0	4	0.0018	
Phenanthrene	10	NA	-	NA	-	6.3	2B	8.3	2B	0.25	0.0419	3	0.0867	3	NA	-	NA	-
Phenol	10	11000.0	1	NA	-	NA	-	NA	-	0.25	NA	-	0.42	3C	100000	4	30	6A
Pyrene	10	180.0	1	NA	-	NA	-	NA	-	0.25	0.053	3	0.153	3	29000	4	NA	-
Metals and Cyanide (6010B/6020, 7470A/7471A, 9010/9012A)																	-	
Aluminum	100	36000	1	NA	-	87	2	NA	-	2	25500	3A	NA	-	100000	4	NA	-
Antimony	1	15	1	NA	-	30	2A	NA	-	0.1	0.16	3A	NA	-	410	4	0.25	
Arsenic	10	0.04	1	NA	-	150	2	36	2	1.8	5.9	3	NA	-	1.6	4	18	
Barium	3	2600	1	NA	-	4	2A	NA	-	0.3	NA	-	NA	-	67000	4	330	
Beryllium	1	73	1	NA	-	0.66	2A	NA	-	0.1	NA	-	NA	-	1900	4	10	6A
Cadmium	2	18	1	NA	-	0.27	2	8.8	2	0.2	0.596	3	NA	-	450	4	0.36	
Calcium	1000	NA	-	NA	-	NA	-	NA	-	30	NA	-	NA	-	NA	-	NA	-
Chromium VI	4	110	1	NA	-	11	2	50	2	0.4	37.3[a]	3	52.3[a]	3	64	4	0.4[a]	6A
Cobalt	1	730	1	NA	-	3	2B	NA	-	0.5	NA	-	NA	-	1900	4	13	
Copper	6	1500	1	NA	-	9.3	2	3.1	2	0.6	35.7	3	NA	-	41000	4	60	6A
Iron	1000	11000	1	NA	-	1000	2	NA	-	10	188400	3A	NA	-	100000	4	200	6A
Lead	1	NA	-	NA	-	3.2	2	8.1	2	0.2	35	3	NA	-	800	4	11	
Magnesium	1000	NA	-	NA	-	NA	-	NA	-	30	NA	-	NA	-	NA	-	NA	-
Manganese	2	880	1	NA	-	80	2B	NA	-	0.2	630	3A	NA	-	19000	4	100	6A
Nickel	2	730	1	NA	-	52	2	8.2	2	0.2	18	3	NA	-	20000	4	30	6A
Potassium	1000	NA	-	NA	-	NA	-	NA	-	100	NA	-	NA	-	NA	-	NA	-

Table 2-1
Investigation Analyte List and Preliminary Screening Levels

		Human Health				Ecological Aquatic Life Criteria					Ecological Sediment Criteria				Human Health		Ecological	
	Reporting	Groundwater		Target Groundwater Concentration Protective of Indoor Air		Surface Water (Freshwater)		Surface Water (Marine)		Reporting	Sediment (Freshwater)		Sediment (Marine)		Soil		Soil[5]	
List of Constituents and Respective Analytical Methods	Limit for Aqueous Samples (µg/L)	Screening Level (µg/L)	Screening Level Source[1]	Screening Level (µg/L)	Screening Level Source[7]	Screening Level (µg/L)	Screening Level Source[2]	Screening Level (µg/L)	Screening Level Source[2]	Limit for Solid Samples (mg/kg)	Screening Level (mg/kg)	Screening Level Source[3]	Screening Level (mg/kg)	Screening Level Source[3]	Screening Level (mg/kg)	Screening Level Source[4]	Screening Level (mg/kg)	Screening Level Source[6]
Selenium	10	180	1	NA	-	5	2	71	2	0.5	NA	-	NA	-	5100	4	0.3	6B
Silver	2	180	1	NA	-	1.9	2B	1.9	2	0.1	NA	-	NA	-	5100	4	2	6A
Sodium	1000	NA	-	NA	-	NA	-	NA	-	100	NA	-	NA	-	NA	-	NA	-
Thallium	1	2.4	1	NA	-	12	2A	NA	-	0.02	NA	-	NA	-	67	4	1	6A
Vanadium	20	36	1	NA	-	19	2B	NA	-	3	NA	-	NA	-	1000	4	2	6A
Zinc	25	11000	1	NA	-	120	2	81	2	1	123.1	3	NA	-	100000	4	50	6A
Mercury (7470A)	0.2	11	1	0.68	7	0.77	2	0.94	2	0.04	0.174	3	NA	-	310	4	0.1	6A
Cyanide (4500-CN C,E)	5	730	1	NA	-	5.2	2	1	2	0.06	NA	-	NA	-	12000	4	NA	-

Notes:

1.(U.S. EPA, 2004e) Region 9 Tap Water Preliminary Remediation Goals (PRGs), October 2004.
2. (ADEC, 2003b) Aquatic Life Criteria for Fresh Waters, Table III of Alaska Water Quality Criteria Manual, May 15, 2003, unless noted
or ADEC Aquatic Life Criteria for Marine Waters, Table IV of Alaska Water Quality Criteria Manual, May 15, 2003, unless noted
2A. Suter and Tsao (1996) Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota, 1996 Revision Tier II Secondary Chronic Values
2B. (U.S. EPA, 1996b) OSWER Ecotox Threshold (ET) Surface Water Values
2C. (MacDonald et al., 2000) Development and Evaluation of Consensus based Sediment Quality Guidelines for Freshwater ecosystems. Archives of Environmental Contamination and Toxicology 39:20-31.
3. (ADEC, 2004a) Sediment Quality Guidelines (ADEC 2004) derived from Buchmann (1999) SQuiRT TEL values for freshwater and marine sediment unless otherwise indicated.
3A. No general TEL in SQuiRT table. Used TEL for *Hyalella azteca* 28 day test listed in same table.
3B. (U.S. EPA, 1996c) OSWER Sediment Quality Benchmark based on EPA Tier II Chronic Value (Region IV 1996), assuming 1% total organic carbon.
3C. (Washington Ecology, 1995) Sediment Management Standards. Chapter 173-204. Washington Administrative Code (WAC). Concentrations reported in ug/g organic carbon and were converted based on 1% organic carbon
4. (U.S. EPA, 2004e) Region 9 Industrial Soil PRGs. October 2004.
5. The ecological soil screening level is represented by the lowest of the soil values presented in Table 4-2.
6. All values presented are derived from U.S. EPA (2005) unless otherwise noted: U.S. EPA, 2005. Guidance for Developing Ecological Soil Screening Levels. Office of Emergency and Remedial Response Washington D.C. November 2003, Revised February 2005.
6A. (Efroymson et al., 1997) Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants. 1997 Revision ES/ER/TM-85/R3
6B. (Washington Department of Ecology, 2001) Terrestrial Ecological Evaluation Process: Interactive User's Guide. Washington State Department of Ecology. Toxics Cleanup Program.
7. U.S. EPA, 2002. Draft Guidance for Evaluating Vapor Intrusion from Subsurface Soil and Groundwater. November 2002. Table 2 (Target risk level = 10^{-5})

[a] Value is for total chromium.
Different screening levels may be used in the RI Report.
mg/kg = milligrams per liter
NA = not available
µg/L = micrograms per liter

Table 2-2
Supplemental Analyte List and Preliminary Screening Levels

		Human Health				Ecological Aquatic Life Criteria					Ecological Sediment Criteria				Human Health		Ecological	
	Reporting	Groundwater		Target Groundwater Concentration Protective of Indoor Air		Surface Water (Freshwater)		Surface Water (Marine)		Reporting	Sediment (Freshwater)		Sediment (Marine)		Soil		Soil[5]	
List of Constituents and Respective Analytical Methods	Limit for Aqueous Samples (µg/L)	Screening Level (µg/L)	Screening Level Source[1]	Screening Level (µg/L)	Screening Level Source[7]	Screening Level (µg/L)	Screening Level Source[2]	Screening Level (µg/L)	Screening Level Source[2]	Limit for Solid Samples (mg/kg)	Screening Level (mg/kg)	Screening Level Source[3]	Screening Level (mg/kg)	Screening Level Source[3]	Screening Level (mg/kg)	Screening Level Source[4]	Screening Level (mg/kg)	Screening Level Source[6]
Pesticides (8081A)																		
4,4'-DDD	0.03	0.28	1	NA	-	0.011	2A	NA	-	0.002	0.0035	3	0.00122	3	10	4	0.75	6B
4,4'-DDE	0.03	0.2	1	NA	-	NA	-	NA	-	0.002	0.0014	3	0.00207	3	7	4	0.75	6B
4,4'-DDT	0.03	0.2	1	NA	-	0.001	2	0.001	2	0.002	0.007	3	0.0019	3	7	4	0.75	6B
Aldrin	0.05	0.0043	1	0.71	7	3	2	1.3	2	0.0015	NA	-	NA	-	0.1	4	0.1	6B
alpha-BHC	0.03	0.011	1	31	7	NA	-	NA	-	0.0015	NA	-	NA	-	0.36	4	6	6B
alpha-Chlordane	0.03	NA	-	NA	-	0.0043	2	0.004	2	0.0015	NA	-	NA	-	NA	-	1	6B
beta-BHC	0.1	0.037	1	NA	-	NA	-	NA	-	0.0015	NA	-	NA	-	1.3	4	6	6B
delta-BHC	0.03	NA	-	NA	-	NA	-	NA	-	0.0015	NA	-	NA	-	NA	-	6	6B
Dieldrin	0.03	0.0042	1	8.6	7	0.056	2	0.0019	2	0.002	0.0019	3A	NA	-	0.11	4	0.000032	
Endosulfan I	0.03	219	1	NA	-	0.056	2	0.0087	2	0.0015	0.0029	3B	NA	-	3700	4	NA	-
Endosulfan II	0.03	219	1	NA	-	0.056	2	0.0087	2	0.002	0.014	3B	NA	-	3700	4	NA	-
Endosulfan sulfate	0.03	NA	-	NA	-	NA	-	NA	-	0.002	NA	-	NA	-	NA	-	NA	-
Endrin	0.03	11	1	NA	-	0.036	2	0.0023	2	0.002	0.00222	3A	NA	-	180	4	0.2	6B
Endrin aldehyde	0.05	NA	-	NA	-	NA	-	NA	-	0.002	NA	-	NA	-	NA	-	NA	-
Endrin ketone	0.03	NA	-	NA	-	NA	-	NA	-	0.002	NA	-	NA	-	NA	-	NA	-
gamma-BHC (Lindane)	0.03	0.052	1	110	7	0.95	2	1.6	2	0.0015	0.00094	3	0.00032	3	1.7	4	6	6B
gamma-Chlordane	0.03	0.19	1	NA	-	0.0043	2	0.004	2	0.0015	0.0045	3	0.00026	3	6.5	4	1	6B
Heptachlor	0.01	0.015	1	0.4	7	0.0038	2	0.0036	2	0.002	NA	-	NA	-	0.38	4	0.4	6B
Heptachlor epoxide	0.03	0.0074	1	NA	-	0.0038	2	0.0036	2	0.002	0.0006	3	NA	-	0.19	4	0.4	6B
Methoxychlor	0.03	180	1	NA	-	0.03	2	0.03	2	0.002	0.019	3B	NA	-	3100	4	NA	-
Toxaphene	0.1	0.061	1	NA	-	0.0002	2	0.0002	2	0.05	0.028	3B	NA	-	1.6	4	NA	-
Polychlorinated biphenyls (8082)																		
Aroclor-1016	0.1	0.96	1	NA	-	NA	-	NA	2	0.05 soil 0.02 sed.	NA	-	NA	-	29	4	NA	-
Aroclor-1221	0.1	NA	-	NA	-	NA	-	NA	2	0.05 soil 0.04 sed.	NA	-	NA	-	NA	-	NA	-
Aroclor-1232	0.1	NA	-	NA	-	NA	-	NA	2	0.05 soil 0.02 sed.	NA	-	NA	-	NA	-	NA	-
Aroclor-1242	0.1	NA	-	NA	-	NA	-	NA	2	0.05 soil 0.02 sed.	NA	-	NA	-	NA	-	NA	-
Aroclor-1248	0.1	NA	-	NA	-	NA	-	NA	2	0.05 soil 0.02 sed.	NA	-	NA	-	NA	-	NA	-
Aroclor-1254	0.1	0.034	1	NA	-	NA	-	NA	2	0.05 soil 0.02 sed.	NA	-	NA	-	NA	-	NA	-
Aroclor-1260	0.1	NA	-	NA	-	NA	-	NA	2	0.05 soil 0.02 sed.	NA	-	NA	-	NA	-	NA	-
Total PCBs	0.1	0.034	1	NA	-	0.14	2	0.03	2	0.05 soil 0.04 sed.	0.0341	3	0.02155	3	0.74	4	0.65	6B
Dioxins/Furans (8290)																		
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	50 pg/L	0.000045	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.0016	4A	NA	-
1,2,3,4,6,7,8-HpCDF	50 pg/L	0.000045	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.0016	4A	NA	-
1,2,3,4,7,8,9-HpCDF	50 pg/L	0.000045	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.0016	4A	NA	-
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	50 pg/L	0.0000045	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.00016	4A	NA	-
1,2,3,4,7,8-HxCDF	50 pg/L	0.0000045	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.00016	4A	NA	-
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	50 pg/L	0.0000045	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.00016	4A	NA	-
1,2,3,6,7,8-HxCDF	50 pg/L	0.0000045	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.00016	4A	NA	-
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	50 pg/L	0.0000045	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.00016	4A	NA	-
1,2,3,7,8,9-HxCDF	50 pg/L	0.0000045	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.00016	4A	NA	-
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	50 pg/L	0.00000045	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.00016	4A	NA	-
1,2,3,7,8-Pentachlorodibenzofuran	50 pg/L	0.000009	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.00032	4A	NA	-

Table 2-2
Supplemental Analyte List and Preliminary Screening Levels

		Human Health				Ecological Aquatic Life Criteria					Ecological Sediment Criteria				Human Health		Ecological	
	Reporting	Groundwater		Target Groundwater Concentration Protective of Indoor Air		Surface Water (Freshwater)		Surface Water (Marine)		Reporting	Sediment (Freshwater)		Sediment (Marine)		Soil		Soil[5]	
List of Constituents and Respective Analytical Methods	Limit for Aqueous Samples (µg/L)	Screening Level (µg/L)	Screening Level Source[1]	Screening Level (µg/L)	Screening Level Source[7]	Screening Level (µg/L)	Screening Level Source[2]	Screening Level (µg/L)	Screening Level Source[2]	Limit for Solid Samples (mg/kg)	Screening Level (mg/kg)	Screening Level Source[3]	Screening Level (mg/kg)	Screening Level Source[3]	Screening Level (mg/kg)	Screening Level Source[4]	Screening Level (mg/kg)	Screening Level Source[6]
2,3,4,6,7,8-HxCDF	50 pg/L	0.0000045	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.00016	4A	NA	-
2,3,4,7,8-PeCDF	50 pg/L	0.0000009	1	NA	-	NA	-	NA	-	5 ng/kg	NA	-	NA	-	0.000032	4A	NA	-
2,3,7,8-TCDD	10 pg/L	0.00000045	1	NA	-	NA	-	NA	-	1 ng/kg	NA	-	NA	-	0.000016	4	NA	-
2,3,7,8-Tetrachlorodibenzofuran	10 pg/L	0.0000045	1	NA	-	NA	-	NA	-	1 ng/kg	NA	-	NA	-	0.00016	4A	NA	-
OCDD	100 pg/L	0.0045	1	NA	-	NA	-	NA	-	10 ng/kg	NA	-	NA	-	0.16	4A	NA	-
OCDF	100 pg/L	0.0045	1	NA	-	NA	-	NA	-	10 ng/kg	NA	-	NA	-	0.16	4A	NA	-
Fuels (AK101/102/103, EPH/VPH)																		
Gasoline Range Organics (GRO)	50	NA	-	NA	-	NA	-	NA	-	1	NA	-	NA	-	NA	-	100	6B
Diesel Range Organics (DRO)	100	NA	-	NA	-	NA	-	NA	-	5	NA	-	NA	-	NA	-	200	6B
Residual Range Organics (RRO)	200	NA	-	NA	-	NA	-	NA	-	10	NA	-	NA	-	NA	-	NA	-
Extractable Petroleum Hydrocarbons	200	NA	-	NA	-	NA	-	NA	-	10	NA	-	NA	-	NA	-	NA	-
Volatile Petroleum Hydrocarbons	50	NA	-	NA	-	NA	-	NA	-	1	NA	-	NA	-	NA	-	NA	-

Notes:

1. (U.S. EPA, 2004e) Region 9 Tap Water Preliminary Remediation Goals (PRGs), October 2004.
2. (ADEC, 2003a) Aquatic Life Criteria for Fresh Waters, Table III of Alaska Water Quality Criteria Manual, May 15, 2003, unless noted or ADEC Aquatic Life Criteria for Marine Waters, Table IV of Alaska Water Quality Criteria Manual, May 15, 2003, unless noted

2A. Suter and Tsao (1996) Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota, 1996 Revision Tier II Secondary Chronic Values

3. ADEC Sediment Quality Guidelines (ADEC, 2004a) derived from Buchmann (1999) SQuiRT TEL values for freshwater and marine sediment unless otherwise indicated.

3A. (MacDonald et al., 2000) Development and Evaluation of Consensus based Sediment Quality Guidelines for Freshwater ecosystems. Archives of Environmental Contamination and Toxicology 39:20-31.

3B. (U.S. EPA, 1996c) Office of Solid Waste and Emergency Response (OSWER) Sediment Quality Benchmark based on EPA Tier II Chronic Value (Region IV 1996), assuming 1% total organic carbon.

3D. (Washington Ecology, 1995) Sediment Management Standards. Chapter 173-204. Washington Administrative Code (WAC). Concentrations reported in ug/g organic carbon and were converted based on 1% organic carbon

4. (U.S. EPA, 2004e) Region 9 Industrial Soil PRGs. October 2004.

4A. Chlorinated dioxins and furans were calculated using toxic equivalency factors based on 2,3,7,8-TCDD

5. The ecological soil screening level is represented by the lowest of the soil values presented in Table 4-2.
6. All values presented are derived from U.S. EPA (2005) unless otherwise noted: U.S. EPA, 2005. Guidance for Developing Ecological Soil Screening Levels. Office of Emergency and Remedial Response Washington D.C. November 2003, Revised February 2005.

6A. (Efroymson et al., 1997) Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants. 1997 Revision ES/ER/TM-85/R3

6B. (Washington Department of Ecology, 2001) Terrestrial Ecological Evaluation Process: Interactive User's Guide. Washington State Department of Ecology. Toxics Cleanup Program.

7. U.S. EPA, 2002. Draft Guidance for Evaluating Vapor Intrusion from Subsurface Soil and Groundwater. November 2002. Table 2 (Target risk level = 10^{-5})

Different screening levels may be used in the RI.
EPH = extractable petroleum hydrocarbons
NA = not available
ng/kg = nanograms per kilogram
pg/L = picograms per liter
Units are parts per billion (µg/L) or parts per million (mg/kg) unless otherwise specified.
VPH = volatile petroleum hydrocarbons

Table 2-3
Disposition of Railyard SWMUs / AOCs

Building or Location	Railyard SWMU / AOC Number and Designation		EPA and RFA Comments (A)	RFA Conclusion	Comments	Proposed Investigation in this RI	Proposed Soil Sample	Applicable Groundwater Location
Air brake shop	SWMU 7	Aerosol Can Collection Containers		NFA	-	-	-	-
Bearing shop	SWMU 18	Bearing Shop Centrifugal Degreaser		NFA	-	-	-	-
Bearing shop	SWMU 19	Bearing Shop Waste Grease Drum		NFA	-	-	-	-
Boiler shop	SWMU 43	Boiler Plant	X (L-M for soil)	FA	Located within active railyard with ongoing operations.	- Site inspection to review management of PCB materials and housekeeping practices. - Determine need for secondary containment for waste oil management - Groundwater migration addressed by "C" wells	Indoors. No sampling.	C1 and C2 are at downgradient locations near the facility margin.
Boiler shop (outside)	SWMU 70	Former Blowdown Sump	(H for soil and GW)	FA	Soil contamination in this area reportedly has been removed, as demonstrated with confirmation samples collected from the base of the excavation	Obtain and review documentation	-	C1 and C2 are at downgradient locations near the facility margin.
Boiler shop (outside)	SWMU 71	Compressor Room Drum		NFA		-		-
Boiler shop (outside)	SWMU 72	Former Waste Oil Underground Storage Tank	(H for soil, M for GW)	FA	Two 10,000-gal used oil tanks were excavated from the same pit. The tank and piping were determined to be in good condition and no evidence of leaks was observed. Results for samples collected at the base and side of the excavation were within cleanup levels established by the State (ARRC 1997) .	No further action	-	-
Boiler shop (outside)	SWMU 73	Former Waste Oil Underground Storage Tank	(H for soil, M for GW)	FA			-	-
Car shop	SWMU 20	Car Shop Air Room Hazardous Waste Storage Area	X (L for all media)	FA	Located within active railyard with ongoing operations.	Visual site inspection	Indoors. No sampling.	-
Car shop	SWMU 21	Car Shop Floor Drain		NFA		-		-
Diesel shop	SWMU 10	Diesel Shop Satellite Accumulation Area	(L for all media)	FA	RFA stated that location undergoing closure.	Review closure documentation	-	-
Diesel shop	SWMU 11	Diesel Shop Drum		NFA	-	-	-	-
Doll house	SWMU 35	Welding Shop Waste Storage	X (L for all media)	FA	Located within active railyard with ongoing operations.	-- Site inspection to review management and practices. - review need for secondary containment of waste oil tank - Groundwater migration addressed along "C" boundary	Indoors. No sampling.	C4 is at downgradient location at railyard boundary
Electric shop	SWMU 12	Electric Shop Caustic Accumulation Drum		NFA	-	-	-	-
Electric shop	SWMU 14	Electric Shop Oil Storage Tank	(L-M for soil and GW)	FA	No indication that releases have occurred (ARRC 1997). Tank located inside building with concrete floor. ARRC believes there is low potential for releases.	Visual site inspection	-	-

Table 2-3
Disposition of Railyard SWMUs / AOCs

Building or Location	Railyard SWMU / AOC Number and Designation		EPA and RFA Comments (A)	RFA Conclusion	Comments	Proposed Investigation in this RI	Proposed Soil Sample	Applicable Groundwater Location
Electric shop	SWMU 15	Former Oil Storage Containers	X (L for all media)	FA	No indication that releases have occurred (ARRC 1997), however, as noted in RFA, insufficient information to assess historical potential for releases	- Visual site inspection - Groundwater (and soil) sample immediately cross gradient	Indoors. No sampling.	E2 immediately cross-gradient to this SWMU
Electric shop	SWMU 17	Electric Shop Traction Motor Cleaning Area		NFA	-	-		-
Electric shop	SWMU 67	Electric Shop Oil/Water Separator	(U for soil and GW)	FA	Located within active railyard with ongoing operations. Perform evaluation as part of investigation of other related SWMUs in this area (i.e., 13, 14, 15), and integrate with overall railyard characterization.	- Visual site inspection - Groundwater (and soil) sample immediately cross gradient	Indoors. No sampling.	E2 immediately cross-gradient to this SWMU
Electric shop (outside)	AOC 1	Refueling Area	X	FA	Located within active railyard with ongoing operations.	Sampling of soil and groundwater at or near this location	Boring E4	E4 is located at the AOC location.
Electric shop (outside)	SWMU 13	Electric Shop Oil Collection Sump	(M for soil and GW)	FA	No indication that releases have occurred (ARRC 1997). Sump interior visually inspected, reportedly in good condition. ARRC believes there is low potential for releases.	- Visual site inspection - Sampling of soil and groundwater as part of co-located boring	Boring E2 near this location	E2 is located near this location
Engineering	SWMU 25	Engineering Shop Former Drum Storage Area		NFA	-	-	-	-
Engineering	SWMU 26	Engineering Shop Equipment Wash Area	X (U for soil)	FA	Located within active railyard with ongoing operations.	- Visual site inspection and review of management and housekeeping practices - Verify integrity of drain to OWS connection - Verify short-circuiting - No specific sampling. Groundwater migration covered at boundary.	Indoors. No sampling.	E20 is located downgradient near the boundary
Fueling Area	AOC 2	Former Refueling Area	X	FA	Located within active railyard	- Visual site inspection - Groundwater migration addressed by railyard boundary wells - Surface soil sampling	E5 and E6	E5 and E6
Fueling Area	AOC 3	Above Ground Storage Tank	X	FA	Located within active railyard with ongoing operations.	- Visual site inspection - Groundwater migration addressed by railyard boundary wells	-	E5 and E6
General repair shop	SWMU 1	Former General Repair Shop Absorbent Pad Accumulation Drums		NFA	-	-	-	-
General repair shop	SWMU 9	General Repair Shop Waste Storage Area		NFA	-	-	-	-
Heavy equipment shop	SWMU 22	Heavy Equipment Shop Floor Drain	X (H for soil and GW)	FA	Located within active railyard with ongoing operations. ARRC has information that supports contention that constituents in floor drain material was non-hazardous.	Site inspection and documentation of activities	Indoors. No sampling.	D4, E2, E3 and E4 are located down-, cross- and upgradient of building

Table 2-3
Disposition of Railyard SWMUs / AOCs

Building or Location	Railyard SWMU / AOC Number and Designation		EPA and RFA Comments (A)	RFA Conclusion	Comments	Proposed Investigation in this RI	Proposed Soil Sample	Applicable Groundwater Location
Heavy equipment shop	SWMU 23	Heavy Equipment Shop Former Drum Storage Area	X (L for all media)	FA	Located within active railyard with ongoing operations.	Visual site inspection	Indoors. No sampling.	D4, E2, E3 and E4 are located down-, cross- and upgradient of building
Heavy equipment shop	SWMU 24	Heavy Equipment Shop Drum Storage Area	(L for all media)	FA	Located within active railyard with ongoing operations. Storage area no longer active, but included concrete floor. Therefore, low potential for releases to soil or groundwater.	Visual site inspection	Indoors. No sampling.	D4, E2, E3 and E4 are located down-, cross- and upgradient of building
Heavy equipment shop	SWMU 27	Used Battery Totes	(L-M for soil)	FA	No indication that releases have occurred (ARRC 1997). Sampling reportedly conducted to verify lead contamination . ARRC reports that totes provide secondary containment and that there have been no releases	Obtain and review documentation	Indoors. No sampling.	D4, E2, E3 and E4 are located down-, cross- and upgradient of building
Heavy equipment shop	SWMU 63	Heavy Equipment Shop 400-Gallon Former Dip Tank	(M for soil)	FA	Located within active railyard with ongoing operations.	Visual site inspection	Indoors. No sampling.	D4, E2, E3 and E4 are located down-, cross- and upgradient of building
New ops bldg	AOC 4	Former Diesel Underground Storage Tank		FA	These sites were removed or addressed as part of construction of new operations building, and are all located within the footprint of the building or the parking lots. Tanks removed. Contaminated soil thermally treated, although relatively small amounts found. See Hart Crowser (2004) report "Soil Excavation and Exploration Assessment Report".	No further action	-	-
New ops bldg	AOC 5	Former Unleaded Gasoline Underground Storage Tank		FA		No further action	-	-
New ops bldg	AOC 7	Former Heating Oil Underground Storage Tank		FA		Review documentation to confirm this unit was removed as part of assessment	-	-
New ops bldg	SWMU 28	Former Bridges and Buildings Shop Drum Storage Area	X (L for all media)	FA		No further action	-	-
New ops bldg	SWMU 36	PCB Storage Area		NFA		-	-	-
Princess Tours (outside)	SWMU 39	Former Stockpile of Westours and Princess Tours Soil	X (L-M for soil)	FA	No indication that releases have occurred (ARRC 1997). Soils reportedly sampled to verify contaminant levels.	- Obtain and review documentation - Visual site inspection	-	C2 located downgradient at railyard boundary
Railyard (eastern)	SWMU 16	Oil Storage Tank Cars	(L-M for soil and GW)	FA	Located within active railyard with ongoing operations. Impacts from tank cars likely minimal. ARRC has noted that lead levels observed are "within background levels observed in the Anchorage Bowl (see documentation in ARRC 1997)."	- Obtain and review documentation	-	-

Table 2-3
Disposition of Railyard SWMUs / AOCs

Building or Location	Railyard SWMU / AOC Number and Designation		EPA and RFA Comments (A)	RFA Conclusion	Comments	Proposed Investigation in this RI	Proposed Soil Sample	Applicable Groundwater Location
Railyard (eastern)	SWMU 37	Contaminated Soil Stockpile	(M for soil, GW and air)	FA	ARRC stated that ten stockpiles were retested in 1995. The stockpiles were non-hazardous. One of the stockpiles (Track 13 Ballast, which was covered in plastic) was treated due to petroleum residue. The other 9 stockpiles met ADEC's cleanup levels for soil in the railyard and have been removed (see documentation in Attachment E of ARRC (1997).	No further action	-	-
Railyard (eastern)	SWMU 40	Former Onsite Landfill	(M for soil, GW and surface water)	FA	Exact location for this SWMU undetermined by either ARRC or EPA (ARRC 1997). Possibly associated with former gravel pit.	Evaluate documentation	-	-
Railyard (eastern)	SWMU 42	Barrel Farm	(H for soil, M-H for GW)	FA	Closure underway at time of RFA reportedly now complete	Verify closure data		-
Railyard (western)	SWMU 41	Railroad Tie Storage Area	(L-M for soil)	FA	No indication that releases have occurred. In addition, ARRC provided consultant's report titled "A Review of TCLP Testing of Railroad Crossties" that indicates a low potential for releases (see Attachment F to ARRC 1997).	No further action	-	-
Railyard (western)	SWMU 69	Former Tank Car Steaming Area Oil/Water Separator	(H for soil, GW and air)	FA	Located within active railyard with ongoing operations. Soil with elevated fuel residue reportedly was removed and treated in 1993 as part of the Westours property improvement (ARRC 1997).	- Evaluate documentation - Sampling of soil and GW	Boring E20 at this location	E20 at this location.
Railyard (western)	SWMU 65	Former Tank Car Steaming Area	(L-M for soil)	FA	Located within active railyard with ongoing operations. Groundwater impacts from area reportedly were addressed with installation of interceptor trenches (ARRC 1997). Concerns stated that SWMUs 65 and 69 have been confused with each other, or possibly with 68	- Evaluate documentation - Sampling of soil and GW	Boring E20 at this location	E20 at this location.
Railyard (western)	SWMU 8	Dumpsters		NFA		-		-
Steam cleaning area	SWMU 64	Tank Car Steaming Area	(L-M for soil and GW)	FA	Located within active railyard with ongoing operations.	- Site inspection to evaluate practices and management.	-	C2 and C3 are at downgradient locations near the facility margin.
Steam cleaning area	SWMU 66	Former Temporary Tank Car Steaming Area	(H for soil, L-M for GW)	FA	Located within active railyard with ongoing operations. Area reportedly cleaned up (see documentation in ARRC 1997).	No further action	-	-
Steam cleaning area	SWMU 68	Tank Car Steaming Area Oil/Water Separator		NFA	-	-	-	-
TOFC Bldg (outside)	AOC 6	Former Gasoline Underground Storage Tank	X	FA	Location uncertain. Reportedly removed.	- Review documentation and records to locate - Visual site inspection - Sampling for GW	-	C-7 located downgradient of presumed location

Table 2-3
Disposition of Railyard SWMUs / AOCs

Building or Location	Railyard SWMU / AOC Number and Designation		EPA and RFA Comments (A)	RFA Conclusion	Comments	Proposed Investigation in this RI	Proposed Soil Sample	Applicable Groundwater Location
Undetermined	SWMU 29	Former Boxcar 10631	(L or unknown for soil)	FA	Soils reportedly sampled to verify contaminant levels .	Obtain and review documentation	-	-
Undetermined	SWMU 30	Former Boxcar 10181	(L or unknown for soil)	FA			-	-
Undetermined	SWMU 31	Boxcar 10157	(L for all media)	FA			-	-
Undetermined	SWMU 32	Boxcar 10160	(L for all media)	FA			-	-
Undetermined	SWMU 33	Railcar 15780	(L or unknown for soil)	FA			-	-
Undetermined	SWMU 34	Railcar 15140	(L or unknown for soil)	FA			-	-
Various	SWMU 6	Scrap Metal Containers		NFA	-	-	-	-
Various	SWMUs 2 - 5	Sandblasting Machines		NFA	-	-	-	-
Various	SWMUs 42 - 62	Dip Tanks		NFA	-	-	-	-
	SWMU 38	Former Stockpile of Fuel Rack Soil	X (L-M for soil)	FA	ARRC stated (ARRC 1997) that soil was maintained at this location for approx. 9 months, and was frozen (likelihood of releases therefore minimal). When soil was removed, the liner was intact. VSI occurred shortly after soil was moved and impacts would have been noted at that time.	No further action	-	-

Notes:

1. The proposed remedial investigation sampling addresses potential off-site migration.

(A). SWMU or AOC specifically mentioned as a priority in EPA comment response July 19, 2005 denoted by "X" parenthesis presents summary of release potentials of SWMUs, as listed in RFA.
L: low, M: Medium, H: high, U: unknown

If no specific mention, low ("L") can be assumed.
AOC = area of concern
ARRC = Alaska Railroad Corporation
ARRC 1997, Letter from ARRC to M. Fagan, USEPA Region X RCRA Compliance Officer, February 21, 1997.
FA = further action
NFA = no further action
RFA = RCRA Facility Assessment
RI = remedial investigation
SWMU = solid waste management unit

Table 2-4
Summary of Leased Property Status

Investigation Area	GW Transect[1]	Grouping	RETEC Site No.	U.S. EPA Site Name	RFA Status	Downgradient Migration (Transect)	On-site (infill) Sampling	Other Sampling or Investigation	Supplemental Information
1	Not on transect	Isolated properties	LP-037	21st Century Trust	NFA	No specific sampling	No specific sampling	-	-
			LP-061	MOA City Dock	NFA	No specific sampling	No specific sampling	-	-
		Area 1 industrial properties	LP-002	Consolidated Freightways	Further action	No specific sampling	No specific sampling	Visual inspection	-
			LP-093	M-I LLC	Further action	No specific sampling	No specific sampling	Visual inspection	-
			LP-119	MOA (Substation)	NFA	No specific sampling	No specific sampling	Visual inspection	-
2	C	Railyard Process Area	RY-065	ARRC	See Table 2-13 for details on ARRC railyard SWMUs				Review of Elmendorf data for background and migration of contaminant on to railyard
			LP-065	Princess Tours	Further action	C-1 through C-3	No specific sampling	-	-
3	Not on transect	East of Ocean Dock Rd.	LP-025	Chevron USA	Further action	Existing monitoring data	2 surface soil at west boundary, per EPA request	-	ADEC Monitoring site
			LP-004	MAPCO (FROG)	NFA	A-3, A-4 and D-1 partial coverage	No. Off-site migration is key concern	-	-
			LP-027	Chevron USA	Further action	Existing monitoring data	No. Off-site migration is key concern	-	ADEC Monitoring site. Groundwater data collected since SBR will be included in RI Report. Analyte list meeting RI requirements will be requested.
			LP-016	Chevron USA (ROW)	Further action	Existing monitoring data	No. Off-site migration is key concern	-	-
			LP-138	Tesoro Alaska Pipeline Co.	NFA	No specific sampling	No concerns noted	-	-
		North End	LP-103	Lone Star	NFA	No specific sampling	No specific sampling	-	-
			LP-019	Tesoro Alaska Petroleum	Further action	E-17 and E-18	1 surface soil sample at west boundary per EPA request	-	ADEC Monitoring site. Groundwater data collected since SBR will be included in RI Report. Analyte list meeting RI requirements will be requested.
		West of Ocean Dock Rd	LP-003/005	Williams Alaska / MAPCO	Further action	Existing monitoring data. A-1 and A-2 partial coverage	No. Off-site migration is key concern	-	ADEC Monitoring site. Groundwater data collected since SBR will be included in RI Report. Analyte list meeting RI requirements will be requested.
			LP-007	Lone Star Northwest	NFA	No specific sampling	No. Off-site migration is key concern	-	-
		Undeveloped	LP-059	MOA Tidelands	NFA	No specific sampling	No specific sampling	-	Undeveloped intertidal area
	A	North of Ship Creek	LP-060	North Star Terminal	Further action	A-1 and A-2	No specific sampling	-	-
			LP-068	Premier Industries	Not noted	A-3	No specific sampling	-	-
			LP-084	Swan Bay Holdings	Not noted	A-3	No specific sampling	-	-
			LP-101	Swan Bay Holdings	Not noted	A-2	No specific sampling	-	-
4	A	South of Post Rd. - discharge to marsh areas	LP-017	Polar Equipment	Further action	A-26	No specific sampling	Off-channel sediment D-2 through D-4	-
			LP-018	LH Construction	Further action	A-26	E-15	Off-channel sediment D-2 through D-5	-
			LP-024	Prescott Equipment	Further action	A-24 and A-25	No specific sampling	Off-channel sediment D-1 through D-3	-
			LP-029	Polar Equipment (Truck Services)	NFA	A-25 and A-26	No specific sampling	Off-channel sediment D-2 through D-4	Possible contaminant source to marsh (Habitat Survey)
			LP-036	Longstaff	NFA	A-25 (cross gradient)	No specific sampling	Off'channel sediment D-1 through D-4	-
			LP-066	Welding School	NFA	A-26	No specific sampling		-
			LP-076	Guardian Security	NFA	A-25	No specific sampling		-
	A	North of Post Rd.	LP-015	Inlet Construction	Further action	No specific sampling	No specific sampling	-	-
			LP-032	Eyak Trucking / Allison's	NFA	No specific sampling	No specific sampling	-	-
			LP-011	Auto Electric	Noted but NFA	No specific sampling	No specific sampling	-	Floor drain potential source
			LP-044	Inlet Glass & Millwork	NFA	No specific sampling	No specific sampling	-	-
			LP-053	F&M Small Engine	NFA	No specific sampling	No specific sampling	-	-
	A	East End of Post Rd.	LP-031	Keystone	Further action	A-29	E-16	-	-
			LP-020	Wholesale Distributors	Further action	A-29	No specific sampling	-	-
			LP-030	Denali Trans-portation	NFA				-
			LP-051	Great Land Fence	Further action				-
	A	East End of Post Rd.	LP-074	DiTomaso	NFA				-
			LP-110	Bob Benson Trucking	Further action			Off-channel sediment E-2	Occupies portions of ex-Standard Steel site
			LP-136	Hickel C	NFA			-	-

Table 2-4
Summary of Leased Property Status

Investigation Area	GW Transect[1]	Grouping	RETEC Site No.	U.S. EPA Site Name	RFA Status	Downgradient Migration (Transect)	On-site (infill) Sampling	Other Sampling or Investigation	Supplemental Information
4	B	East of Marsh area	**LP-056**	Steel Fabricators	Further action	A-27, A-28	A-27 and A-28 located within lease	-	-
			LP-033	The Sumiko Group/ Air Van Lines	Further action	A-27, A-28	No specific sampling	-	-
	B	West End of Area 4	**LP-045**	Newbery Alaska	Further action	A-23, A-24	No specific sampling	-	-
			LP-050	Alaska Crate and Pallet	Further action	No specific sampling	A-24	-	-
			LP-063	Denali Leasing	NFA, but some action recom-mended	A-23	No specific sampling	-	Check files confirm old dump site
			LP-091	General Metals	Not noted	A-22, A-23		-	Review Phase 2 data
			LP-122	Jackovich	Not noted	A-22		-	-
	B	Southeast side	**LP-094**	Alaska Basic Industries	Further action	E-14	No specific sampling	-	-
			LP-028	Alaska DNR	NFA	n.a	n.a	-	Undeveloped marshland
			LP-099	Emulsion Products	NFA	No specific sampling		-	Worker letter on site practices
			LP-082	Summit Paving	NFA	B-20	No specific sampling	-	-
			LP-083	Pruhs Corp.	Further action	B-19	B-19 located in middle of property	-	-
	B	Southwest Side	**LP-072**	Karen's RV Service Center	Further action	B-18	B-18 collected on property	Visual Site Assessment	-
			LP-125	L&J Cabs / CPR Automotive	Further action	B-17	No specific sampling	-	ARRC considers it suspect
5	A	Near Cotenancy	**LP-043**	Alaska Truck Center	Further action	A-17, A-18	No specific sampling	-	-
			LP-127	Post Road Co - Tenancy	Further action	A-16 through A-18	All 3 wells located within lease	Off-channel sediment E-1	-
	A	South of Whitney Rd - migration to waste water pond	**LP-034**	CDF Inc.	Further action	A-14, A-14, E-22, E-23	No specific sampling	Off-channel sediment B-5	-
			LP-052	Patrick M. Hickey	Further action	E-11	E-11 located on lease	Off-channel sediment B-1-B-4	-
			LP-069	Dean's Automotive	Further action	A-11, A-12	E-7, E-8, E-9,	Off-channel sediment B-1-B-4	-
			LP-078	Criterion General, Inc.	Further action	E-10	No specific sampling	Off-channel sediment B-1-B-4	-
			LP-090	Ashley Home Stores	Further action	A-13, A-14	No specific sampling	Off-channel sediment B-1-B-4	-
			LP-123	CAT Transport	Further action	A-13	No specific sampling	Off-channel sediment B-1-B-4	-
			LP-991	Arctic Cooperage	Further action	E-22, E-23, A-13, A-14, A-15	E-20, E-21	Off-channel sediment B-4, B-5	-
	A	North of Whitney Rd.	**LP-008**	Craig Taylor Equipment	NFA	E-7, A-11	No specific sampling, C-4 is on north boundary	-	-
			LP-026	Alaska Teamster	Further action	E-20 to 23	E-12	-	-
			LP-079	Alaska Pride Baking	Further action	E-20 to 23	No specific sampling	-	Make tank removal records are complete. Look for potential upgradient sources here.
			LP-112	Whitney Enterprises	Further action	E-20 to 23	E-13	-	-
			LP-132	Whitney Road Warehouse	Noted as "open"	No specific sampling	No specific sampling	-	Fringe of railyard - recommend sampling
	A	South and East of Post Rd.	**LP-001**	Alaska Iron Works	NFA	A-21	No specific sampling	--	RFA incorrect address (address is LP-006 in RFA) at LP-001 - Sparks leasehold potential UST residual.
			LP-006	Joe's Body Paint and Frame	Further action	A-22			Previous EPA NOV, tenant following former rust proofing operation notified ARRC of drum removal -
			LP-035	Janssen Contracting	NFA	A-20			-
			LP-085	CBS Equipment	Further action	A-19, A-18			Determine if remediation system was installed and operational history
			LP-105	Saturn Construction	Further action	A-21			EPA has wrong site info in RFA. - floor
			LP-134	HW Alaska	Further action	A-20	E-24	-	-
			LP-040	Walsky Construction	NFA	No specific sampling	No specific sampling	-	-
	A	Between Whitney Rd. and Railroad	**LP-098**	Hayden (Warehouse)	Noted as "open"	No specific sampling	No specific sampling	Off-channel sediment sample C-1 to C-3	Possible runoff to ditch (Habitat Survey)
			LP-116	Suburban Propane	NFA	No specific sampling		Off-channel sediment sample C-1 and C-2	-
			LP-137	Laidlaw Transit	Further action	E-22, E-23, A-14, A-16		Future MNA sampling. Off-channel sediment sample C-3	-
			LP-022	Municipal Light & Power	Further action	B-9, B-10, B-11, B-12	B-12 located on the lease	-	Ongoing ADEC monitoring

Table 2-4
Summary of Leased Property Status

Investigation Area	GW Transect[1]	Grouping	RETEC Site No.	U.S. EPA Site Name	RFA Status	Downgradient Migration (Transect)	On-site (infill) Sampling	Other Sampling or Investigation	Supplemental Information
5	B	Near MPL site	**LP-055**	Altex Distributing	Further action	B-10, B-11	No specific sampling	-	-
			LP-077	Tire Centers	NFA	B-9		-	-
			LP-113	AAA Moving	NFA	B-10		-	Within ML&P area - get current data
			LP-135/041	Brado Properties	NFA	No specific sampling		-	-
	B	South side, East of Post Road	**LP-014**	UCSC / Motor Doctor	Further action	B-14	No specific sampling	-	-
			LP-109	Beat's Walking Automotive	Further action	B-14		-	-
			LP-048	Arrow Moving & Storage	NFA	B-13		-	-
			LP-092	Odom Corp.	Further action	B-15		-	-
			LP-115	Technic Services	Noted as "open"	B-12, B-13		Visual Site Assessment	-
			LP-010	Five Star Partnership	NFA	B-12, B-13		-	Former Don Chemicals and Van Waters and Rogers - past lessees
			LP-130	Plaschem Supply	Further action	B-13 (cross gradient)		-	-
6	A	Whitney Road	**LP-021**	Inupiat	NFA	A-10	No specific sampling	-	Review files
			LP-042	York Steel	Noted as "open"	A-10	No specific sampling	Visual Site Assessment	Review photos
			LP-131	Alaska Sheet Metal	Further action	A-10		-	-
			LP-120	KAPP LLC	Further action	A-8	A-8 located on property. 3 surface soils to be collected per EPA request	Off-channel sediment A-1 to A-3, and Ship Creek sediment S-4	-
			LP-049	Wrightway Auto Carriers	Further action	E-19, A-7, seep sample on Ship Creek bank	A-7 and E-19 located on lease	-	-
			LP-111	E.J. Bartells Co.	NFA	A-9, A-10	No specific sampling	-	-
			LP-139	Suburban Propane	NFA	A-9, A-10		-	-
	B	Ship Creek Avenue Leases	**LP-012**	Midnight Sun Tile	NFA	B-7	No specific sampling	-	-
			LP-013	Alaska Floor-Wall	NFA	B-8		-	-
			LP-038	JV Rentals	Noted as "open"	No specific sampling		-	-
			LP-070	Golden Ears Investment	Noted as "open"	B-7		-	-
			LP-080	Fleenor Paper Co.	NFA	-		-	New site data being collected for new tenant - will add to RI
			LP-087	Alaska Marble & Granite	NFA	B-6		-	-
			LP-089	Rock Partners	Noted as "open"	B-6		-	-
			LP-095	Bayview Commercial Building	NFA	B-8		-	Test laboratory operated in building
			LP-124	Alma Corp.	Noted as "open"	B-5, B-6		Visual Site Assessment	-
			LP-126	Bayview Parking Lot	NFA	B-8		-	-
			LP-128	Seamless Flooring	Further action	B-7		Visual Site Assessment	-
			LP-129	Statewide Door & Glass	NFA	B-6		-	-
			LP-133	Northrim Bank	NFA	B-7		-	-
			LP-073	Glass, Sash & Door Supply	NFA	B-8		-	-
	B	First Ave. Leases	**LP-107**	Safety Kleen, Inc.	Further action	B-4, B-5	No specific sampling	-	-
			LP-117	Walker Preflight	NFA	B-4, B-5		-	-
			LP-106	Trade Center	NFA	B-1, B-2		-	-
			LP-121	Nana Management Services	NFA	B-2, B-3		-	-
			LP-023	Denali Credit Union	NFA	n.a.	n.a.	-	Data from Ship Creek Intermodal studies to be added for RI
			LP-062	Anchorage Cold Storage	NFA	n.a.	n.a.	-	-
			LP-064	Anchorage Cold Storage	NFA	B-4, B-5	No specific sampling	-	-
	B	Near Ship Creek, south side	**LP-057**	Railroad Office Building	NFA	B-2	No specific sampling	-	Check files
			LP-058	Inn-Vestment Association	NFA	B-5		-	-
			LP-071	BDK Partnership	NFA	B-3		-	-
			LP-075	Ulu Factory	NFA	B-4		-	-
			LP-108	Covered Bridge	NFA	No specific sampling		-	Bridge: no surface or subsurface contact

Table 2-4
Summary of Leased Property Status

Investigation Area	GW Transect[1]	Grouping	RETEC Site No.	U.S. EPA Site Name	RFA Status	Downgradient Migration (Transect)	On-site (infill) Sampling	Other Sampling or Investigation	Supplemental Information
NA	Not on transect	Government Hill	**LP-009**	Anchorage Auto Detail	Further action	No	No	-	Property not within ARRC Terminal Reserve.
			LP-039	Anchorage Neighborhood	NFA	D-7 through D-10, SP-24	No specific sampling	-	-
			LP-047	Tesoro Northshore Co.	NFA	D-4 and D-5		-	-
			LP-054	MOA Greenbelt	NFA	D-1 through D-4		-	Undeveloped site. Complete review ARRC files and data
			LP-081	Video City	NFA	D-4 and D-5		-	Former Texaco gas station - likely not clean closed. Review reports for data adequacy
			LP-097	Lighthouse Christian Fellowship	NFA	D-4 and D-5		-	-
			LP-086	MOA Cottages	NFA	A-3		-	-
-	-	-	**LP-067**	Spenard Building Supply	Noted as "open"	-	-	-	-
			LP-088	World Net (Fiber Optic Lines)	NFA	-	-	-	-
			LP-096	Alaska Fiber Star LLC	Noted as "not investigated" but NFA	-	-	-	-
			LP-100	Signature Flight Support - Bulk Fuel Storage	NFA	-	-	-	-
			LP-102	Signature Flight Support	NFA	-	-	-	-
			LP-104	Williams Alaska Petroleum	NFA	-	-	-	-
			LP-114	Anchorage Fueling & Service Co.	NFA	-	-	-	-
			LP-118	Enstar Natural Gas Company	NFA	-	-	-	-
			LP-046	Alaska DNR	Note as "open" but removed from RFA	-	-	-	-

Notes:

1. Groundwater transects are discussed in Section 3 and shown on Figure 3-3.

ARRC = Alaska Railroad Corporation
GW = groundwater
NA = not available
NFA = no further action
MOA = Municipality of Anchorage
RFA = RCRA Facility Assessment
RI = remedial investigation
ROW = right-of-way
U.S. EPA = United States Environmental Protection Agency

Table 3-1
Sediment and Surface Water Investigation Details

Sediment Investigation Area	Preliminary Site Identifier	Investigation Rationale	Location/Description	Nearest Leased Property ID	Comments	Sediment Sample Collection Depth		Surface Water Sample	Access to Location	Sediment Sampling Method	Sediment Sample Analyses			Surface Water Analysis[1]		
						0" - 4"	4" - 12"				Investigation Analyte List	Supplemental Analyte List[4]	Additional Analyses[3]	Investigation Analyte List	Conventional Parameters	Supplemental Analyses
Off-Channel Areas Sediment Investigation																
KAPP Pond	S-A-1	Area with known residual contamination: determine if residual contamination present	West pond, center	LP-120	-	X	X	-	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH			-
	S-A-2		Central pond, center		-	X	X	X	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
	S-A-3		East pond, center		-	X	X	-	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH			-
Wastewater Pond	S-B-1	Area with known and suspected upgradient source areas; evidence of sheening; high ecological value; but no existing data	North end of pond	LP-069, 052, 123, 090, 991, and 034	Deepest part of pond	X	X	X	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
	S-B-2		South end, old outlet		Located near inactive outlet of pond	X	X	-	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH			-
	S-B-3		East arm of pond		Eastern lobe of pond, downgradient of LP-991	X	X	-	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH			-
	S-B-4		West end of marshy area		-	X	X	X	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
	S-B-5		East of marsh area, in old channel below LP-991		Downgradient of LP-991	X	X	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH			-
	S-B-6		Channel below outfall		Marshy areas below storm water outfall	X	X (if available)	X	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
Railroad Ditch	S-C-1	No existing data; potential source areas upgradient	East end of ditch	LP-098, 116, 137, 043, 127	-	X	X (if available)	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH			-
	S-C-2		Mid section of ditch		-	X	X (if available)	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH			-
	S-C-3		West end of ditch		-	X	X (if available)	X	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
Railroad Avenue Marsh	S-D-1	Area with upgradient source areas, evidence of contamination, high ecological value, but no existing data	Relict channel, West end	LP-024, 076, 036, 029, 066, and 056	Possible past discharge channel for marsh	X	X	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH			-
	S-D-2		West end of marshy area		Main body of marsh	X	X	X	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
	S-D-3		East end of marshy area		Near point of water seepage to Ship Creek	X	X	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
	S-D-4		Ditch area		Downgradient of evidence of contamination	X	X	X (if available)	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
Area E Misc. Area	S-E-1	Confirmation samples in areas downgradient of past source areas.	Old Std Steel ditch	Std Steel NPL site	PCBs reported in 1980s.	X	X	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH			-
	S-E-2		Relict channel, below Cotenancy	LP-127	Prior PCB source area located nearby (LP-127)	X	X	X (if available)	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
	S-E-3		Relict channel, below Alaska Sheet Metal	LP-042, LP-131	Downgradient of properties with possible past releases	X	X	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH			-
Ship Creek Sediment and Surface Water Investigation																
Ship Creek	S-S-1	Existing data needs to be complemented with sediment collected from defined "worst case" depositional zones. Unclear if prior data did this. Surface water data to provide better temporal coverage.	Lower channel (center) bl. RR	-	Lower intertidal area. No data available	X	-	-	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH			-
	S-S-2		Tidal channel, near C St. bridge	-	Lower tidal zone of creek, below all discharges	X	-	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
	S-S-3		Tidal channel, below dam	-	Upper tidal zone	X	-	-	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH			-
	S-S-4		Backwater area above dam	-	Key accumulation zone for fines	X	X (if available)	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH			-
	S-S-5		Sandy area above dam	-	Sand accumulation zone behind dam	X	-	X	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs

Table 3-1
Sediment and Surface Water Investigation Details

Sediment Investigation Area	Preliminary Site Identifier	Investigation Rationale	Location/Description	Nearest Leased Property ID	Comments	Sediment Sample Collection Depth		Surface Water Sample	Access to Location	Sediment Sampling Method	Sediment Sample Analyses			Surface Water Analysis[1]		
						0" - 4"	4" - 12"				Investigation Analyte List	Supplemental Analyte List[4]	Additional Analyses[3]	Investigation Analyte List	Conventional Parameters	Supplemental Analyses
Ship Creek Cont'd.	S-S-6	Existing data needs to be complemented with sediment collected from defined "conservative" depositional zones. Unclear if prior data did this. Surface water data to provide better temporal coverage.	Main channel below Area 2	-	Below potential source areas B and C	X	-	-	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH			-
	S-S-7		Main channel near RR bridge	-	Above potential source area B	X	-	-	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH			-
	S-S-8		Main channel above Post Rd.	-	Possible accumulation zones in upper creek	X	-	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
	S-S-9		Main channel below Area 4	-	Below potential source area D	X	-	-	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH			-
	S-S-10		Main channel above Std Steel	-	Above potential source area D and E	X	-	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
	S-S-12	Evaluate conditions in channel below outfall from KAPP pond and downgradient of LP-120	Main channel, below KAPP dam and outfalls	-	Below migration from Lp-120, and KAPP pond outfall. Also below ARRC/MOA stormwater outfall.	X	-	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
	S-S-13	Evaluate seep approximately 200 feet downgradient of Wrightway Auto (LP-049)	Seep south of Wrightway Auto (LP-049)	LP-049	-	X (if available)	X (if available)	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs
Ship Creek Background	SC-11	Current conditions in upgradient Ship Creek	Main channel, above Reeve Blvd. bridge	-	Background (upstream) of site	X	-	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	hardness, field[2]	PCBs

Notes:

1. Surface water samples will be analyzed for dissolved and total metals on the Investigation Analyte List.
2. "Field" denotes field measured parameters: temperature, dissolved oxygen, conductivity, pH and oxidation-reduction potential
3. Additional analyses will be conducted for sediment samples: total organic carbon (TOC) and grain-size distribution.
4. Includes constituents specified as a subset of the Supplemental Analyte List.

KAPP = Knik Arm Power Plant
NPL = National Priorities List
PCB = polychlorinated biphenyls
RR = railroad
TOC = total organic content

Table 3-2
Soil and Groundwater Investigation Details

											Sampling Rationale									**Groundwater Analyses**		**Soil Analyses**		
Groundwater Investigation Area	**Soil Investigation Area**	**Nearest Property ID**	**Preliminary Site Identifier**	**New or Existing Well**	**Drilling Method (HS/DP)**	**Surface Soil Sample Only**	**Proposed Soil Samples[1]**	**Geotech. Subsurface Soil Sample[2]**	**Proposed Groundwater Sample**	**Category[3] (A,B,C,D)**	***To provide GW elevation***	***To condcut tidal study***	***To investigate migration from source areas***	***To Investigate migration to downgradient areas***	***To provide infill data in areas of limited data or of special concern***	***To evalaute NAPL occurrence***	***To evaluate specific soil Issues***	***To provide background Data***	***To meet other data needs***	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Additional Analyses[6]**
Tank Farm	3	LP-060 North Star	**A-1**	New	HS	-	X	X	X	E	*X*	*-*	*X (BTEX from LP-060)*	*Cook Inlet*		*X*				BTEX, Lead, PAHs, EDB, 1,2DCA	EPH/VPH	BTEX, Lead, PAHs, EDB, 1,2DCA	EPH/VPH	X
Tank Farm	3	LP-101 C4 Swan Bay - Barge Docking	**A-2**	New	HS	-	X	X	X	E	*X*	*X*	*X (BTEX from Area 3 LP's)*	*Ship Creek*	*X*	*X*				BTEX, Lead, PAHs, EDB, 1,2DCA	EPH/VPH	BTEX, Lead, PAHs, EDB, 1,2DCA	EPH/VPH	X
Tank Farm	3	LP-084 Swan Bay Holding	**A-3**	New	DP	-	-	-	X	E	*X*	*-*	*X*	*Ship Creek*	*X*	*X*				BTEX, Lead, PAHs, EDB, 1,2DCA	EPH/VPH	BTEX, Lead, PAHs, EDB, 1,2DCA	-	-
N. of Ship Creek	2	RY-065 Railyard	**A-4**	New	HS	-	X	X	X	E	*X*	*X*	*X (sources in western rail yard)*	*Ship Creek*						X	EPH/VPH	X	EPH/VPH	X
N. of Ship Creek	6	RY-065 Railyard	**A-5**	New	HS	-	X	-	X	A	*X*	*-*	*X (sources in western rail yard)*	*Ship Creek*						X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	6	RY-065/LP-049 Railyard/ Wrightway Auto	**A-6**	New	DP	-	-	-	X	B	*X*	*-*	*X (sources in western rail yard)*	*Ship Creek and water supply well*		*X (based on oil seep info in RFA)*				X	EPH/VPH	-	-	-
N. of Ship Creek	6	LP-049 Wrightway Auto	**A-7**	New	HS	-	X	-	X	B	*X*	*-*	*X (sources in former USTs in LP-049)*	*Ship Creek*		*X (based on oil seep info in RFA)*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	6	LP-120 KAPP	**A-8**	New	HS	-	X	-	X	A,B	*X*	*-*	*X (sources in LP-120)*	*Ship Creek and pond*		*X*	*PCBs*			X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	6	LP-120 KAPP	**A-9**	New	HS	-	X	-	X	A,B	*X*	*-*	*X (sources in LP-120)*	*Ship Creek and pond*		*X*	*PCBs*			X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	6	LP-131 Alaska Sheet Metal	**A-10**	New	HS	-	X	-	X	B	*X*	*-*	*X (sources at LP-131)*	*Ship Creek*			*X (in local SWMU/AOC)*			X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	5	LP-069 Dean's Automotive	**A-11**	New	DP	-	-	-	X	B,D	*X*		*X (sources at LP-069 (reported pools of oil))*	*Ship Creek*		*X*				X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-069 Dean's Automotive	**A-12**	New	HS	-	X	-	X	D	*X*	*-*	*X (sources at LP-069 (reported pools of oil))*	*Ship Creek*		*X*			*Old pump house*	X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	5	LP-090	**A-13**	New	HS	-	X	-	X	D	*X*	*-*	*X*	*X (although no upgradeint source noted)*	*Random infill sample*					X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	5	LP-991 Artic Cooperage	**A-14**	Existing	-	-	-	-	X	B	*X*	*-*	*X (LP-991)*	*Ship Creek*		*X (Whitney Rd. plume)*				X	EPH/VPH, PCB	-	-	-
N. of Ship Creek	5	LP-034 CDF	**A-15**	Existing	-	-	-	-	X	B	*X*	*-*	*X (LP-034 and 137)*	*Ship Creek (identifeid in RFA as AOC due to proximity to sources)*		*X (Whitney Rd. plume)*				X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-127 Post Rd. Co-Tenancy	**A-16**	New	HS	-	X	-	X	A,B	*X*	*-*	*X (LP-127: although PCBs removed possible TCE)*	*Ship Creek*		*X (Whitney Rd. plume)*				X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	5	LP-127 Post Rd. Co-Tenancy	**A-17**	New	HS	-	X	-	X	A,B	*X*	*-*	*X (LP-127: although PCBs removed possible TCE)*	*Ship Creek*		*X (Whitney Rd. plume)*				X	EPH/VPH, PCB	X	EPH/VPH, PCB	-

Table 3-2
Soil and Groundwater Investigation Details

											Sampling Rationale									Groundwater Analyses		Soil Analyses		
Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Proposed Groundwater Sample	Category[3] (A,B,C,D)	*To provide GW elevation*	*To condcut tidal study*	*To investigate migration from source areas*	*To Investigate migration to downgradient areas*	*To provide infill data in areas of limited data or of special concern*	*To evalaute NAPL occurrence*	*To evaluate specific soil Issues*	*To provide background Data*	*To meet other data needs*	Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
N. of Ship Creek	5	LP-127 Post Rd. Co-Tenancy	**A-18**	New	HS	-	X	-	X	A,B	*X*	-	*X (LP-127: although PCBs removed possible TCE)*	*Ship Creek*		*X (Whitney Rd. plume)*				X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	5	LP-040/LP-085 Walsky Constructions Equipment	**A-19**	New	HS	-	X	-	X	A	*X*	-	*X (former waste oil UST)*	*Ship Creek (possible TCE and PCE)*		*X*				X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	5	LP-085/LP-134 CBS Hw/HW Alaska	**A-20**	New	HS	-	X	-	X	A	*X*	-	*X (former gasoline UST)*	*Ship Creek (BTEX, GRO, mostly attenuated at this time*		*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	LP-105 Saturn Construction	**A-21**	New	HS	-	X	-	X	D	*X*	-	*X*	*Ship Creek*	*Random infill sample*	*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-006 Joe's Body Paint	**A-22**	New	HS	-	X	-	X	C	*X*	-	*X (LP-006)*	*Ship Creek*						X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-063 Denali Leasing	**A-23**	New	HS	-	X	-	X	D	*X*	-	*X*	*Ship Creek*	*Random infill sample*	*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-050 Alaska Crate and Pallet	**A-24**	New	HS	-	X	-	X	A	*X*	-	*X (LP-024)*	*Ship Creek*	*Random infill sample*					X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	4	LP-024 Prescott	**A-25**	New	HS	-	X	-	X	A	*X*	-	*X (LP-024)*	*Ship Creek*	*Random infill sample*					X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	4	LP-017 Polar Equipment	**A-26**	New	HS	-	X	-	X	A,D	*X*	-	*X (LP-017), authoirtatively placed well*	*Ship Creek*						X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-056 Steel Fabricator	**A-27**	New	HS	-	X	-	X	A,D	*X*	-	*X (LP-056, water supply from deep aquifer)*	*Ship Creek. Locate by VSI near SWMU 56-4*						X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-056 Steel Fabricator	**A-28**	New	HS	-	X	-	X	A,D	*X*	-	*X (LP-056, water supply from deep aquifer)*	*Ship Creek. Locate by VSI near SWMU 56-5*						X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-110 Bob Benson Trucking	**A-29**	New	DP	-	-	-	X	A	*X*	-	*X (LP-110 and former Standard Steel)*	*Ship Creek*						X	EPH/VPH	-	-	-
S. of Ship Creek	-	LP-057 Railyard Office Building	**B-1**	New	DP	-	-	-	X	D	*X*	-	*X*	*Ship Creek*	*Infill GW data*					X	EPH/VPH	-	-	-
S. of Ship Creek	-	LP-057 Railyard Office Building	**B-2**	New	DP	-	-	-	X	D	*X*	-	*X*	*Ship Creek*	*Infill GW data*					X	EPH/VPH	-	-	-
S. of Ship Creek	6	LP-071 BDK Partnership	**B-3**	New	DP	-	-	-	X	D	*X*	-	*X*	*Ship Creek*	*Infill GW data*					X	EPH/VPH	-	-	-
S. of Ship Creek	6	LP-075 Ulu Factory	**B-4**	New	DP	-	-	-	X	D	*X*	-	*X*	*Ship Creek*	*Infill GW data*					X	EPH/VPH	-	-	-
S. of Ship Creek	6	LP-058 Comfort Inn	**B-5**	New	DP	-	-	-	X	D	*X*	-	*X*	*Ship Creek*	*Infill GW data*					X	EPH/VPH	-	-	-

Table 3-2
Soil and Groundwater Investigation Details

Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Proposed Groundwater Sample	Category[3] (A,B,C,D)	***Sampling Rationale***									**Groundwater Analyses**		**Soil Analyses**		
											To provide GW elevation	*To condcut tidal study*	*To investigate migration from source areas*	*To Investigate migration to downgradient areas*	*To provide infill data in areas of limited data or of special concern*	*To evalaute NAPL occurrence*	*To evaluate specific soil Issues*	*To provide background Data*	*To meet other data needs*	Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
S. of Ship Creek	6	LP-129 Statewide Door and Glass	**B-6**	New	HS	-	X	X	X	D	*X*	*X*	*X*	*Ship Creek*	*Infill GW data*					X	EPH/VPH	X	EPH/VPH	X
S. of Ship Creek	6	LP-128 Seamless Flooring	**B-7**	New	HS	-	X	X	X	D	*X*	-	*X*	*Ship Creek*	*Infill soil and GW data*				*hydraulic conductivity*	X	EPH/VPH	X	EPH/VPH	X
S. of Ship Creek	6	LP-013 Alaska Floor-Wall	**B-8**	New	HS	-	X	-	X	D	*X*	-	*X*	*Ship Creek*	*Infill soil and GW data*					X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	6	LP-135 Rowan Pacific Decorators	**B-9**	Existing	-	-	-	-	X	D	*X*	-	*X*	*Ship Creek*						X	EPH/VPH	-	-	-
S. of Ship Creek	6	LP-113 AAA Moving	**B-10**	Existing	-	-	-	-	X	D	*X*	-	*X*	*Ship Creek*						X	EPH/VPH	-	-	-
S. of Ship Creek	5	LP-055 Altex Distributing	**B-11**	New	HS	-	X	-	X	B	*X*	-	*X (LP-022 former AST spill in 1964, possible BTEX source)*	*Ship Creek. Existing well if present, else drive point well*		*X (downgradient of former AST)*				X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	5	LP-022 ML&P	**B-12**	New	HS	-	X	X	X	A,B	*X*	-	*X (LP-022 possible BTEX source)*	*Ship Creek. Existing well if present, else drive point well*		*X (downgradient of former AST)*				X	EPH/VPH	X	EPH/VPH	X
S. of Ship Creek	5	LP-048 Air Van Lines	**B-13**	New	DP	-	-	-	X	D	*X*	-	*X*	*Ship Creek*						X	EPH/VPH	-	-	-
S. of Ship Creek	5	LP-109 Beat's Walking	**B-14**	New	HS	-	X	-	X	D	*X*	-	*X (minor potential, only some rusty drums reported)*	*Ship Creek*	*Infill soil and GW data*					X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	5	LP-092 Odom	**B-15**	Existing	-	-	-	-	X	D	*X*	-	*X*	*Ship Creek*	*Infill GW data*					X	EPH/VPH	-	-	-
S. of Ship Creek	4	LP-092 Odom	**B-16**	Existing	-	-	-	-	X	D	*X*	-	*X*	*Ship Creek*	*Infill GW data*					X	EPH/VPH	-	-	-
S. of Ship Creek	4	LP-125 L&J Cabs	**B-17**	New	HS	-	X	-	X	A	*X*	-	*X (four former USTs)*	*Ship Creek*	*Infill soil and GW data*	*X*				X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	4	LP-072 Karens RV	**B-18**	New	DP	-	-	-	X	A,D	*X*	-	*X (former USTs)*	*Ship Creek*		*X*				X	EPH/VPH	-	-	-

Table 3-2
Soil and Groundwater Investigation Details

Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Proposed Groundwater Sample	Category[3] (A,B,C,D)	***Sampling Rationale***									**Groundwater Analyses**		**Soil Analyses**		
											To provide GW elevation	*To condcut tidal study*	*To investigate migration from source areas*	*To Investigate migration to downgradient areas*	*To provide infill data in areas of limited data or of special concern*	*To evalaute NAPL occurrence*	*To evaluate specific soil Issues*	*To provide background Data*	*To meet other data needs*	Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
S. of Ship Creek	4	LP-083 Pruhs	**B-19**	New	HS	-	X	-	X	A	*X*	-	*X (above ground oil/water seprator*	*Ship Creek*		*X*				X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	4	LP-082 Summit Paving	**B-20**	New	DP	-	-	-	X	D	*X*	-	*X (also confirm results fromprevious pond investigation)*	*Ship Creek*	*Infill GW data*					X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**C-1**	New	HS	-	X	-	X	E	*X*	-	*Railyard sources*	*LP-120*	*Infill GW data*					X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	**C-2**	New	HS	-	X	-	X	E	*X*	-	*SWMU 39 sources*	*LP-120*						X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	**C-3**	New	HS	-	X	-	X	E	*X*	-	*SWMU 39 sources*	*LP-120*						X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	**C-4**	New	HS	-	X	X	X	E	*X*	*X*	*Railyard sources*	*LP-108 and other LP's*	*Infill soil and GW data*					X	EPH/VPH	X	EPH/VPH	X
N. of Ship Creek	5	RY-065 Railyard	**C-5**	New	DP	-	-	-	X	A	*X*	-	*Railyard sources and nearby AOC4, 5 and SWMU 28*	*Migration south of Whitney Rd.*						X	EPH/VPH	-	-	-
N. of Ship Creek	5	RY-065 Railyard	**C-6**	New	DP	-	-	-	X	A	*X*	-	*Railyard sources and nearby AOC4, 5 and SWMU 29*	*Migration south of Whitney Rd.*						X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-079, LP-116, LP-098	**C-7**	New	HS	-	X	-	X	D	*X*	-	*Railyard sources*	*Migration south of Whitney Rd.*	*Impacts related to AOC-6*	*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	RY-065 Railyard	**C-8**	New	HS	-	X	-	X	D	*X*	-	*Eastern Railyard sources*	*Migration to LP-132 and Whitney Rd area*	*Infill soil from eastern railyard*					X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	**C-9**	New	HS	-	X	X	X	E	*X*	*X*	*Eastern Railyard sources*	*Migration to Post Rd.*	*Infill soil data from eastern railyard*					X	EPH/VPH	X	EPH/VPH	X
N. of Ship Creek	2	RY-065 Railyard	**C-10**	New	HS	-	X	X	X	E	*X*	-	*OU-5 and eastern railyard sources*	*Migration to Post Rd.*	*Infill soil data from eastern railyard*					X	EPH/VPH	X	EPH/VPH	X
N. of Ship Creek	2	RY-065 Railyard	**C-11**	New	DP	-	-	-	X	E	*X*	-	*OU-5 seeps and TCE sources*	*Migration across railyard boundary*	*Infill soil data from eastern railyard*					X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**C-12**	New	HS	-	X	-	X	E	*X*	-	*OU-5 seeps and TCE sources*	*Migration across railyard boundary*	*Infill soil data from eastern railyard*					X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	2	RY-065 Railyard	**D-1**	New	HS	-	X	X	X	E	*X*	-	*Sources upgradient of ARRC*	*Towards A-4 and Ship Creek*	*Infill soil and GW data*		*Near SWMU 41*			X	EPH/VPH	X	EPH/VPH	X
N. of Ship Creek	2	RY-065 Railyard	**D-2**	New	DP	-	-	-	X	E	*X*	-	*Sources upgradient of ARRC*	*Migration onto railyard*						X	EPH/VPH	-	-	-

Table 3-2
Soil and Groundwater Investigation Details

											Sampling Rationale									Groundwater Analyses		Soil Analyses		
Groundwater Investigation Area	**Soil Investigation Area**	**Nearest Property ID**	**Preliminary Site Identifier**	**New or Existing Well**	**Drilling Method (HS/DP)**	**Surface Soil Sample Only**	**Proposed Soil Samples[1]**	**Geotech. Subsurface Soil Sample[2]**	**Proposed Groundwater Sample**	**Category[3] (A,B,C,D)**	***To provide GW elevation***	***To condcut tidal study***	***To investigate migration from source areas***	***To Investigate migration to downgradient areas***	***To provide infill data in areas of limited data or of special concern***	***To evalaute NAPL occurrence***	***To evaluate specific soil Issues***	***To provide background Data***	***To meet other data needs***	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Additional Analyses[6]**
N. of Ship Creek	2	RY-065 Railyard	**D-3**	New	DP	-	-	-	X	E	*X*	-	*Sources upgradient of railyard (including LP's on Government Hill)*	*Migration onto railyard*						X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**D-4**	Existing	-	-	-	-	X	E	*X*	-	*Sources upgradient of railyard (including LP's on Government Hill)*	*Migration onto railyard*	*Near SWMU 22, 23, 24, 27, and 63*					X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**D-5**	Existing	-	-	-	-	X	E	*X*	-	*Sources upgradient of railyard. Use existing well Tp-03.*	*Migration onto railyard*				*X*		X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**D-6**	New	HS	-	X	-	X	E	*X*	-	*Sources upgradient of ARRC*	*Upgradient of AOC2 and AOC3*						X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	**D-7**	New	DP	-	-	-	X	E	*X*	-	*Sources upgradient of ARRC*	*Migration onto railyard*				*X*	*Near SWMU 35*	X	EPH/VPH, Herbicides	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**D-8**	New	HS	-	X	-	X	E	*X*	-	*Sources upgradient of ARRC*	*Migration onto railyard*	*Infill soil and GW data*			*X*	*Near SWMU 16*	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	**D-9**	New	DP	-	-	-	X	E	*X*	-	*Sources upgradient of ARRC*	*Migration onto railyard*	*Infill GW data*			*X*	*Near SWMU 37*	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**D-10**	New	DP	-	-	-	X	E	*X*	-	*Sources upgradient of ARRC*	*Migration onto railyard*	*Infill GW data*			*X*		X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**D-11**	Existing	-	-	-	-	X	E	*X*	-	*Sources upgradient of ARRC*	*Migration onto railyard*					*Existing well MNW2 if available, else drier point*	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**D-12**	New	DP	-	-	-	X	E	*X*	-	*Sources upgradient of ARRC*	*Migration onto railyard*	*Infill GW data*			*X*	*At "knob"*	X	EPH/VPH, Pesticides	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**D-13**	Existing	-	-	-	-	X	E	*X*	-	*Sources in OU'5 area*	*Migration onto railyard*				*X*	*Use existing MW1 if availabel, else drive point*	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**E-1**	New	HS	-	X	-	X	E	*X*	-			*Infill well, based on visual inspection*					X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	**E-2**	New	HS	-	X	-	X	E	*X*	-			*Infill near fuel rack and electric shop SWMUs*	*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	**E-3**	New	HS	-	X	-	X	E	*X*	-				*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	**E-4**	New	HS	-	X	-	X	E	*X*	-				*X*				X	EPH/VPH	X	EPH/VPH	-

Table 3-2
Soil and Groundwater Investigation Details

Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Proposed Groundwater Sample	Category[3] (A,B,C,D)	*Sampling Rationale*									Groundwater Analyses		Soil Analyses		
											To provide GW elevation	*To condcut tidal study*	*To investigate migration from source areas*	*To Investigate migration to downgradient areas*	*To provide infill data in areas of limited data or of special concern*	*To evalaute NAPL occurrence*	*To evaluate specific soil Issues*	*To provide background Data*	*To meet other data needs*	Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
N. of Ship Creek	2	RY-065 Railyard	**E-5**	New	HS	-	X	-	X	E	*X*	-			*GW and soil data for AOC 2 and 3*	*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	**E-6**	New	HS	-	X	-	X	E	*X*	-				*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	LP-069 Dean's Automotive	**E-7**	New	HS	-	X	-	X	C	*X*	-			*Infill, LP-069 potential source*	*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	LP-069 Dean's Automotive	**E-8**	New	HS	-	X	-	X	C	*X*	-			*Infill, LP-069 potential source*	*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	LP-069 Dean's Automotive	**E-9**	New	HS	-	X	-	X	C	*X*	-			*Infill, LP-069 potential source*	*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	LP-078	**E-10**	New	HS	-	X	-	X	C	*X*	-			*Infill, LP-078 potential source*	*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-052 Patrick M. Hickey	**E-11**	New	HS	-	X	-	X	C	*X*	-			*Infill, LP-052 potential source*	*X*				X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	4	LP-026 Alaska Teamster	**E-12**	New	HS	-	X	-	X	C	*X*	-			*Infill, LP-026 potential source AOC 26-1*	*X (vicinity of Whiteny Rd. plume)*				X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	4	LP-112 Whitney Express	**E-13**	New	HS	-	X	-	X	C	*X*	-			*Infill, LP-112 potential source*	*X (vicinity of Whiteny Rd. plume)*				X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	4	LP-094 Alaska Basic Industries	**E-14**	New	DP	-	-	-	X	C	*X*	-	*X (LP-094)*	*X (LP-082)*		*X*				X	EPH/VPH	-	-	-
N. of Ship Creek	4	LP-018 LH Construction	**E-15**	New	HS	-	X	-	X	A	*X*	-	*X (Sources upgradient of LP-018)*		*Infill soil and GW data, LP-018*					X	EPH/VPH, PCB	X	EPH/VPH, PCB	-
N. of Ship Creek	4	LP-031 Keystone Services	**E-16**	New	HS	-	X	X	X	A	*X*	-	*X (Sources upgradient of LP-031)*		*Infill soil and GW, LP-031*					X	EPH/VPH, PCB	X	EPH/VPH, PCB	X
N. of Ship Creek	3	LP-019 Tesoro Terminal #1	**E-17**	New	HS	-	X	-	X	E	*X*	-	*X (LP-019)*	*Cook Inlet*						BTEX, Lead, PAHs, EDB, 1,2DCA	EPH/VPH	BTEX, Lead, PAHs, EDB, 1,2DCA	EPH/VPH	-
N. of Ship Creek	3	LP-019 Tesoro Terminal #1	**E-18**	New	HS	-	X	-	X	E	*X*	-	*X (LP-019)*	*Cook Inlet*						BTEX, Lead, PAHs, EDB, 1,2DCA	EPH/VPH	BTEX, Lead, PAHs, EDB, 1,2DCA	EPH/VPH	-
N. of Ship Creek	6	LP-049 Wrightway Auto	**E-19**	New	HS	-	X	-	X	B	*X*	-			*Infill soil and GW, LP-049 former USTs*	*X (previous oil seeps to Ship creek)*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	**E-20**	New	HS	-	X	-	X	E	*X*	-		*X (to LP-049)*	*SWMU 65/69 area*	*X*				X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	LP-991 Arctic Cooperage	**E-21**	Existing	-	-	-	-	X	B	*X*	-			*Sample existing well on LP-991*	*X*			*Evaluate MNA locations*	X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-991 Arctic Cooperage	**E-22**	Existing	-	-	-	-	X	B	*X*	-			*Sample existing well on LP-991*	*X*			*Evaluate MNA locations*	X	EPH/VPH	-	-	-

Table 3-2
Soil and Groundwater Investigation Details

											Sampling Rationale									**Groundwater Analyses**		**Soil Analyses**		
Groundwater Investigation Area	**Soil Investigation Area**	**Nearest Property ID**	**Preliminary Site Identifier**	**New or Existing Well**	**Drilling Method (HS/DP)**	**Surface Soil Sample Only**	**Proposed Soil Samples[1]**	**Geotech. Subsurface Soil Sample[2]**	**Proposed Groundwater Sample**	**Category[3] (A,B,C,D)**	***To provide GW elevation***	***To condcut tidal study***	***To investigate migration from source areas***	***To Investigate migration to downgradient areas***	***To provide infill data in areas of limited data or of special concern***	***To evalaute NAPL occurrence***	***To evaluate specific soil Issues***	***To provide background Data***	***To meet other data needs***	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Additional Analyses[6]**
N. of Ship Creek	5	LP-137 Laidlaw Transit	**E-23**	Existing	-	-	-	-	X	B	*X*	-	*X (LP-991, LP-137 sources)*	*Ship Creek*		*X*			*Evaluate MNA locations*	X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-134 HW Alaska LLC	**E-24**	Existing	-	-	-	-	X	A	*X*	-			*Sample existing well on LP-034*	*X*			*Evaluate MNA locations*	X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-991 Arctic Cooperage	**E-25**	Existing	-	-	-	-	X	B	*X*	-			*Sample existing well on LP-991*	*X*			*Evaluate MNA locations*	X	EPH/VPH	-	-	-
Tank Farm	3	LP-004, LP-019, LP-025, LP-103	**SS-01 SS-02 SS-03 SS-04**	-	-	X	-	-	-	E	-	-					*Request from EPA along Ocean Dock Rd.*			-	-	X	EPH/VPH	-
N. of Ship Creek	6	LP-120 KAPP	**SS-05 SS-06 SS-07**	-	-	X	-	-	-	-	-	-			*Soil on LP-120*		*Request from EPA on LP-120*			-	-	X	EPH/VPH	-
S. of Ship Creek	6	LP-049 Wrightway Auto	**SP-60**	-	-	-	-	-	X	C			*Previous seep migration from LP-049*	*Ship Creek*						X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	**SP-01, SP-24, SP-35, SP-40, and SP-48 (seeps)**	-	-	-	-	-	X	E	-	-	*Sources upgradient of ARRC*					*X*	*Spring / groundwater interactions*	X	EPH/VPH	-	-	-

Notes:

1. Includes surface and subsurface soil sampling.
2. Geotech. = geotechnical analyses including air-filled porosity, water-filled porosity, grain size, permeability, and soil dry-bulk density
3. Categories:
   A = Actively managed /NFA/Little interest in RFA
   B = Work started but incomplete dataset
   C = Interest in site and/or work requested but not started
   D = Not much interest in site but little or no information available
   E = Industrial Area - only interest is potential for off-site migration.
4. Includes all constituents on the Investigation Analyte List, with the exception of samples proposed in Area 3. Specific analyses proposed for samples collected in Area 3 are identified within the table. Groundwater samples will be analyzed for dissolved metals on the Investigation Analyte List.
5. Includes constituents specified as a subset of the Supplemental Analyte List:
   DRO = diesel range organics
   GRO = gasoline range organics
   PCB = polychlorinated biphenyls
   RRO = residual range organics
6. Additional analyses to be performed on a subsurface soil sample and will include the following geotechnical parameters: air-filled porosity, water-filled porosity, grain size distribution, permeability, and soil dry bulk density.

AOC = area of concern
AST = above ground storage tank
BTEX = benzene, toluene, ethylbenzene, and total xylenes
DP = direct push drilling method
GW = groundwater
HS = hollow-stem auger drilling method
LNAPL = light non-aqueous phase liquid
RFA = RCRA Facility Assessment
SWMU = solid waste management unit
TCE = trichloroethylene
UST = underground storage tank

Table 3-3
Surface Water and Sediment Data Quality Objectives

DQO Steps[a]	**Action**
State Problem(s)	1) Analytical data may not be adequate to develop list of constituents of potential concern (COPC). 2) The nature and extent of COPC which exceed relevant screening levels in wetland sediment and surface water of the riparian zones adjacent to Ship Creek have not been delineated. 3) The accumulation or downstream transport of COPC which exceed relevant screening levels in Ship Creek sediment and surface water has not been determined. 4) If COPC which exceed relevant screening levels exist in surface water or sediment, the data may not be sufficient to determine potential upgradient sources. 5) If COPC which exceed relevant screening levels exist in surface water or sediment, the data may not be sufficient to calculate potential human health or ecological risk. 6) The existing assessment of COPC in surface water and sediment may not be adequate to evaluate alternatives for any remedial action that may be necessary.
Identify the Decision(s)	1) Are analytical data adequate to screen for COPC? 2) Are COPC which exceed relevant screening levels present in riparian wetland areas adjacent to Ship Creek? 3) Are COPC which exceed relevant screening levels in surface water or sediment accumulations in Ship Creek? 4) If COPC which exceed relevant screening levels exist in surface water or sediments, can they be attributed to specific upgradient sources? 5) If COPC which exceed relevant screening levels exist in surface water or sediments, do they present an unacceptable human health or ecological risk? 6) If COPC present an unacceptable risk, are the data adequate to evaluate alternatives for remedial action?
Identify Input to Decision(s)	1) Review of data/information provided in historical documents including: • SAIC, 1996. *RCRA Facility Assessment Report*. Alaska Railroad Corporation. Prepared for U.S. Environmental Protection Agency by Science Applications International Corporation. U.S. EPA I.D. No. AKD 98176 7403. March 1996.

Table 3-3
Surface Water and Sediment Data Quality Objectives

DQO Steps[a]	Action
Identify Input to Decision(s) Cont'd.	• Booz-Alllen Hamilton, 2002. *RCRA Facility Assessment Report for Leased Properties*. Prepared for U.S Environmental Protection Agency by Booz-Allen Hamilton. U.S. EPA I.D. No. AKD 98176 7403. July 2002.RETEC, 2004. • RETEC, 2005*.* *Site Background Report*. March 21, 2005. • RETEC, 2004d. *North Boundary Assessment Groundwater and Soil Results*. December 3, 2004. • RETEC, 2004e. *Ship Creek Preliminary Habitat Assessment*. December 3, 2004. • Hart Crowser, 2004a. *Ship Creek Water and Sediment Assessment Report*, Anchorage, Alaska. May 2004. • Hart Crowser, 2004b. *Ship Creek Literature Review*, Alaska Railroad Corporation, April 2004. Document 8877. July 2004. • Other documents from Elmendorf Air Force Base, Fort Richardson, Municipality of Anchorage, Alaska Fish and Game, Alaska Highway Department, etc will be reviewed. 2) Analytical results from sediment sampling in wetland areas in riparian zone completed during the RI 3) Analytical results from focused surface water and sediment sampling in Ship Creek completed during the RI 4) Analytical results from groundwater sampling near Ship Creek 5) Water quality, quantity, and discharge data from MOA, Elmendork Air Force Base and water management agencies 6) Human health and ecological conceptual site models 7) Human health and ecological screening benchmarks (see Table 4-2)

Table 3-3
Surface Water and Sediment Data Quality Objectives

DQO Steps[a]	Action
Define Study Boundaries	**Lateral Boundary**: The Anchorage Terminal Reserve Site as defined in the Administrative Order of Consent, U.S. EPA Docket No. CERCLA 10-2004-0065 (Figure 1-1). The Ship Creek area includes Ship Creek itself and its adjacent undeveloped riparian zone from Reeve Blvd. to Knik Arm, including any associated ponds, marshes, or wetland areas **Vertical Boundary**: Sediment in Ship Creek is defined as accumulations of fine-grained mobile material in depositional zones. Sediment sampling focuses on the top 10 cm (deeper in potential scour zones) of biologically active sediment. Sediment in the riparian zone includes the entire accumulation of fine-grained sediment above the native alluvial gravel and cobble. **Temporal Boundary**: The samples collected and analyzed during the upcoming RI will be added to the dataset of valid historical data to evaluate the nature and extent of contaminants of concern, and human health and ecological risk.
Define Study Boundaries Cont.	**Analytical Boundary:** The lateral and vertical extent of those constituents listed on the U.S. EPA hazardous substance list of target analytes for Superfund Sites. The list is modified to be Site appropriate. Specific analytes, detection limits, and QA procedures are provided in the Quality Assurance Project Plan (QAPP) (RETEC, 2005c).
Develop a Decision Rule(s)	1) Are analytical data adequate to develop a list of COPC for Site characterization? *Yes.* Proceed with Site characterization and risk assessment *No.* Collect additional data as determined upon consultation with U.S. EPA. 2) Are the data adequate to evaluate the nature and extent of the COPC which exceed relevant screening levels in riparian zone wetlands and ponds? *Yes.* Proceed to risk assessment. *No.* Collect additional data as determined upon consultation with U.S. EPA. 3) Are the data adequate to evaluate COPC which exceed relevant screening in sediment accumulations and water in Ship Creek adjacent to and downstream of the site? *Yes* Proceed to risk assessment *No* Collect additional data in underrepresented areas upon consultation with U.S. EPA

Table 3-3
Surface Water and Sediment Data Quality Objectives

DQO Steps[a]	Action
Develop a Decision Rule(s) Cont.	4) If COPC exceed relevant screening levels in surface water or sediment, are the data adequate to identify potential upgradient sources *Yes* Delineate nature and extent of source area *No* Collect additional data in underrepresented areas upon consultation with U.S. EPA 5) If COPC exceed relevant screening levels in surface water or sediment, are the data sufficient to complete human health and ecological risk? *Yes.* Calculate human health and ecological risk *No*. Collect additional data in underrepresented areas as determined upon consultation with U.S. EPA 6) If an unacceptable human health or ecological risk is identified, are the data adequate to evaluate potential remedial action alternatives? *Yes.* Proceed with Feasibility Study and evaluation of remedial action alternatives. *No.* Collect additional data in underrepresented areas as determined upon consultation with U.S. EPA
Specify Tolerable Limits on Decision Errors	Quantitative limits on decision errors have not been calculated. However, for risk assessment and remedial action decisions the dataset is intended to be representative of the selected exposure areas. Total decision error will be minimized by controlling measurement errors and sampling design errors as follows: 1) Measurement errors will be identified and documented in accordance with the QAPP (RETEC, 2005c). Acceptable data will meet all criteria established in the QAPP. U.S. EPA Guidance for Data Quality Assessment – *Practical Methods for Data Analysis* (U.S. EPA, 1996d) will be used to establish the methodology for evaluating data outliers, censored data, and area coverage. The need for additional sampling will be determined upon review of acceptable data. The QAPP is intended to minimize decision errors resulting from measurement errors. 2) Sampling design errors with authoritative sampling based on professional experience and historical Site data. This sampling strategy will insure a distribution of samples in Ship Creek and associated wetland areas most representative of Site activities based on historical sampling and operational history. If initial sampling does not produce a representative dataset than additional sampling will be proposed.

Table 3-3
Surface Water and Sediment Data Quality Objectives

DQO Steps[a]	Action
Optimize Design for Obtaining Data	Water and sediment sampling program in the Ship Creek riparian area will be based on authoritative sampling (i.e., will be biased toward depositional areas as identified in the field at the time of sampling) of the location of known or suspected sources as determined through review of site history; spill/release history; site hydrogeology; previous investigation results. Water and sediment sampling of depositional areas in Ship Creek will be based on authoritative sampling of zones where there has been sufficient deposition of fine-grained, mobile sediments downstream of known or suspected sources of contaminants to Ship Creek. Additional sampling, if required, will be based on step-outs from RI sample locations to generate statistically representative data adequate for delineation of the nature and extent of COPC in sediment and surface water, identification of potential upgradient source, human health and ecological risk assessment, and evaluation of remedial action if necessary.

Note:

[a] U.S. EPA, 2000a

Table 3-4
Groundwater and LNAPL Data Quality Objectives

DQO Steps[a]	Action
State Problem(s)	1) Analytical data may not be adequate to develop a list of constituents of potential concern (COPC). 2) The nature and extent of dissolved phase COPC in groundwater that could migrate to Ship Creek or contribute to vapor intrusion is not fully delineated. 3) Background concentrations and the relative contribution of upgradient sources to dissolved phase COPC in groundwater beneath the Site may not be fully known. 4) Hydrogeologic conditions (e.g., groundwater flow regime, hydraulic conductivity, tidal influences, etc.) beneath the Site may not be understood to an extent which allows adequate development of conceptual site models (CSMs). 5) Human health and ecological risks for dissolved phase COPC beneath the Site, which may impact potential receptors via completed exposure pathways, are not fully calculated. 6) The distribution and type of LNAPL which may be a source of dissolved COPC may not be fully delineated at the Site 7) Groundwater and LNAPL data may not be adequate to evaluate alternatives for any remedial actions, including monitored natural attenuation (MNA), that may be required
Identify the Decision(s)	1) Are analytical data adequate to screen for COPC? 2) Are analytical data adequate to understand the nature and extent of dissolved phase COPC which could potentially migrate to Ship Creek or contribute to vapor intrusion? 3) Are analytical data adequate to calculate background concentrations and understand the relative contribution of upgradient dissolved phase COPC to the groundwater at the Site? 4) Are hydrogeologic conditions at the Site sufficiently known to develop CSMs? 5) If dissolved phase COPC are present beneath the Site and migrate to Ship Creek or other receptors via a completed pathways, are the analytical data adequate to calculate human health and ecological risk? 6) Is the distribution of LNAPL at the Site adequate to evaluate LNAPL a potential source to groundwater and soil vapors? 7) If groundwater or LNAPL present an unacceptable risk through exposure at Ship Creek or another pathway (e.g. vapor intrusion), are the groundwater and LNAPL data adequate to evaluate potential remedial actions including MNA?

Table 3-4
Groundwater and LNAPL Data Quality Objectives

DQO Steps[a]	Action
Identify Input to Decision	1) Review of data/information provided in historical documents including: • SAIC, 1996. *RCRA Facility Assessment Report*. Alaska Railroad Corporation. Prepared for U.S. Environmental Protection Agency by Science Applications International Corporation. U.S. EPA I.D. No. AKD 98176 7403. March 1996. • Booz-Alllen Hamilton, 2002. *RCRA Facility Assessment Report for Leased Properties.* Prepared for U.S Environmental Protection Agency by Booz-Allen Hamilton. U.S. EPA I.D. No. AKD 98176 7403. July 2002.RETEC, 2004*. Site Background Report*. October 15, 2004. • RETEC, 2005a*. Site Background Report*. March 21, 2005. • RETEC, 2004d. *North Boundary Assessment Groundwater and Soil Results*. December 3, 2004. • RETEC, 2004e. *Ship Creek Preliminary Habitat Assessment*. December 3, 2004. • Hart Crowser, 2004a. *Ship Creek Water and Sediment Assessment Report*, Anchorage, Alaska. May 2004. • Hart Crowser, 2004b. *Ship Creek Literature Review*, Alaska Railroad Corporation, April 2004. Document 8877. July 2004. • Other documents from Elmendorf Air Force Base, Fort Richardson, Municipality of Anchorage, Alaska Fish and Game, Alaska Highway Department, etc will be reviewed. 2) Analytical results from groundwater sampling to be conducted during the RI at selected locations at the Site and potential upgradient sources 3) Field studies including: aquifer testing, fluid level gauging, LNAPL analyses, and tidal influence study 4) Human health and ecological conceptual site models 5) Human health and ecological screening benchmarks (see Table 4-2)

Table 3-4
Groundwater and LNAPL Data Quality Objectives

DQO Steps[a]	Action
Define Study Boundaries	**Lateral Boundary**: The Anchorage Terminal Reserve Site as defined in the Administrative Order of Consent, U.S. U.S. EPA Docket No. CERCLA 10-2004-0065 (Figure 1-1). The upgradient boundary for groundwater evaluation is the south and north boundary of the Terminal Reserve. The downgradient boundary is Ship Creek and Knik Arm. **Vertical Boundary**: The RI groundwater investigation will evaluate the shallow saturated zone above the Bootlegger Cove Formation. **Temporal Boundary**: Fluid level sampling and gauging events will be conducted semiannually over a period of up to two years to evaluate seasonality and attenuation. **Analytical Constraints:** The lateral and vertical extent of those constituents listed on the U.S. EPA hazardous substance list of target analytes for Superfund Sites. The list is modified to be Site appropriate. Specific analytes, detection limits, and QA procedures are provided in the Quality Assurance Project Plan (QAPP) (RETEC, 2005c).
Develop a Decision Rule	1) Are the analytical data adequate to develop a list of COPC? *Yes.* Screen data to determine list of COPC and evaluate nature and extent *No.* Collect additional groundwater samples and analyze for a list of constituents adequate to develop a COPC list as determined upon consultation with U.S. EPA 2) Are the nature and extent of dissolved phase COPC at the Site that could migrate to Ship Creek or other receptors adequately delineated? *Yes.* Proceed with evaluation of upgradient sources, if necessary *No.* Additional sampling of groundwater to be determined upon consultation with U.S. EPA 3) Are background concentrations and the relative contribution of upgradient sources to dissolved phase COPC beneath the Site adequately characterized? *Yes.* Proceed with evaluation of exposure pathways and CSMs. *No.* Additional sampling of groundwater to be determined upon consultation with U.S. EPA

Table 3-4
Groundwater and LNAPL Data Quality Objectives

DQO Steps[a]	Action
Develop a Decision Rule cont.	4) Are hydrogeologic data adequate to develop CSMs? *Yes.* Develop CSMs and evaluate exposure pathways *No.* Additional hydrogeologic data to be collected as determined upon consultation with U.S. EPA 5) If completed exposure pathways to Ship Creek or upland areas (including vapor intrusion) are identified for groundwater with dissolved phase COPC, can the human health and ecological risk be calculated based on the existing dataset? *Yes.* Calculate risk *No.* Additional sampling of groundwater to be determined upon consultation with U.S. EPA 6) Is the distribution of LNAPL which may be a source to dissolved phase COPC delineated? *Yes.* Delineate LNAPL sources *No.* Additional gauging and sampling of LNAPL to be determined upon consultation with U.S. EPA 7) If groundwater or LNAPL present an unacceptable human health or ecological risk, are the groundwater and LNAPL data adequate to evaluate potential remedial action alternatives? *Yes.* Evaluate alternatives *No.* Additional data requirements to be determined upon consultation with U.S. EPA
Specify Tolerable Limits on Decision Errors	Quantitative limits on decision errors have not been calculated. However, for risk assessment and remedial action decisions the dataset is intended to be representative of the selected exposure areas. Total decision error will be minimized by controlling measurement errors and sampling design errors as follows: 1) Measurement errors will be identified and documented in accordance with the QAPP (RETEC, 2005c). Acceptable data will meet all criteria established in the QAPP. U.S. EPA Guidance for Data Quality Assessment – *Practical Methods for Data Analysis* (U.S. EPA, 1996d) will be used to establish the methodology for evaluating data outliers, censored data, and area coverage. The need for additional sampling will be determined upon review of acceptable data. The QAPP is intended to minimize decision errors resulting from measurement errors.

Table 3-4
Groundwater and LNAPL Data Quality Objectives

DQO Steps[a]	Action
Specify Tolerable Limits on Decision Errors cont.	2) Sampling design errors by combining systematic and authoritative sampling based on professional experience and historical Site data. This sampling strategy will insure a distribution of samples across the Site. If initial sampling does not produce a statistically representative dataset than additional sampling will be proposed.
Optimize Design for Obtaining Data	The groundwater and LNAPL data collection program will be to identify areas potential sources through a series of well transects and selected well locations based on review of Site operational history, spill/release history, Site hydrogeology, and visual observations at the time of sampling. Additional sampling, if required, will be based delineating upgradient sources based on groundwater analytical results, groundwater flow patterns, and potential risk to human health and the environment. Evaluation of the contribution of upgradient sources to dissolved COPC at the Site will be evaluated though monitoring of groundwater and seeps, as appropriate, along the North Bluffs. This data will also be used to evaluate background conditions at the railyard. Identification of Site sources to receptors (including vapors) will be evaluated through monitoring of groundwater along transects located on the north and south banks of Ship Creek, along the southern boundary of the railyard, and along the north boundary of the railyard. Additional sampling will also be completed at selected new and existing well locations. These selected samples are to provide infill data in areas with limited historical sampling.

Note:

[a] U.S. EPA, 2000a

Table 3-5
Soil Data Quality Objectives

DQO Step[a]	Action
State Problem(s)	1) Analytical data may not be adequate to develop a list of constituents of potential concern (COPC). 2) The nature and extent of COPC in soil at known or suspected sources are not fully delineated. 3) Soil conditions (e.g., soil type, physical properties, etc.) at the Site may not be understood to an extent which allows adequate development of conceptual site models (CSMs). 4) The data currently available may not be sufficient to evaluate human health and ecological risk. 5) Current soil data may not be adequate to evaluate alternatives for remedial action that may be necessary.
Identify the Decision(s)	1) Are analytical data adequate to screen for COPC? 2) Are the nature and extent of COPC adequately characterized? 3) Are soil conditions at the Site adequate to develop CSMs? 4) If the nature and extent of COPC are adequately characterized, are the available data adequate to evaluate potential exposure pathways and calculate human health and ecological risk? 5) If constituent concentrations in soil present an unacceptable risk through completed exposure pathways, are the data adequate to evaluate potential remedial actions?
Identify Input to Decision(s)	1) Review of data/information provided in historical documents including: • SAIC, 1996. *RCRA Facility Assessment Report*. Alaska Railroad Corporation. Prepared for U.S. Environmental Protection Agency by Science Applications International Corporation. U.S. EPA I.D. No. AKD 98176 7403. March 1996. • Booz-Alllen Hamilton, 2002. *RCRA Facility Assessment Report for Leased Properties.* Prepared for U.S Environmental Protection Agency by Booz-Allen Hamilton. U.S. EPA I.D. No. AKD 98176 7403. July 2002.RETEC, 2004*. Site Background Report*. October 15, 2004. • RETEC, 2004d. *North Boundary Assessment Groundwater and Soil Results*. December 3, 2004. • RETEC, 2004e. Ship Creek Preliminary Habitat Assessment. December 3, 2004.

Table 3-5
Soil Data Quality Objectives

DQO Step[a]	Action
Identify Input to Decision(s) Cont.	• RETEC, 2005a. *Site Background Report*. March 21, 2005. • Hart Crowser, 2004a. *Ship Creek Water and Sediment Assessment Report*, Anchorage, Alaska. May 2004. • Hart Crowser, 2004b. *Ship Creek Literature Review*, Alaska Railroad Corporation, April 2004. Document 8877. July 2004. • Other documents from Elmendorf Air Force Base, Fort Richardson, Municipality of Anchorage, Alaska Fish and Game, Alaska Highway Department, etc will be reviewed. 2) Analytical results from authoritative soil sampling around known and suspected source areas to be completed during the RI 3) Field logs of all soil boring completed during the RI. 4) Analytical results for soil samples taken during groundwater well installation 5) Human health and ecological conceptual site models 6) Human health and ecological screening benchmarks (see Table 4-2)
Define Study Boundaries	**Lateral Boundary**: The Anchorage Terminal Reserve Site as defined in the Administrative Order of Consent, U.S. EPA Docket No. CERCLA 10-2004-0065 (Figure 1-1). **Vertical Boundary**: The nature and extent of COPC in soil necessary to assess potential human health and ecological risk, and to evaluate potential remedial action alternatives will be defined as follows: surface soil 0 to 0.5 feet below ground surface (bgs) (would be included in evaluation of excavation worker); subsurface soil 0.5 feet bgs to the water table. Soil type and physical properties data will be collected from the surface to approximately 5 feet below the top of the Bootlegger Cove Formation and used to evaluate fate and transport and potential remedial action alternatives. **Temporal Boundary**: The samples collected and analyzed during the upcoming RI will be added to the dataset of valid historical data to evaluate the nature and extent of COPC, and human health and ecological risk. However, COPC concentrations in soils removed by excavation, and validated through confirmation sampling, will not be included in evaluations. **Analytical Boundary:** The lateral and vertical extent of those constituents listed on the U.S. EPA hazardous substance list of target analytes for Superfund Sites. The list is modified to be Site appropriate. Specific analytes, detection limits, and QA procedures are provided in the Quality Assurance Project Plan (QAPP) (RETEC, 2005c).

Table 3-5
Soil Data Quality Objectives

DQO Step[a]	Action
Develop a Decision Rule(s)	1) Are the analytical data adequate to develop a list of COPC? *Yes.* Screen data to determine list of COPC and evaluate nature and extent *No.* Collect additional groundwater samples and analyze for a list of constituents adequate to develop a COPC list as determined upon consultation with U.S. EPA 2) Are the data adequate to evaluate the nature and extent of COPC which exceed relevant screening levels in soil? *Yes.* Nature and extent defined, proceed to risk assessment *No.* Additional authoritative sampling in the vicinity of insufficiently characterized source areas to be determined upon consultation with U.S. EPA 3) Are soil data adequate to develop CSMs? *Yes.* Develop CSMs and evaluate exposure pathways *No.* Additional soil data to be collected as determined upon consultation with U.S. EPA 4) Are the data sufficient to evaluate potential human health and ecological exposure pathways (for example from subsurface soil to indoor air) in a risk assessment? *Yes.* Calculate risk *No.* Collect additional data in potentially underrepresented areas as determined upon consultation with U.S. EPA 5) If an unacceptable human health and ecological risk is identified, are the data adequate to evaluate remedial action alternatives? *Yes.* Proceed to evaluation of remedial action alternatives. *No.* The scope of required additional sampling will be evaluated upon review of the field and analytical data collected during the RI, and upon consultation with U.S. EPA.
Specify Tolerable Limits on Decision Errors	Quantitative limits on decision errors have not been calculated. However, for risk assessment and remedial action decisions the dataset is intended to be representative of the selected exposure areas. Total decision error will be minimized by controlling measurement errors and sampling design errors as follows: 1) Measurement errors will be identified and documented in accordance with the QAPP (RETEC, 2005c). Acceptable data will meet all criteria established in the QAPP. U.S. EPA Guidance for Data Quality Assessment – *Practical Methods for Data Analysis* (U.S. EPA, 1996d) will be used to establish the methodology for evaluating data outliers, censored data, and area coverage. The need for additional sampling will be determined upon review of acceptable data. The QAPP is intended to minimize decision errors resulting from measurement errors.

Table 3-5
Soil Data Quality Objectives

DQO Step[a]	Action
Specify Tolerable Limits on Decision Errors Cont.	2) Sampling design errors by combining systematic and authoritative sampling based on professional experience and historical Site data. This sampling strategy will insure a distribution of samples across the Site. If initial sampling does not produce a statistically representative dataset then additional sampling will be proposed.
Optimize Design for Obtaining Data	An authoritative soil sampling program will be designed based on the location of known or suspected sources as determined through review of site history; spill/release history; site hydrogeology; previous investigation results, and visual observations. Soil samples will be collected at selected well bore locations and a limited number of surface sample locations during the RI. Additional sampling, if required, will be based on the following: 1) Groundwater analytical results indicate an upgradient source exceeding risk based screening levels in an area with a potentially complete exposure pathway 2) Initial soil results exceed risk based screening levels in an area of potentially complete exposure pathways and further delineation of the area is needed. Sampling will be completed at step out locations until the area exceeding risk based screening levels is adequately delineated. 3) Additional data are needed to develop a representative database to complete risk assessment.

Note:

[a] U.S. EPA, 2000a

Table 3-6
Natural Background Data for Soil[1]

Metal	Depth Range[2]	Concentrations (mg/kg soil)				Number of Cases	Number of Non Detects	Upper Tolerance Limit (mg/kg)	Upper 99 % Confidence Limit for the Mean (mg/kg)	Number of Points Exceeding the Upper Tolerance Limit
		Minimum	Mean	Maximum	Standard Deviation					
Aluminum	Surface	4,750	15,094	25,000	5,813	14	0	35,627	19,211	0
	Root zone	14,850	19,700	23,800	2,391	14	0	31,655	21,393	0
	Deep	9,380	12,878	16,600	1,606	21	0	18,013	13,764	0
Antimony	Surface	1.45	1.83	3.40	N/A	14	13	N/A	N/A	N/A
	Root Zone	1.20	1.40	1.60	N/A	14	14	N/A	N/A	N/A
	Deep	1.10	1.29	3.10	N/A	21	20	N/A	N/A	N/A
Arsenic	Surface	3.90	7.20	13.10	2.54	14	0	16.18	9.00	0
	Root Zone	4.70	6.87	9.60	1.28	14	0	11.40	7.78	0
	Deep	3.50	5.46	8.35	1.18	21	0	9.24	6.12	0
Barium	Surface	77.3	113.8	154.0	24.9	14	0	201.7	131.4	0
	Root Zone	43.4	103.3	171.0	31.4	14	0	214.3	125.5	0
	Deep	37.1	54.5	82.5	12.7	21	0	95.0	61.5	0
Beryllium	Surface	0.12	0.37	0.62	0.15	14	3	0.91	0.47	0
	Root Zone	0.29	0.41	0.55	0.08	14	0	0.70	0.46	0
	Deep	0.09	0.28	0.48	0.11	21	3	0.63	0.34	0
Cadmium	Surface	0.17	1.07	1.95	0.55	14	2	3.01	1.46	0
	Root Zone	0.93	1.62	1.90	0.26	14	0	2.53	1.80	0
	Deep	0.96	1.63	2.70	0.44	21	0	3.03	1.87	0
Calcium	Surface	1,330	2,803	8,210	1,721	14	0	8,881	4,021	0
	Root Zone	1,730	3,283	7,530	1,474	14	0	8,490	4,327	0
	Deep	2,980	5,312	10,800	1,503	20	0	10,169	6,165	1
Chromium	Surface	9.6	19.8	34.3	8.1	14	0	48.4	25.5	0
	Root Zone	19.0	31.8	45.3	6.4	14	0	54.4	36.3	0
	Deep	18.5	31.6	80.9	13.9	21	0	76.1	39.3	1

Table 3-6
Natural Background Data for Soil[1]

		Concentrations (mg/kg soil)								
Metal	**Depth Range[2]**	**Minimum**	**Mean**	**Maximum**	**Standard Deviation**	**Number of Cases**	**Number of Non Detects**	**Upper Tolerance Limit (mg/kg)**	**Upper 99 % Confidence Limit for the Mean (mg/kg)**	**Number of Points Exceeding the Upper Tolerance Limit**
Cobalt	Surface	1.3	7.1	12.6	3.9	14	2	20.7	9.81	0
	Root Zone	7.2	12.3	14.3	2.2	14	0	20.2	13.8	0
	Deep	7.2	11.1	16.6	2.0	21	0	17.5	12.2	0
Copper	Surface	7.8	14.8	24.8	4.9	14	0	32.2	18.3	0
	Root Zone	14.0	20.8	28.3	4.0	14	0	34.7	23.6	0
	Deep	14.5	29.5	59.9	9.3	21	0	59.2	34.7	1
Iron	Surface	8,970	22,359	32,700	7,609	14	0	49,237	27,748	0
	Root Zone	23,450	28,082	32,000	3,039	14	0	38,818	30,235	0
	Deep	18,500	24,581	38,000	4262	21	0	38,210	26,932	0
Lead	Surface	4.30	6.93	11.10	1.80	14	0	13.3	8.2	0
	Root Zone	4.10	5.65	7.00	0.89	14	0	8.78	6.28	0
	Deep	3.00	5.30	9.10	1.48	21	0	10.0	6.12	0
Magnesium	Surface	769	2,821	6,610	2,133	14	0	10,356	4,332	0
	Root Zone	2,160	6,371	10,100	1,929	14	0	13,183	7,737	0
	Deep	3,690	7,895	14,800	2,112	21	0	14,648	9,060	1
Manganese	Surface	67.8	319.9	738.0	197.0	14	0	1,015.7	459.4	0
	Root Zone	193.5	489.4	742.5	136.2	14	0	970.5	585.8	0
	Deep	375.0	518.3	640.0	58.6	21	0	705.8	550.6	0
Mercury	Surface	0.050	0.090	0.150	0.029	14	0	0.19	0.11	0
	Root Zone	0.040	0.075	0.220	0.044	14	0	0.23	0.11	0
	Deep	0.040	0.088	0.165	0.036	21	0	0.20	0.11	0
Nickel	Surface	1.3	13.0	31.7	10.1	14	2	48.5	20.1	0
	Root Zone	11.0	29.6	44.5	8.8	14	0	60.6	35.8	0
	Deep	17.6	34.6	73.1	11.4	21	0	71.1	40.9	1

Table 3-6
Natural Background Data for Soil[1]

Metal	Depth Range[2]	Concentrations (mg/kg soil)				Number of Cases	Number of Non Detects	Upper Tolerance Limit (mg/kg)	Upper 99 % Confidence Limit for the Mean (mg/kg)	Number of Points Exceeding the Upper Tolerance Limit
		Minimum	Mean	Maximum	Standard Deviation					
Potassium	Surface	244	406	685	144	14	0	915.7	508.5	0
	Root Zone	236.0	466	630.0	119	14	0	887.1	550.3	0
	Deep	221.0	612	842.0	154	21	0	1105.1	697.3	0
Selenium	Surface	0.055	0.295	0.510	0.113	14	1	0.69	0.37	0
	Root Zone	0.045	0.161	0.290	0.089	14	3	0.47	0.22	0
	Deep	0.040	0.104	0.400	0.116	21	16	N/A	N/A	N/A
Silver	Surface	0.23	0.63	1.60	0.39	14	4	2.00	0.91	0
	Root Zone	0.16	0.51	1.20	0.32	14	5	1.62	0.73	0
	Deep	0.15	0.41	0.78	0.20	21	6	1.05	0.52	0
Sodium	Surface	242.0	327.8	381.0	44.5	11	0	497.8	364.9	0
	Root Zone	178.5	251.2	317.0	40.5	11	0	406.1	285.0	0
	Deep	181.0	234.8	306.0	38.3	17	0	363.1	258.7	0
Thallium	Surface	0.105	0.133	0.280	N/A	14	13	N/A	N/A	N/A
	Root Zone	0.085	0.101	0.115	N/A	14	14	N/A	N/A	N/A
	Deep	0.080	0.092	0.190	N/A	21	20	N/A	N/A	N/A
Vanadium	Surface	21.5	53.4	83.1	18.5	14	0	118.6	66.5	0
	Root Zone	46.9	60.0	76.6	8.8	14	0	91.3	66.3	0
	Deep	33.2	44.3	59.9	6.7	21	0	65.8	48.0	0
Zinc	Surface	12.9	36.7	77.7	18.7	14	0	102.9	49.9	0
	Root Zone	33.7	51.3	62.9	9.5	14	0	84.8	58.0	0
	Deep	34.1	51.7	63.0	7.5	21	0	75.7	55.9	0

Notes:

1. Values reported in table are adapted from Table 5-3 of the Elmendorf Air Force Base Basewide Background Sampling Report (USAF, 1993)
2. These ranges are defined as follows: surface = 0-0.5 feet below ground surface (bgs), Root Zone = 0.5 - 3 feet bgs, Deep = 3 feet bgs - Water Table

mg/kg = milligrams per kilogram
N/A = not applicable

Table 3-7
Preliminary Background Data for Groundwater

Metal (dissolved unless indicated otherwise)	North Bluff Section [a]	Anthropogenic Background (North Bluff seeps) (ug/L)								
		Number of Cases	Minimum	Maximum [b]	Mean	2 x Mean	Reporting Limit for this Investigation	Background Value [e]	Background Basis	Data Sources
Metals										
Arsenic	West	10	<100	<100	n.a.	n.a.	10	10	Reporting limit	1
	East	10	<100	<100	n.a.	n.a.	10	10	Reporting limit	1
Barium	West	10	<10	260	138	277	3	260	Twice mean, 8 detects or MDC	1
	East	10	110	260	160	320	3	260	Twice mean or MDC	1
Cadmium	West	10	<6	9.30	n.a.	n.a.	2	9	Single detection	1
	East	10	<6	<6	n.a.	n.a.	2	2	Reporting limit	1
Calcium (total)	West	n.a	n.a.	n.a.	n.a.	n.a.	1000	n.a	n.a	n.a.
	East	3	62100	75300	67130	134200	1000	75300	Twice mean or MDC	2
Chromium	West	11	<10	<10	n.a.	n.a.	4	4	Reporting limit	1
	East	10	<10	<10	n.a.	n.a.	4	4	Reporting limit	1
Lead	West	10	<50	<50	n.a.	n.a.	1	1	Reporting limit	1
	East	13	<2	<50	n.a.	n.a.	1	6.5	Single detection	1, 2
Magnesium (total)	West	n.a	n.a.	n.a.	n.a.	n.a.	1000	n.a	n.a	n.a.
	East	3	15600	21500	13500	27000	1000	21500	Twice mean or MDC	2
Mercury	West	10	<0.2	0.29	n.a.	n.a.	0.2	0.29	Single detection	1
	East	10	<0.2	0.26	n.a.	n.a.	0.2	0.26	Single detection	1
Selenium	West	10	<100	<100	n.a.	n.a.	10	10	Reporting limit	1
	East	10	<100	<100	n.a.	n.a.	10	10	Reporting limit	1
Silver	West	10	<15	<15	n.a.	n.a.	2	2	Reporting limit	1
	East	10	<15	<15	n.a.	n.a.	2	2	Reporting limit	1
VOCs and Hydrocarbons (detected)										
Note: Two seeps, SP-12 in West, and SP-35 in East report additional detections. See note (d) below..										
1,1,1-Trichloroethane	West	10	<2	<2	n.a.	n.a.	1	1	Reporting limit	1
	East	13	<2	12 (6 det.)	n.a.	n.a.	1	12	Maximum detected	1, 2
1,1-Dichlroethane	West	10	<2	<2	n.a.	n.a.	1	1	Reporting limit	1
	East	13	<2	5.9 (6 det.)	n.a.	n.a.	1	5.9	Maximum detected	1, 2
1,2-Dichloroethene	West	10	<2	<2	n.a.	n.a.	1	1	Reporting limit	1
	East	13	<2	4.6 (4 det.)	n.a.	n.a.	1	4.6	Maximum detected	1, 2
Trichloroethene	West	10	<2	<2	n.a.	n.a.	1	1	Reporting limit	1
	East	13	<2	15 (6 det.)	n.a.	n.a.	1	15	Maximum detected	1, 2
Chloroform	West	10	<2	7.6 (6 det.)	n.a.	n.a.	1	1	Reporting limit	1
	East	13	<2	<2	n.a.	n.a.	1	1	Reporting limit	1, 2

Notes:

1. RETEC (2004d) North Bluff Investigation. In West 10 seeps were sampled, two of these in duplicate. In East 10 seeps were sampled. One of these, SP-33 was also sampled (as SW-3) in the 2001 investigation.

2. MWH (2001) North Ship Creek Railroad Yard Expansion Data Report. Three seeps sampled. One of these (SW-3) is same seep as SP-33 of RETEC investigation.

a. "West" is the section of bluff including the "cut" and the areas west of it. "East" is the section of bluff including the "knob" and the entire OU-5 treatment area

b. Number of detections of analyte indicated in parenthesis.

c. Background estimates are preliminary. Background estimates are based on twice the mean of background values, or the reporting limit for non-detected constituents, or the detected value for analytes only detected once, following guidance for preliminary groundwater background recommended by U.S. EPA Region 4 (U.S. EPA, 2000b). Final background values may differ from these values.

d. Seep SP-12 reports 4,300 ug/L DRO and 2,300 ug/L RRO. Two additional seeps (SP-01 and SP-26 report trace levels, <300 ug/L, RRO). Seep SP-35 reports 12 VOCs, in addition to 1,600 ug/L GRO, 1,600 ug/L DRP, and 500 ug/L RRO. The reported VOCs include BTEX (benzene at 8.4 ug/L)), naphthalene (46 ug/L), and trimethyl benzenes. This location does not report chlorinated VOCs and appears to be unrelated to observed concentrations in other seeps.

e. Note that due to elevated reporting limits in the North Bluff Investigation, the data set is highly censored and use of the lower investigation reporting limit may result in a conservative estimate.

MDC - Maximum Detected Concentration

Table 3-8

Background Data for Ship Creek Sediment and Surface Water[a]

Metal	Concentrations (mg/kg sediment)									Concentrations of total metal (ug/L surface water)								
	Number of Cases	Minimum	Maximum	Mean	2 x Mean	Anchorage Basin 1st and 2nd Order Stream Range (per Clark 1978)	Background Value	Background Basis [b]	Data Sources	Number of Cases	Reporting Limit for Current Investigation	Minimum	Maximum	Mean	2 x Mean	Background Value	Background Basis [b]	Data Sources
Aluminum	1	17,100	18,150	n.a	n.a	n.a.	18,150	Mean of two replicates	1	5	100	110	621	345	691	621	Twice the mean or MDC	5, 6
Antimony	1	<1.5	<1.7	n.a	n.a	n.a.	<1.6	Mean of two replicates	1	5	1	0.07	<30	n.a	n.a	1.00	Reporting limit	5, 6
Arsenic	10	3.00	6.90	5.10	10	n.a.	10.00	Twice the mean	1, 2, 3, 4	5	10	0.20	<1	n.a	n.a	10.00	Reporting limit	5, 6
Barium	8	31	152.0	65	130	20 - 1000	130.0	Twice the mean	1, 2, 4	5	3	9	12.3	10.5	21.1	112.3	Twice the mean or MDC	5, 6
Beryllium	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	4	1	<0.2	<0.7	n.a	n.a	1.00	Reporting limit	6
Cadmium	3	0.20	0.30	0.25	0.5	n.a	<0.5	Reporting limit	1, 3	5	2	<0.6	<4	n.a	n.a	2.00	Reporting limit	5, 6
Calcium	1	7,450	8,120	n.a	n.a	n.a	7,785	Mean of two replicates	1	5	1000	19,000	39,800	24,920	49880	39,800	Twice the mean or MDC	5, 6
Chromium	10	27.3	37.6	32.0	64	70 - 5000	64.0	Twice the mean	1, 2, 3, 4	5	4	1.2	<4	n.a	n.a	4.0	Reporting limit	5, 6
Cobalt	3	8.6	12.1	10.3	21	7 - 200	21.0	Twice the mean	1, 2	5	1	<0.5	<5	n.a	n.a	1.0	Reporting limit	5, 6
Copper	5	22.7	37.3	28.4	57	15 - 150	57.0	Twice the mean	1, 2, 3	5	6	1.6	<7	1.6	3.2	6.0	Reporting limit	5, 6
Iron	1	28,500	30,250	n.a	n.a	n.a	30,250	Mean of two replicates	1	5	1000	178	818	463	925	1,000	Reporting limit	5, 6
Lead	10	4.00	87.20	12.70	25	10 - 70	25.00	Twice the mean	1, 2, 3, 4	5	1	0.06	1.06	0.36	0.72	1.00	Reporting limit	5, 6
Magnesium	1	8340	8,850	n.a	n.a	n.a	8,595	Mean of two replicates	1	5	1000	3040	6,130	3,794	6130	7,588	Twice the mean or MDC	5, 6
Manganese	3	384.0	596.0	521.0	1042	700 - 1500	1042.0	Twice the mean	1, 2	5	2	19.2	158.0	57.6	115	115.0	Twice the mean	5, 6
Mercury	3	0.090	0.300	0.200	0.4	0.06 - 2.4	0.400	Twice the mean	1, 2	1	0.2	<0.2	<0.2	n.a	n.a	0.200	Reporting limit	5
Molybdenum	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	4	n.a	0.3	4.0	1.8	3.55	3.6	Twice the mean	6
Nickel	10	21.0	36.3	27.0	54	30 - 1500	54.0	Twice the mean	1, 2, 3, 4	5	2	1.03	<4	n.a	n.a	2	Reporting limit	5, 6
Potassium	1	1460	1670	n.a	n.a	n.a	1565	Mean of two replicates	1	5	1000	320	660	449	887	1000	Reporting limit	5, 6
Selenium	1	<0.5	<0.56	n.a	n.a	n.a	<0.53	Mean of two replicates	1	5	10	<0.5	<1	n.a	n.a	10.000	Reporting limit	5, 6
Silver	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	4	2	<3	<6	n.a	n.a	2.00	Reporting limit	6
Sodium	1	346.0	346.0	n.a	n.a	n.a	346.0	Mean of two replicates	1	5	1000	1980.0	3530.0	2347.0	4694	3530.0	Twice the mean or MDC	5, 6
Thallium	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	4	1	<0.01	<0.02	n.a	n.a	1	Reporting limit	6
Vanadium	3	46.6	62.3	53.3	107	50 - 300	107.0	Twice the mean	1, 2	5	20	1.2	<7	n.a	n.a	20.0	Reporting limit	5, 6
Zinc	5	51.9	159.0	78.7	157	n.a	157.0	Twice the mean	1, 2, 3	5	25	2.0	<10	4.3	8.6	25.0	Reporting limit	5, 6

Notes:

1. Hart Crowser (2004a) Ship Creek monitoring data from Station HC-05 (located at Elmendorf hatchery). Mean of 2 replicate samples.
2. Elmendorf Air Force Base data from upper Ship Creek (1 sample) and lower Ship Creek (mean of 4 samples), cited in CH2M Hill (1996)
3. Boden (1997) background data from two stations: UB above Davis Highway, and I-1 at Elmendorf hatchery
4. ENSR (1995) OU-D data from 5 stations located near Ship Creek discharge points at Fort Richardson
5. Hart Crowser (2004a) Ship Creek surface water monitoring data from Station HC-05 Located at Elmednorf Hatchery) collected 3/18/2004
6. United States Air Force (2001), basewide monitoring data for Elmendorf Air Force Base, 1st round (5/21/99) and 2nd round (7/31/01) at stations SC-07 (Elmendorf Hatchery) and SC-08 (Reeve Boulevard). For SC-08 used mean of two replicates.

a. Background conditions in Ship Creek are the upgradient conditions. These conditions may include anthropogenic sources located upstream of ARRC, and are not necessarily natural background values.

b. Background estimates for sediment and surface water are preliminary. Background estimates are based on twice the mean of background values, or the reporting limit for non-detected constituents, following guidance for preliminary groundwater background recommended by U.S. EPA Region 4 (U.S. EPA, 2000b). Final background values may differ from these values.

MDC - Maximum detected concentration

Table 4-1
Laboratory Analytical Methods, Sample Containers, Preservatives, and Hold Time Requirements

Analysis	Laboratory Analytical Method	Sample Container		Preservative		Holding Time	
		Soild	Aqueous	Solid	Aqueous	Solid	Aqueous
Volatile Organic Compounds	8260B	4 oz Glass Jar	3 - 40 ml VOA Vials	4^{o}C, MeOH	4^{o}C, HCl	14 days	14 days
Semivolatile Organic Compounds	8270C	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C	4^{o}C	14 days to extraction, 40 days from extraction to analysis	7 days to extraction, 40 days from extraction to analysis
Pesticides	8081A	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C	4^{o}C		
Polychlorinated biphenyls (PCBs)	8082	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C	4^{o}C		
Dioxins and Furans	8290	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C	4^{o}C	30 days to extraction, 45 days from extraction to analysis	30 days to extraction, 45 days from extraction to analysis
Metals	6010B/6020 & 7471A/7470A	8 oz Glass Jar	1 -1 Liter Poly	4°C recommended	4^{o}C, HNO3	6 months (28 days for Hg)	6 months (28 days for Hg)
Cyanide	9010/9012A/4500-CN	4 oz Glass Jar	1 - 250 ml Poly	4^{o}C	4^{o}C, NaOH	28 days	14 days
Gasoline Range Organics	AK101	4 oz Glass Jar	3 - 40 ml VOA Vials	4^{o}C, MeOH	4^{o}C, HCl	28 days	14 days
Diesel Range Organics	AK102	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C, MeOH	4^{o}C, HCl	14 days to extraction, 40 days from extraction to analysis	7 days to extraction, 40 days from extraction to analysis
Extractable Petroleum Hydrocarbons	EPH	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C, MeOH	4^{o}C, HCl		
Volatile Petroleum Hydrocarbons	VPH	4 oz Glass Jar	3 - 40 ml VOA Vials	4^{o}C, MeOH	4^{o}C, HCl	28 days	14 days

Table 4-2
Preliminary Human Health and Ecological Screening Levels

				Human Health Screening Levels for Groundwater								Human Health Screening Levels for Surface Water		Human Health Screening Levels for Soil and Sediment						Migration to Groundwater		Human Health Indoor Air			Ecological Screening Levels for Sediment				Ecological Screening Levels for Surface Water				Ecological Screening Levels for Soil							
Analyte	Target Compound List	Practical Quantitation Limit [1] µg/L	Practical Quantitation Limit [2] mg/kg	Alaska 1° Maximum Contaminant Level (A) µg/L	Comments	Federal Drinking Water Equivalent (B) µg/L	Comments	ADEC Groundwater Cleanup Level (x 0.1) (C) µg/L	Comments	U.S. EPA Region IX Tap Water PRG (D) µg/L	Comments	Aquatic Organisms Only (F) µg/L	Comments	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Ingestion (x 0.1) (G) mg/kg	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Inhalation (x 0.1) (G) mg/kg	Comments	U.S. EPA Region IX Residential Soil PRG (H) mg/kg	U.S. EPA Region IX Industrial Soil PRG (H) mg/kg	Comments	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Migration to Groundwater (x 0.1) (G) mg/kg	Comments	EPA Target Groundwater Concentration Protective of Indoor Air (µg/L)	Volatile	Comments	Fresh-water Sediment (I) mg/kg	Commetns	Marine Sediment (I) mg/kg	Comments	Fresh Water (J) ug/L	Comments	Marine Water (K) ug/L	Comments	Plants (L) mg/kg	Comments	Soil Biota (L) mg/kg	Comments	Wildlife (L) mg/kg	Comments	Bio-accumulation (tissue residue), wildlife protection (M) ug/kg diet(ww)	Comments
Volatile Organic Compounds																																								
1,1,1-Trichloroethane	X	1	0.025	200		1000		20		3172		NA		NA	46		1200	1200		0.1		3100	#N/A	27	0.17	15	NA		62	12	NA		NA		NA		NA		NA	
1,1,1,2-Tetrachloroethane		2	0.002	NA		1000		NA		0.43		NA		NA	NA		3.20	7.30		NA		33	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
1,1,2,2-Tetrachloroethane	X	0.5	0.05	NA		2		0.4		0.055		4	17	4.2	0.54		0.41	0.93		0.0017		30	#N/A	27	0.94	15	NA		420	12	NA		NA		NA		NA		NA	
1,1,2-Trichloro-1,2,2-trifluoroethane^{2a}	X	NA	NA	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		1.50E+03	y	27	NA		NA		NA		NA		NA		NA		NA		NA	
1,1,2-Trichloroethane	X	1	0.025	5		100		0.5		0.20		16	17	15	1		0.73	1.6		0.0017		41	#N/A	27	NA		NA		1200	11	NA		NA		NA		NA		NA	
1,1,-Dichloroethene	X	1	0.025	7		2000		0.7		339		7100	17	1.4	0.09		120	410		0.003		190	#N/A	27	NA		NA		25	11	NA		NA		NA		NA		NA	
1,1-Dichloroethane	X	1	0.025	NA		NA		365		811		NA		1000	89		510	1700		1.2		2200	#N/A	27	NA		NA		47	11	NA		NA		NA		NA		NA	
1,1-Dichloropropane		NA	NA	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA	y		NA		NA		NA		NA		NA		NA		NA		NA	
1,1-Dichloropropene		2	0.0025	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA	y		NA		NA		NA		NA		NA		NA		NA		NA	
1,2,4-Trimethylbenzene		2.7	0.002	NA		NA		NA		12		NA		NA	NA		52.00	170.00		NA		24	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
1,3,5-Trimethylbenzene		2	0.002	NA		NA		NA		12		NA		NA	NA		21.00	70.00		NA		25	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
1,2,3-Trichloropropane		2.5	0.002	NA		200		NA		0.01		NA		NA	NA		0.034	0.076		NA		290	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
1,2-Dibromo-3-chloropropane (DBCP)	X	2	0.1	0.2		NA		NA		0.048		NA		NA	NA		0.45	2		NA		33	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
1,2-Dibromoethane (EDB)	X	1	0.025	0.05		NA		0.005		0.0056		NA		0.01	0.12		0.032	0.073		0.00000306		3.6	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
1,2-Dichlorobenzene	X	1	0.025	600		3000		60		370		17,000		910	11		600	600		0.7		2600	#N/A	27	0.34	15	0.023	16	14	12	NA		NA		NA		NA		NA	
1,2-Dichloroethane	X	0.5	0.025	5		NA		0.5		0.12		37	17	9.1	0.5		0.28	0.60		0.0015		23	#N/A	27	NA		NA		910	11	NA		NA		NA		NA		NA	
1,2-Dichloropropane	X	1	0.025	5		NA		0.5		0.16		15	17	12	1.7		100	360		0.0017		35	#N/A	27	NA		NA		NA		NA		NA		700	29	NA		NA	
1,3-Dichlorobenzene	X	1	0.025	NA		3000		110		183		2,600		304	NA		530	600		1.21		830	#N/A	27	1.7	15	NA		71	12	NA		NA		NA		NA		NA	
1,3-Dichloropropane		2	0.002	NA		NA		NA		NA		NA		NA	NA		100	360		NA		NA	#N/A		NA		NA		NA		NA		NA		NA		NA		NA	
1,4-Dichlorobenzene	X	0.5	0.025	75		4000		7.5		0.50		2600		35	800		3.40	7.90		0.08		8200	#N/A	27	0.35	15	0.031	16	15	12	NA		NA		20	29	NA		NA	
2-Butanone (MEK)	X	10	0.25	NA		20000		2200		6968		NA		6080	2810		22000	110000		6		440000	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
2-Hexanone	X	10	0.25	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA	y		NA		NA		99	11	NA		NA		NA		NA		NA	
2,2-Dichloropropane		2	0.002	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA	y		NA		NA		NA		NA		NA		NA		NA		NA	
4-Methyl-2-pentanone (MIBK)	X	10	0.25	NA		NA		NA		1993		NA		NA	NA		5300	47000		NA		14000	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Acetone	X	10	0.25	NA		NA		365		5475		NA		1000	NA		14000	54000		1		220000	#N/A	27	NA		NA		1500	11	NA		NA		NA		NA		NA	
Benzene	X	0.4	0.013	5		NA		0.5		0.35		51	17	15	0.9		0.64	1.40		0.002		14	#N/A	27	NA		NA		46	12	NA		NA		NA		NA		NA	
Bromobenzene		2	0.002	NA		NA		NA		20		NA		NA	NA		28	92		NA		6.7	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Bromochloromethane	X	1	0.025	NA		500		NA		NA		NA		NA	NA		NA	NA		NA		0.84	y	27	NA		NA		NA		NA		NA		NA		NA		NA	
Bromodichloromethane	X	0.5	0.025	80		100		10		0.18		17	17	NA	NA		0.82	1.8		NA		21	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Bromoform	X	1	0.025	80		1000		10		8.5		140	17	105	50		62	218		0.038		0.083	y	27	NA		NA		NA		NA		NA		NA		NA		NA	
Bromomethane (Methyl bromide)	X	3	0.1	NA		50		NA		8.7		4000		NA	NA		3.9	13		NA		14	#N/A	27	NA		NA		19	12	NA		NA		NA		NA		NA	
Carbon Disulfide	X	2	0.1	NA		NA		365		1000		NA		1000	45.3		360	720		1.7		560	#N/A	27	NA		NA		0.92	11	NA		NA		NA		NA		NA	
Carbon Tetrachloride	X	1	0.025	5		30		0.5		0.17		1.6	17	6.4	0.34		0.25	0.55		0.003		5	#N/A	27	NA		NA		240	12	NA		NA		1000	29	NA		NA	
Chlorobenzene	X	0.5	0.025	100		NA		10		110		21,000		200	11		150	530		0.06		390	#N/A	27	0.82	15	NA		130	12	NA		NA		40	29	NA		NA	
Chloroethane	X	1	0.01	NA		NA		NA		4.6		NA		NA	NA		3.0	6.5		NA		28000	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Chloroform	X	1	0.025	80		400		10		0.17		470	17	100	0.34		0.22	0.47		0.034		80	#N/A	27	NA		NA		28	11	NA		NA		NA		NA		NA	
Chloromethane	X	1	0.025	NA		100		NA		160		NA		NA	NA		47	160		NA		67	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
cis-1,2-Dichloroethene	X	1	0.025	70		400		7		61		NA		100	NA		43	150		0.02		180	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
cis-1,3-Dichloropropene*	X	0.5	0.025	NA		1000		0.9		0.40		1700		8.3	1.4		0.78	1.80		0.002		8.4	y	27	NA		NA		23	11	NA		NA		NA		NA		NA	
Cyclohexane^{2a}	X	NA	NA	NA		NA		NA		10000		NA		NA	NA		140	140		NA		5	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Dibromochloromethane	X	0.5	0.025	80		700		NA		0.13		13	17	NA	NA		1.1	2.6		NA		32	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Dibromomethane		2.2	0.002	NA		NA		NA		61		NA		NA	NA		NA	NA	5	NA		990	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Dichlorodifluoromethane	X	1	0.025	NA		5000		730		390		NA		2030	26		93.88	308.06	5	6		14	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Ethylbenzene	X	1	0.025	700		3000		70		1300		29,000		1000	8.9		400	400		0.55		700	#N/A	27	3.6	15	NA		290	12	NA		NA		NA		NA		NA	
Isopropylbenzene	X	1	0.025	NA		4000		365		660		NA		1010	58.5		570	2000		22.7		33000	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Methyl Acetate^{2a}	X	NA	NA	NA		NA		NA		6100		NA		NA	NA		22000	92000		NA		720000	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Methyl tert-Butyl Ether	X	5	0.04	20		NA		NA		11		NA		NA	NA		32	70		NA		120000	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Methylcyclohexane^{2a}	X	NA	NA	NA		NA		NA		5200		NA		NA	NA		2600	8700		NA		710	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Methylene Chloride	X	5	0.1	5		2000		0.5		4.3		590	17	110	18		9.1	21		0.0015		3300	#N/A	27	NA		NA		2200	11	NA		NA		NA		NA		NA	
Methyl pentanone		NA	NA	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
n-Butylbenzene		2.7	0.002	NA		NA		NA		240		NA		NA	NA		240	240		NA		360000	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
n-Propylbenzene		2	0.002	NA		NA		NA		240		NA		NA	NA		240	240		NA		10	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Styrene	X	1	0.025	100		7000		10		1600		NA		2030	28		1700	1700		0.13		8900	#N/A	27	NA		NA		NA		NA		300	23	NA		NA		NA	
Tetrachloroethene	X	1	0.025	5		500		0.5		0.1		3.3	17	16	8		0.48	1.3		0.003		11	#N/A	27	0.53	15	NA		120	12	NA		NA		NA		NA		NA	
Toluene	X	1	0.05	1000		7000		100		720		200,000		2030	18		520	520		0.54		1500	#N/A	27	0.67	15	NA		130	12	NA		200	23	NA		NA		NA	
trans-1,2-Dichloroethene	X	1	0.025	100		700		10		120		140000		200	NA		69	230		0.04		180	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
trans-1,3-Dichloropropene*	X	1	0.025	NA		1000		0.9		0.40		1700		8.3	1.4		0.78	1.80		0.002		8.4	y	27	NA		NA		NA		NA		NA		NA		NA		NA	
Trichloroethene	X	1	0.025	5		200		0.5		0.028		30	17	75	4.3		0.053	0.11		0.0027		5	y	27	1.6	15	0.041		NA		NA		NA		NA		NA		NA	
Trichlorofluoromethane	X	1	0.025	NA		10,000		NA		1300		NA		NA	NA		386	2000		NA		180	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Trichlorotriflouroethane		2	0.002	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		0.071	y	27	NA		NA		NA		NA		NA		NA		NA		NA	
Vinyl Chloride	X	1	0.025	2		100		0.2		0.020		2.4	17	0.6	0.4		0.079	0.75		0.0009		2.5	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Xylene (total)		2	0.002	10000		7000		1000		210		NA		20300	8.1		275	420		7.8		22000	#N/A	27	0.025	15	NA		1.8	12	NA		NA		NA		NA		NA	
m&p-Xylene	X	2	0.05	10000		NA		NA		NA		NA		NA	NA		NA	NA		NA		22000	y	27	NA		NA		1.8	12	NA		NA		NA		NA		NA	
o-Xylene	X	1	0.025	10000		7000		NA		NA		NA		NA	NA		NA	NA		NA		33000	y	27	NA		NA		NA		NA		NA		NA		NA		NA	
SemiVolatile Organic Compounds																																								

Table 4-2
Preliminary Human Health and Ecological Screening Levels

				Human Health Screening Levels for Groundwater								Human Health Screening Levels for Surface Water		Human Health Screening Levels for Soil and Sediment						Migration to Groundwater		Human Health Indoor Air			Ecological Screening Levels for Sediment				Ecological Screening Levels for Surface Water				Ecological Screening Levels for Soil							
Analyte	Target Com-pound List	Practical Quan-titation Limit ^{1} µg/L	Practical Quan-titation Limit ^{2} mg/kg	Alaska 1^o Maximum Contam-inant Level (A) µg/L	Comments	Federal Drinking Water Equivalent (B) µg/L	Comments	ADEC Ground-water Cleanup Level (x 0.1) (C) µg/L	Comments	U.S. EPA Region IX Tap Water PRG (D) µg/L	Comments	Aquatic Organisms Only (F) µg/L	Comments	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Ingestion (x 0.1) (G) mg/kg	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Inhalation (x 0.1) (G) mg/kg	Comments	U.S. EPA Region IX Residential Soil PRG (H) mg/kg	U.S. EPA Region IX Industrial Soil PRG (H) mg/kg	Comments	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Migration to Groundwater (x 0.1) (G) mg/kg	Comments	EPA Target Groundwater Concentration Protective of Indoor Air (µg/L)	Volatile	Comments	Fresh-water Sediment (I) mg/kg	Commetns	Marine Sediment (I) mg/kg	Comments	Fresh Water (J) ug/L	Comments	Marine Water (K) ug/L	Comments	Plants (L) mg/kg	Comments	Soil Biota (L) mg/kg	Comments	Wildlife (L) mg/kg	Comments	Bio-accumulation (tissue residue), wildlife protection (M) ug/kg diet(ww)	Comments
1,1'-Biphenyl^{2a}	X	NA	NA	NA		NA		NA		304		NA		NA	NA		3000	23000		NA		0.4	#N/A	27	1.1	15	NA		NA		NA		60	25	NA		NA		NA	
1,2,3-Trichlorobenzene	X	1	0.05	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA	y		NA		NA		NA		NA		NA		20	25	NA		NA	
1,2,4-Trichlorobenzene	X	1	0.05	70		400		7		7.2		940		100	57		62	220		0.2		3400	#N/A	27	9.2	15	NA		NA		NA		NA		20	25	NA		NA	
2,2'-oxybis(1-Chloropropane)^{2a}	X	NA	NA	NA		1000		NA		0.27		NA		NA	NA		2.9	7.4		NA		NA	#N/A		NA		NA		NA		NA		NA		NA		NA		NA	
2,4,5-Trichlorophenol	X	10	0.25	NA		NA		365		3600		9,800		1000	NA		6100	62000		9		NA			NA		NA		NA		NA		4	23	9	29	NA		NA	
2,4,6-Trichlorophenol	X	10	0.25	NA		10		7.7		3.6		2.4	17	75	150		6.1	62		0.06		NA			NA		NA		NA		NA		NA		10	29	NA		NA	
2,4-Dichlorophenol	X	10	0.25	NA		100		10		110		790		30	NA		180	1800		0.045		NA			NA		NA		NA		NA		20	23	20	29	NA		NA	
2,4-Dimethylphenol	X	10	0.25	NA		NA		70		730		2,300		200	NA		1200	12000		0.4		NA			NA		0.029	16	NA		NA		NA		NA		NA		NA	
2,4-Dinitrophenol	X	70	2	NA		NA		7		73		14000		20	NA		120	1200		0.02		NA			NA		NA		NA		NA		20	23	NA		NA		NA	
2,4-Dinitrotoluene	X	10	0.25	NA		100		0.125		73		3.4	17	1.2	NA		120	1200		0.0005		NA			NA		NA		NA		NA		NA		NA		NA		NA	
2,6-Dinitrotoluene	X	10	0.25	NA		40		0.125		36		NA		1.2	NA		61	620		0.00044		NA			NA		NA		NA		NA		NA		NA		NA		NA	
2-Chloroethylvinyl ether		10	0.01	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA	y		NA		NA		NA		NA		NA		NA		NA		NA	
2-Chloronaphthalene	X	10	0.25	NA		NA		290		490		4,300		811	NA		4900	23000		7		NA	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
2-Chlorophenol	X	10	0.25	NA		200		20		30		400		51	NA		63	240		0.14		1000	#N/A	27	NA		NA		NA		NA		NA		10	29	NA		NA	
2-Chlorotoluene		2	0.002	NA		NA		NA		120		NA		NA	NA		160	560		NA		NA	#N/A		NA		NA		NA		NA		NA		NA		NA		NA	
1-Methylnaphthalene		NA	NA	NA		NA		NA		NA		NA		410	NA		NA	NA		4.3		3300	y	27	NA		NA		2.1	11	NA		NA		NA		NA		NA	
2-Methoxyethyl acetate		NA	NA	NA		NA		NA		73		NA		NA	NA		120	1200		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
2-Methylnaphthalene	X	10	0.25	NA		NA		78		NA		NA		203	NA		NA	NA		6.09		3300	y	27	NA		0.0202		NA		NA		NA		NA		NA		NA	
2-Methylphenol	X	10	0.25	NA		NA		180		1800		NA		510	NA		3100	31000		0.7		NA			NA		0.063	16	13	11	NA		NA		NA		NA		NA	
2-Nitroaniline	X	10	0.25	NA		NA		NA		110		NA		NA	NA		180	1800		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
2-Nitrophenol	X	10	0.25	NA		300		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
3,3'-Dichlorobenzidine	X	10	0.25	NA		NA		0.2		0.15		0.028	17	1.8	NA		1.1	3.8		0.002		NA			NA		NA		NA		NA		NA		NA		NA		NA	
3,4-Methylphenol*		5	0.17	NA		NA		NA		180		NA		NA	NA		310	3100		NA		NA			NA		0.67	16	NA		NA		NA		NA		NA		NA	
3-Methylphenol		NA	NA	NA		NA		NA		1800		NA		NA	NA		3100	31000		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
3-Nitroaniline	X	10	0.25	NA		NA		NA		3.2		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
4,6-Dinitro-2-methylphenol	X	50	2	NA		NA		NA		3.6		280	17	NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
4-Bromophenyl-phenylether	X	10	0.25	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		1.5	12	NA		NA		NA		NA		NA	
4-Chloro-3-methylphenol	X	10	0.25	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
4-Chloroaniline	X	10	0.25	NA		NA		15		150		NA		41	NA		240	2500		0.05		NA			NA		NA		NA		NA		NA		NA		NA		NA	
4-Chlorophenyl-phenylether	X	10	0.25	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
4-Chlorotoluene		2	0.002	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA	y		NA		NA		NA		NA		NA		NA		NA		NA	
4-Isopropyltoluene		2.8	0.002	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA	y		NA		NA		NA		NA		NA		NA		NA		NA	
4-Methylphenol^{2a}	X	20	0.3	NA		NA		NA		180		NA		NA	NA		310	3100		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
4-Nitroaniline	X	10	0.5	NA		NA		NA		3.2		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
4-Nitrophenol	X	50	1	NA		300		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		7	29	NA		NA	
Acenaphthene	X	10	0.25	NA		2000		220		370		2,700		610	NA		3700	29000		21		NA		27	NA		0.00671		23	12	40	12	20	23	NA		NA		NA	
Acenaphthylene	X	10 (0.05)	0.25 (0.005)	NA		NA		220		NA		NA		610	NA		NA	NA		21		NA			NA		0.00587		NA		NA		NA		NA		NA		NA	
Acetophenone^{2a}	X	NA	NA	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		800000	y	27	NA		NA		NA		NA		NA		NA		NA		NA	
Aniline		NA	NA	NA		NA		NA		12		NA		NA	NA		85	300		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Anthracene	X	10 (0.05)	0.25 (0.005)	NA		10000		1100		1800		110,000		3000	NA		22000	100000		430		NA	#N/A		0.01	14	0.0468		0.73	11	NA		NA		NA		NA		NA	
Benzaldehyde^{2a}	X	10	0.33	NA		NA		NA		3600		NA		NA	NA		6100	62000		NA		360000	y	27	NA		NA		NA		NA		NA		NA		NA		NA	
Benzo (a) anthracene	X	10 (0.05)	0.25 (0.005)	NA		NA		0.1		0.092		0.018	17	1.1	NA		0.62	2.1		0.6		NA			0.0317		0.0748		0.027	11	NA		NA		NA		NA		NA	
Benzo (a) pyrene	X	10 (0.05)	0.25 (0.005)	0.2		NA		0.02		0.0092		0.018	17	0.1	NA		0.062	0.21		0.3		NA			0.0319		0.0888		0.014	12	NA		NA		NA		12	25	NA	
Benzo (b) fluoranthene	X	10 (0.05)	0.25 (0.005)	NA		NA		0.1		0.092		0.018	17	1.1	NA		0.62	2.1		2		NA	y	27	NA		2.3	16	NA		NA		NA		NA		NA		NA	
Benzo (g,h,i) perylene	X	10 (0.05)	0.25 (0.005)	NA		NA		110		NA		NA		300	NA		NA	NA		150		NA			NA		0.31	16	NA		NA		NA		NA		NA		NA	
Benzo (k) fluoranthene	X	10 (0.05)	0.25 (0.005)	NA		NA		1		0.92		0.018	17	11	NA		6.2	21		20		NA			0.0272	14	2.3	16	NA		NA		NA		NA		NA		NA	
Benzoic Acid		130	1.3	NA		NA		14600		150000		NA		41000	NA		100000	100000		39		NA			NA		0.65	16	42	11	NA		NA		NA		NA		NA	
Benzyl alcohol		10	0.17	NA		NA		NA		11000		NA		NA	NA		18000	100000		NA		NA			NA		0.057	16	8.6	11	NA		NA		NA		NA		NA	
bis (2-Ethylhexyl) phthalate	X	10	0.25	6		NA		0.6		4.8		2.2	17	59	NA		35	120		120		NA			NA		0.182		32	12	NA		NA		NA		NA		NA	
bis(2-Chloroethoxy)methane	X	10	0.25	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA	y		NA		NA		NA		NA		NA		NA		NA		NA	
bis(2-Chloroethyl)ether	X	10	0.25	NA		NA		0.077		0.010		0.53	17	0.8	0.3		0.22	0.58		0.0002		100	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
bis(2-Chloroisopropyl)ether		5	0.22	NA		NA		NA		0.27		170000		NA	NA		2.9	7.4		NA		510	y		NA		NA		NA		NA		NA		NA		NA		NA	
Butylbenzylphthalate	X	10	0.25	NA		7000		730		7300		5,200		2000	NA		12000	100000		560		NA			11	15	0.049	16	NA		NA		NA		NA		NA		NA	
Caprolactam^{2a}	X	NA	NA	NA		NA		NA		18000		NA		NA	NA		31000	100000		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Carbazole^{2a}	X	NA	NA	NA		NA		4		3.4		NA		42	NA		24	86		0.2		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Chrysene	X	10 (0.05)	0.25 (0.005)	NA		NA		10		9.2		0.018	17	110	NA		62	210		62		NA	y	27	0.0571		0.108		NA		NA		NA		NA		NA		NA	
Dibenzo (a,h) anthracene	X	10 (0.05)	0.25 (0.005)	NA		NA		0.01		0.0092		0.018	17	0.1	NA		0.062	0.21		0.6		NA			0.01		0.00622		NA		NA		NA		NA		NA		NA	
Dibenzofuran	X	10	0.25	NA		NA		7.3		12		NA		20.3	NA		150	1600		0.778		NA	#N/A	27	2	15	0.15	16	NA		NA		NA		NA		NA		NA	
Diethylphthalate	X	10	0.25	NA		30000		2900		29000		120,000		8100	NA		49000	100000		19		NA			0.63	15	0.61	16	220	12	NA		100	23	NA		NA		NA	
Dimethylphthalate	X	10	0.25	NA		NA		NA		360000		2,900,000		100000	NA		100000	100000		140		NA			NA		0.53	16	NA		NA		NA		200	29	NA		NA	
Di-n-butylphthalate	X	10	0.25	NA		4000		365		3600		12,000		1000	NA		6100	62000		170		NA			11	15	2.2	16	NA		NA		200	23	NA		NA		NA	
Di-n-octylphthalate	X	10	0.25	NA		NA		70		1500		NA		200	NA		2400	25000		81000		NA			NA		0.58	16	NA		NA		NA		NA		NA		NA	
Fluoranthene	X	10 (0.1)	0.25 (0.005)	NA		NA		146		1500		370		410	NA		2300	22000		210		NA			0.111		0.113		8.1	12	11	12	NA		NA		NA		NA	
Fluorene	X	10 (0.05)	0.25 (0.005)	NA		1000		146		240		14,000		410	NA		2700	26000		27		NA	#N/A	27	0.01		0.0212		3.9	12	NA		NA		NA		NA		NA	
Hexachlorobenzene	X	10	0.25	1		30		0.1		0.042		0.00029	17	0.5	0.7		0.30	1.1		0.073		1	y	27	NA		0.0038	16	NA		NA		NA		1000	29	NA		NA	
Hexachlorobutadiene	X	10	0.25	NA		7		1		0.86		18	17	2	5.5		6.2	22		0.8		3.3	y	27	NA		0.039	16	NA		NA		NA		NA		NA		NA	

Table 4-2
Preliminary Human Health and Ecological Screening Levels

				Human Health Screening Levels for Groundwater								Human Health Screening Levels for Surface Water		Human Health Screening Levels for Soil and Sediment						Migration to Groundwater		Human Health Indoor Air			Ecological Screening Levels for Sediment				Ecological Screening Levels for Surface Water				Ecological Screening Levels for Soil							
	Target Compound List	Practical Quantitation Limit [1]	Practical Quantitation Limit [2]	Alaska 1° Maximum Contaminant Level	Comments	Federal Drinking Water Equivalent	Comments	ADEC Ground-water Cleanup Level (x 0.1)	Comments	U.S. EPA Region IX Tap Water PRG	Comments	Aquatic Organisms Only	Comments	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Ingestion (x 0.1)	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Inhalation (x 0.1)	Comments	U.S. EPA Region IX Residential Soil PRG	U.S. EPA Region IX Industrial Soil PRG	Comments	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Migration to Groundwater (x 0.1)	Comments	EPA Target Groundwater Concentration Protective of Indoor Air (µg/L)	Volatile	Comments	Fresh-water Sediment	Commetns	Marine Sediment	Comments	Fresh Water	Comments	Marine Water	Comments	Plants	Comments	Soil Biota	Comments	Wildlife	Comments	Bio-accumulation (tissue residue), wildlife protection	Comments
Analyte		µg/L	mg/kg	(A) µg/L		(B) µg/L		(C) µg/L		(D) µg/L		(F) µg/L		(G) mg/kg	(G) mg/kg		(H) mg/kg	(H) mg/kg		(G) mg/kg					(I) mg/kg		(I) mg/kg		(J) ug/L		(K) ug/L		(L) mg/kg		(L) mg/kg		(L) mg/kg		(M) ug/kg diet(ww)	
Hexachlorocyclopentadiene	X	30	1	50		200		5		220		17,000		71	0.7		370	3700		13		50	y	27	NA		NA		NA		NA		10	25	NA		NA		NA	
Hexachloroethane	X	10	0.25	NA		40		6		4.80		3.3	17	10.1	39		35	120		0.16		38	y	27	1	15	NA		12	12	NA		NA		NA		NA		NA	
Indeno (1,2,3-cd) pyrene	X	10 (0.05)	0.25 (0.005)	NA		NA		0.1		0.092		0.018	17	1.1	NA		0.62	2.1		5.4		NA			0.0173	14	0.34	16	NA		NA		NA		NA		NA		NA	
Isophorone	X	10	0.25	NA		7000		90		71		960	17	870	NA		510	510		0.3		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Naphthalene	X	10 (0.05)	0.25 (0.005)	NA		700		70		6.2		NA		200	12		56	190		2.1		150	#N/A	27	0.0146	14	0.0346		24	12	NA		NA		NA		NA		NA	
Nitrobenzene	X	10	0.25	NA		NA		1.8		3.40		1,900		5.1	9		20	100		0.006		2000	#N/A	27	NA		NA		NA		NA		NA		40	29	NA		NA	
N-Nitrosodimethylamine[2a]	X	10	0.26	NA		NA		NA		0.0013		NA		170	NA		0.0095	0.034		0.34		NA			NA		NA		NA		NA		NA		NA		NA		NA	
N-Nitroso-di-n-propylamine	X	10	0.25	NA		NA		0.01		0.0096		0.51	17	0.12	NA		0.069	0.25		0.000036		NA			NA		NA		NA		NA		NA		NA		NA		NA	
N-Nitrosodiphenylamine		10	0.25	NA		NA		17		14		6	17	170	NA		99	350		0.34		NA			NA		0.11	16	210	11	NA		NA		20	29	NA		NA	
Pentachlorophenol	X	50	1	1		1000		0.1		0.56		3	17	3.5	NA		3.0	9.0		0.001		NA			NA		0.36	16	6.7	8	7.9		5	24	31	24	0.0018	24	NA	
Phenanthrene	X	10 (0.1)	0.25 (0.005)	NA		NA		1100		NA		NA		3000	NA		NA	NA		430		NA			0.0419		0.0867		6.3	12	8.3	12	NA		NA		NA		NA	
Phenol	X	10	0.25	NA		11000		2200		11000		4,600,000		6080	NA		18000	100000		6.7		NA			NA		0.42	16	NA		NA		70	23	30	29	NA		NA	
Pyrene	X	10 (0.05)	0.25 (0.005)	NA		NA		110		180		11,000		300	NA		2300	29000		150		NA	#N/A	27	0.053		0.153		NA		NA		NA		NA		NA		NA	
Retene		NA	NA	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
sec-Butylbenzene		2.2	0.002	NA		NA		NA		240		NA		NA	NA		220	220		NA		250	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
tert-Butylbenzene		3	0.002	NA		NA		NA		240		NA		NA	NA		390	390		NA		290	#N/A	27	NA		NA		NA		NA		NA		NA		NA		NA	
Total Petroleum Hydrocarbons																																								
Gasoline Range Organics (GRO)	X	50	1	NA		NA		130		NA		NA		140	140	2	NA	NA		30	2	NA	y		NA		NA		NA		NA		NA		100	25	5000	25	NA	
Diesel Range Organics (DRO)	X	100	5	NA		NA		150		NA		NA		1025	1250	2	NA	NA		25	2	NA			NA		NA		NA		NA		NA		200	25	6000	25	NA	
Residual Range Organics (RRO)	X	200	10	NA		NA		110		NA		NA		1000	2200	2	NA	NA		1100	2	NA			NA		NA		NA		NA		NA		NA		NA		NA	
Extractable Petroleum Hydrocarbons	X	200	10	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Volatile Petroleum Hydrocarbons	X	50	1	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA	y		NA		NA		NA		NA		NA		NA		NA		NA	
Dioxins and Furans																																								
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxi	X	0.00005	0.000005	NA		NA		NA		0.000045	26	NA		NA	NA		0.00039	0.0016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
1,2,3,4,6,7,8-HPCDF	X	0.00005	0.000005	NA		NA		NA		0.000045	26	NA		NA	NA		0.00039	0.0016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
1,2,3,4,7,8,9-HPCDF	X	0.00005	0.000005	NA		NA		NA		0.000045	26	NA		NA	NA		0.00039	0.0016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	X	0.00005	0.000005	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
1,2,3,4,7,8-HXCDF	X	0.00005	0.000005	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	X	0.00005	0.000005	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
1,2,3,6,7,8-HXCDF	X	0.00005	0.000005	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	X	0.00005	0.000005	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
1,2,3,7,8,9-HXCDF	X	0.00005	0.000005	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
1,2,3,7,8-Pentachlorodibenzofuran	X	0.00005	0.000005	NA		NA		NA		0.000009	26	NA		NA	NA		0.000078	0.00032	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	X	0.00005	0.000005	NA		NA		NA		0.00000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
2,3,4,6,7,8-HXCDF	X	0.00005	0.000005	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
2,3,4,7,8-PECDF	X	0.00005	0.000005	NA		NA		NA		0.0000009	26	NA		NA	NA		0.0000078	0.000032	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
2,3,7,8-TCDD	X	0.00001	0.000001	0.00003		0.00004		3E-06		0.00000045	26	NA		NA	NA		0.0000039	0.000016		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
2,3,7,8-Tetrachlorodibenzofuran	X	0.00001	0.000001	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
OCDD	X	0.0001	0.00001	NA		NA		NA		0.0045	26	NA		NA	NA		0.039	0.16	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
OCDF	X	0.0001	0.00001	NA		NA		NA		0.0045	26	NA		NA	NA		0.039	0.16	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
HPCDD, total		NA	NA	NA		NA		NA		0.000045	26	NA		NA	NA		0.00039	0.0016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
HPCDF, total		NA	NA	NA		NA		NA		0.000045	26	NA		NA	NA		0.00039	0.0016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
HXCDD, total		NA	NA	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
HXCDF, total		NA	NA	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
PeCDD, total		NA	NA	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
PeCDF, total		NA	NA	NA		NA		NA		0.0000090	26	NA		NA	NA		0.000078	0.00032	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
TCDD, total		NA	NA	NA		NA		NA		0.00000045	26	NA		NA	NA		0.0000039	0.000016	26	NA		NA			NA		NA		NA		NA		NA		NA		0.000002	25	0.00071	20
TCDF, total		NA	NA	NA		NA		NA		0.0000045	26	NA		NA	NA		0.000039	0.00016	26	NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Pesticides and Herbicides																																								
2,4-D		NA	NA	70		NA		NA		360		NA		NA	NA		690	7700		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Aldrin	X	0.05	0.0015	NA		NA		0.005		0.004		NA		0.05	2.4		0.029	0.10		0.16		0.71	y	27	NA		NA		3	10	1.3	10	NA		NA		0.1	25	NA	
alpha-BHC	X	0.03	0.0015	NA		NA		0.01		0.011		NA		0.13	0.55		0.090	0.36		0.00026		31	y	27	NA		NA		NA		NA		NA		NA		6	25	NA	
alpha-Chlordane	X	0.03	0.0015	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA	y	27	NA		NA		0.0043		0.004		NA		1	25	2.7	25	NA	
Atrazine[2a]	X	NA	NA	3		1000		NA		0.30		NA		NA	NA		2.2	7.8		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
beta-BHC	X	0.1	0.0015	NA		NA		0.047		0.037		NA		0.46	4.3		0.32	1.3		0.0009		NA	y	27	NA		NA		NA		NA		NA		NA		6	25		
4,4'-DDD	X	0.03	0.002	NA		NA		0.36		0.28		NA		3.5	NA		2.4	10		4.7		NA			0.0035		0.0012		0.011	11	NA		NA		NA		0.75	25	14	28
4,4'-DDE	X	0.03	0.002	NA		NA		0.25		0.20		NA		2.4	NA		1.7	7.0		15		NA		27	0.0014		0.0021		NA		NA		NA		NA		0.75	25	14	28
4,4'-DDT	X	0.03	0.002	NA		NA		0.25		0.20		NA		2.4	530		1.7	7.0		8.8		NA			0.0070		0.0019		0.001		0.001		NA		NA		0.75	25	14	28
delta-BHC	X	0.03	0.0015	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		6	25	NA	
Dichloropropanol		NA	NA	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Dieldrin	X	0.03	0.002	NA		NA		0.005		0.0042		NA		0.05	0.8		0.030	0.11		0.0015		8.6	y	27	0.0019	13	NA		0.056		0.0019		NA		NA		0.000032	24	NA	
Endosulfan I*	X	0.03	0.0015	NA		NA		NA		219		240		61	NA		370	3700		0.7		NA	y	27	0.0029	15	NA		0.056		0.0087		NA		NA		NA		NA	
Endosulfan II*	X	0.03	0.002	NA		NA		NA		219		240		61	NA		370	3700		0.7		NA	y	27	0.0140	15	NA		0.056		0.0087		NA		NA		NA		NA	
Endosulfan Sulfate	X	0.03	0.002	NA		NA		NA		NA		240		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Endrin	X	0.03	0.002	2		NA		0.2		11		0.81		3	NA		18	180		0.03		NA			0.0022	13	NA		0.036		0.0023		NA		NA		0.2	25	NA	
Endrin aldehyde	X	0.05	0.002	NA		NA		NA		NA		0.81		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Endrin ketone	X	0.03	0.002	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	

Table 4-2
Preliminary Human Health and Ecological Screening Levels

				Human Health Screening Levels for Groundwater								Human Health Screening Levels for Surface Water		Human Health Screening Levels for Soil and Sediment						Migration to Groundwater		Human Health Indoor Air			Ecological Screening Levels for Sediment				Ecological Screening Levels for Surface Water				Ecological Screening Levels for Soil							
Analyte	Target Compound List	Practical Quantitation Limit[1] µg/L	Practical Quantitation Limit[2] mg/kg	Alaska 1° Maximum Contaminant Level (A) µg/L	Comments	Federal Drinking Water Equivalent (B) µg/L	Comments	ADEC Groundwater Cleanup Level (x 0.1) (C) µg/L	Comments	U.S. EPA Region IX Tap Water PRG (D) µg/L	Comments	Aquatic Organisms Only (F) µg/L	Comments	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Ingestion (x 0.1) (G) mg/kg	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Inhalation (x 0.1) (G) mg/kg	Comments	U.S. EPA Region IX Residential Soil PRG (H) mg/kg	U.S. EPA Region IX Industrial Soil PRG (H) mg/kg	Comments	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Migration to Groundwater (x 0.1) (G) mg/kg	Comments	EPA Target Groundwater Concentration Protective of Indoor Air (µg/L)	Volatile	Comments	Fresh-water Sediment (I) mg/kg	Commetns	Marine Sediment (I) mg/kg	Comments	Fresh Water (J) ug/L	Comments	Marine Water (K) ug/L	Comments	Plants (L) mg/kg	Comments	Soil Biota (L) mg/kg	Comments	Wildlife (L) mg/kg	Comments	Bio-accumulation (tissue residue), wildlife protection (M) ug/kg diet(ww)	Comments
Chlordane	X	0.03	0.0015	2		NA		0.2		0.19		NA		2.4	51		1.6	6.50		0.3		NA	y	27	0.0045		0.00026		0.0043		0.004		NA		1	25	2.7	25	NA	
gamma-BHC (Lindane)	X	0.03	0.0015	0.2		NA		0.02		0.052		NA		0.64	NA		0.44	1.7		0.0003		110	y	27	0.00094		0.00032		0.95	10	1.6	10	NA		NA		6	25	NA	
Heptachlor	X	0.01	0.002	0.4		NA		0.04		0.015		NA		0.2	0.08		0.11	0.38		0.8		0.4	y	27	NA		NA		0.0038		0.0036		NA		NA		0.4	25	NA	
Heptachlor epoxide	X	0.03	0.002	0.2		NA		0.02		0.0074		NA		0.09	3.3		0.053	0.19		0.02		NA			0.0006		NA		0.0038		0.0036		NA		NA		0.4	25	NA	
Methoxychlor	X	0.03	0.002	40		NA		4		180		NA		51	NA		310	3100		5.2		NA	y	27	0.0190	15	NA		0.03		0.03		NA		NA		NA		NA	
Toxaphene	X	0.1	0.05	3		NA		0.3		0.061		NA		0.8	62		0.44	1.6		1		NA			0.028	15	NA		0.0002		0.0002		NA		NA		NA		6.3	
Inorganics																																								
Aluminum	X	100	2	NA		NA		NA		36000		NA		NA	NA		76000	100000		NA		NA			25500	14	NA		87		NA		nontoxic	24	nontoxic	24	NA		NA	
Ammonia (as N)		NA	NA	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		5370	5	35	9	NA		NA		NA		NA	
Antimony	X	1	0.1	6		10		0.6		15		4300		4.1	NA		31	410		0.36		NA			0.16	14	NA		30	11	NA		5	23	78	24	0.25	24	NA	
Arsenic	X	10	1.8	10	3	10		5		0.045		NA		0.55	NA		0.39	1.6		0.2		NA			5.9		7.24		150		36		18	24	60	29	43	24	NA	
Barium	X	3	0.3	2000		2000		200		2600		NA		710	NA		5400	67000		110		NA			NA		NA		4	11	NA		500	23	330	24	2000	24	NA	
Beryllium	X	1	0.1	4		70		0.4		73		NA		20	NA		150	1900		4.2		NA			NA		NA		0.66	11	NA		10	23	40	24	21	24	NA	
Cadmium	X	2	0.2	5		20		0.5		18		NA		10	NA		37	450		0.5		NA			0.596		0.676		0.27	6	8.8		32	24	140	24	0.36	24	NA	
Calcium	X	1000	30	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Chromium	X	4	0.4	100		100		10		110	18	NA		30	NA		210	450	19	2.6		NA			37.3		52.3		11	7	50	7	NA	24	0.4	29	26	24	NA	
Cobalt	X	1	0.5	NA		NA		NA		730		NA		NA	NA		900	1900		NA		NA			NA		NA		3	12	NA		13	24	1000	29	120	24	NA	
Copper	X	6	0.6	1300	4	NA		130		1500		NA		406	NA		3100	41000		700		NA			35.7		18.7		9.3	6	3.1		100	23	60	29	217	25	NA	
Cyanide (free)	X	5	0.06	200				20		730		220000		200	NA		1200	12000		2.7		NA			NA		NA		5.2		1		NA		NA		NA		NA	
Iron	X	1000	10	NA		NA		NA		11000		NA		NA	NA		23000	100000		NA		NA			188400	14	NA		1000		NA		NA		200	29	NA		NA	
Lead	X	1	0.2	15	4	NA		1.5		NA		NA		40	40		400	800		NA		NA			35		30.24		3.2	6	8.1		110	24	1700	24	11	24	NA	
Magnesium	X	1000	30	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Manganese	X	2	0.2	NA		1600		NA		880		100		NA	NA		1800	19000		NA		NA			630	14	NA		80	12	NA		500	23	100	29	1500	25	NA	
Mercury	X	0.2	0.04	2		10		0.2		11		0.051		NA	1.8		23	310		0.14		0.68	y	27	0.174		0.13		0.77		0.94		0.3	23	0.1	29	5.5	25	33	21
Nickel	X	2	0.2	100		700		10		730		4600		200	NA		1600	20000		8.7		NA			18		15.9		52	6	8.2		30	23	90	29	980	25	NA	
Nitrate/Nitrite		NA	NA	10000		NA		NA		1000		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Potassium	X	1000	100	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Selenium	X	10	0.5	50		200		5		180		11000		51	NA		390	5100		0.35		NA			NA		NA		5	6	71		1	23	70	29	0.3	25	NA	
Silver	X	2	0.1	100	4	200		18		180		NA		51	NA		390	5100		2.1		NA			NA		0.73		1.9	10	1.9	10	2	23	50	29	NA		NA	
Sodium	X	1000	100	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Sulfate		NA	NA	250000	4	NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Thallium	X	1	0.02	2		2		0.2		2.4		6.3		NA	NA		5.2	67		NA		NA			NA		NA		12	11	NA		1	23	NA		NA		NA	
Vanadium	X	20	3	NA		NA		26		36		NA		71	NA		78	1000		340		NA			NA		NA		19	12	NA		2	23	20	29	7.8	24	NA	
Zinc	X	25	1	NA		10000		1100		11000		69000		3000	NA		23000	100000		910		NA			123.1		124		120	6	81		50	23	100	29	360	25	NA	
PCBs																																								
Aroclor 1016 (or low risk unspeciated mix	X	0.1	0.05	NA		NA		NA		0.96		NA		NA	NA		3.9	29		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Aroclor 1221	X	0.1	0.05	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Aroclor 1232	X	0.1	0.05	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Aroclor 1242	X	0.1	0.05	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Aroclor 1248	X	0.1	0.05	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Aroclor 1254	X	0.1	0.05	NA		NA		NA		0.034		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
Aroclor 1260	X	0.1	0.05	NA		NA		NA		NA		NA		NA	NA		NA	NA		NA		NA			NA		NA		NA		NA		NA		NA		NA		NA	
PCBs, total	X	NA	NA	0.5		NA		0.05	1	0.034		NA		0.1	0.1		0.22	0.74		NA		NA			0.0341		0.02155		0.014		0.03		40	23	NA		0.65	25	0.00079	22

Notes:

NA = not available
ADEC = Alaska Department of Environmental Conservation
mg/L = milligrams per liter
mg/kg = milligrams per kilogram
µg/L = micrograms per liter
µg/kg = micrograms per kilogram
U.S. EPA = United States Environmental Protection Agency
PRG = preliminary remediation goal
TEL = threshold effect level
* Surrogate compound was used.

[1]. Practical Quantitation Limits for water provided by Analytical Laboratory.

[2]. Practical Quantitation Limits for soil and sediment provided by Analytical Laboratory

[2a] Practical Quantitation Limits for individual compounds provided by EPA Contract Lab Program, Analytical could not provide.

[3] Target Compound List per CERCLA Target Compound List for Superfund sites. Analytes not on TCL will not be specific targets for site investigation unless specifically added.

Source References

(A) (ADEC, 2003b) Drinking Water Primary Maximum Contaminant Levels, Table I of Alaska Water Quality Criteria Manual, May 15, 2003, unless noted
(B) (U.S. EPA, 2004f). 2004 Edition of the Drinking Water Standards and Health Advisories. MCLs and DWELs. EPA 822R02038. Office of Water. Winter 2004.
(C) (ADEC, 2004b) Groundwater Cleanup Levels Table C of 18 AAC 75, as amended May 26, 2004

Table 4-2
Preliminary Human Health and Ecological Screening Levels

				Human Health Screening Levels for Groundwater								Human Health Screening Levels for Surface Water		Human Health Screening Levels for Soil and Sediment						Migration to Groundwater		Human Health Indoor Air			Ecological Screening Levels for Sediment				Ecological Screening Levels for Surface Water				Ecological Screening Levels for Soil							
	Target Compound List	Practical Quantitation Limit 1	Practical Quantitation Limit 2	Alaska 1° Maximum Contaminant Level	Comments	Federal Drinking Water Equivalent	Comments	ADEC Groundwater Cleanup Level (x 0.1)	Comments	U.S. EPA Region IX Tap Water PRG	Comments	Aquatic Organisms Only	Comments	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Ingestion (x 0.1)	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Inhalation (x 0.1)	Comments	U.S. EPA Region IX Residential Soil PRG	U.S. EPA Region IX Industrial Soil PRG	Comments	ADEC "Under 40 inch Zone" Method 2 Cleanup Level for Migration to Groundwater (x 0.1)	Comments	EPA Target Groundwater Concentration Protective of Indoor Air (µg/L)	Volatile	Comments	Fresh-water Sediment	Commetns	Marine Sediment	Comments	Fresh Water	Comments	Marine Water	Comments	Plants	Comments	Soil Biota	Comments	Wildlife	Comments	Bio-accumulation (tissue residue), wildlife protection	Comments
Analyte		µg/L	mg/kg	(A) µg/L		(B) µg/L		(C) µg/L		(D) µg/L		(F) µg/L		(G) mg/kg	(G) mg/kg		(H) mg/kg	(H) mg/kg		(G) mg/kg					(I) mg/kg		(I) mg/kg		(J) ug/L		(K) ug/L		(L) mg/kg		(L) mg/kg		(L) mg/kg		(M) ug/kg diet(ww)	

Notes cont.

(D) (U.S. EPA, 2004e). Region IX Preliminary Remediation Goals (PRGs) for tap water. Available at U.S. EPA Region IX website: www.epa.gov/region 09/waste/sfund/prg/intro.htm October, 2004
(E) (ADEC, 2003b) Human Health Criteria for Noncarcinogens, Water and Aquatic Organisms, Table V of Alaska Water Quality Criteria Manual, May 15, 2003, unless noted
(F) (ADEC, 2003b) Human Health Criteria for Noncarcinogens, Aquatic Organisms Only, Table V of Alaska Water Quality Criteria Manual, May 15, 2003, unless noted
(G) (ADEC, 2004c) Method 2 Soil Cleanup Levels, Under 40 inch Zone. Table B1 of 18 AAC 75, as amended May 26, 2004
(H) (U.S. EPA, 2004e) Region IX Preliminary Remediation Goals (PRGs). Available at U.S. EPA Region IX website: www.epa.gov/region 09/waste/sfund/prg/intro.htm October, 2004.
(I) ADEC Sediment Quality Guidelines (ADEC, 2004a) derived from Buchmann (1999) SQuiRT TEL values for freshwater and marine sediment unless otherwise indicated.
(J) (ADEC, 2003b) Aquatic Life Criteria for Fresh Waters, Table III of Alaska Water Quality Criteria Manual, May 15, 2003, unless note
(K) (ADEC, 2003b) Aquatic Life Criteria for Marine Waters, Table IV of Alaska Water Quality Criteria Manual, May 15, 2003, unless noted
(L) Sources for soil screening values as detailed for each analyte. In general, USEPA (2005) EcoSSL values were preferred ahead of alternate sources. Wildlife screening levels are based on the lower of avian or mammalian concentrations.
(M) (Canadian Environmental Quality, 2002). Canadian Environmental Quality Guidelines for Tissue Residue protective of Wildlife, Update 2002. Units in ug/kg wet weight tissue residue in prey

Comments

1. Total PCBs defined as the sum of the seven specific Aroclors listed above
2. Petroleum Hydrocarbon cleanup levels are from Table B2 of the same source
3. The Alaska Primary MCL for As is 50 ug/L. Recent USEPA MCL is 10 ug/L which was applied here.
4. These values derived from the USEPA Lead and Copper rules, or USEPA Secondary MCLs
5. Ammonia criterion calculated based on a pH=7 and a temperature of 16 degrees C, per Table VII B of the Alaska Water Quality Criteria
6. Expressed as total recoverable metal at a hardness of 100 mg/L.
7. Value for Cr VI. The equivalent value for Cr III (at hardness=100) is 86.2 ug/L
8. At pH=7
9. As unionized ammonia
10. No chronic value. Used the acute value.
11. Source: Suter and Tsao (1996) Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota, 1996 Revision Tier II Secondary Chronic Values
12. Source: (U.S. EPA, 1996b) OSWER Ecotox Threshold (ET) values, USEPA 1996
13. Source: (MacDonald et al., 2000) Development and Evaluation of Consensus based Sediment Quality Guidelines for Freshwater ecosystems. Archives of Environmental Contamination and Toxicology 39:20-31.
14. No general TEL in SQuiRT table. Used TEL for *Hyalella azteca* 28 day test listed in same table.
15. Source: (U.S. EPA, 1996c) OSWER Sediment Quality Benchmark based on EPA Tier II Chronic Value (Region IV 1996), assuming 1% total organic carbon.
16. Source: (Washington Ecology, 1995) Sediment Management Standards. Chapter 173-204. Washington Administrative Code (WAC). Concentrations reported in ug/g organic carbon and were converted based on 1% organic carbon
17. Source: (U.S. EPA, 2002c) Human Health Fact Sheet: Revised National Recommended Water Quality Criteria. EPA822F03012. November 2002.
18. Based on value for Cr VI. Cr III value is 55000 ug/L
19. Value for a 1:6 ratio of Cr VI:CrIII
20. Expressed as TEQ (wildlife toxicity equivalents for all chlorinated dibenzo-*p*-dioxin and furan congeners)
21. Applies to methylmercury
22. Expressed as TEQ (wildlife toxicity equivalents for all PCB congeners)
23. (Efroymson et al., 1997) Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants. 1997 Revision ES/ER/TM-85/R3
24. (U.S. EPA, 2005b) Guidance for Developing Ecological Soil Screening Levels. Office of Emergency and Remedial Response Washington D.C. November 2003, Revised February 2005.
25. (Washington Department of Ecology, 2001) Terrestrial Ecological Evaluation Process: Interactive User's Guide. Washington State Department of Ecology. Toxics Cleanup Program.
26. All chlorinated dioxin and furan values were calculated based on Worl Health Organization (WHO) toxicity equivalent factors for dioxins: Van den Berg, M., Birnbaum, L., Bosveld, B.T.C., Brunstrom, B., Cook, P., Feeley, M., Giesy, J.P., Hanberg, A., Hasegawa, R., Kennedy, S.W., Kubiak, T., Larsen, J.C., van Leeuwen, F.X.R., Liem, A.K.D., Nolt, C., Peterson, R.E., Poellinger, L., Safe, S., Schrenck, D., Tillitt, D., Tysklind, M., Younes, M., Waern, F., and Zacharewski, T. (1998). Toxic Equivalency Factors (TEFs) for PCBs, PCDDs, PCDFs for Humans and for Wildlife. Environmental Health Perspectives 106, 775.
27. U.S. EPA, 2002. Draft Guidance for Evaluating Vapor Intrusion from Subsurface Soil and Groundwater. November 2002. Table 2 (Target risk level = 10^{-5})
28. The value presented is for total DDT, which equals DDT + DDE + DDD.
29. (Efroymson et al., 1997) Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebratres and Heterotrophic Process: 1997 Revision ES/ER/TM-126/R2

Table 4-3
Proposed Natural Attenuation Performance Monitoring Parameters and Analytical Methods/Protocols

Data Requirement	EPA/ASTM Method	Laboratory Reporting Limit (mg/L)	Field or Lab	Minimum Sample Size	Number of Containers Per Sample	Container Type/Size	Sample Preservation	Holding Time
Dissolved Oxygen	EPA 360.1	NA	Field	NA	NA	NA	NA	NA
Temperature	NA	NA	Field	NA	NA	NA	NA	NA
Conductivity	NA	NA	Field	NA	NA	NA	NA	NA
pH	EPA 150.1	NA	Field	NA	NA	NA	NA	NA
Oxidation/Reduction Potential	NA	NA	Field	NA	NA	NA	NA	NA
Nitrate/Nitrite	EPA 300.0	1	Lab	100 ml	1	poly/glass	H_2SO_4 to pH<2	28 days
Sulfate	EPA 300.0	0.1	Lab	100 ml	1	poly/glass	Cool, 4^oC	28 days
Sulfide	EPA 376.2	0.1	Lab	100 ml	1	poly/glass	Zinc Acetate & NaOH	7days
Ferrous Iron (field filtered)	SW-846 6020	1	Lab	100 ml	1	poly	HNO_3 to pH<2	6 months
Dissolved Manganese (field filtered)	SW-846 6020	0.002	Lab	100 ml	1	poly	HNO_3 to pH<2	6 months
Alkalinity	SM20 2320B	10	Lab	100 ml	1	poly/glass	Cool, 4^oC	14 days
Dissolved Gases (O_2,CO,CO_2,CH_4^+)	MS GC-Thermal	NA	Lab	40 ml	2	VOA vial	Cool, 4^oC	14 days

Notes:
NA = not applicable
Field = field measurement
mg/L = milligrams per liter
ml = milliliter
poly = polyethylene sample container
glass = glass sample container

Figures

To navigate to the figures for this electronic version of the RI/FS Work Plan *Revision 1*, click on the appropriate link on the List of Figures page.

To go to the List of Figures page, click *here*.

Appendix A

Project Management Plan

Project Management Plan
Alaska Railroad Corporation
Anchorage Terminal Reserve
U.S. EPA Docket No. CERCLA 10-2004-0065
Anchorage, Alaska

Prepared by:

The RETEC Group, Inc.
1726 Cole Boulevard,
Building 22, Suite 150
Golden, Colorado 80401

Prepared for:

Alaska Railroad Corporation
327 West Ship Creek Avenue
Anchorage, AK 99501

June 22, 2005

Table of Contents

1 Project Overview

This Project Management Plan serves as a reference document for the Alaska Railroad Corporation (ARRC) project implementation of the *Administrative Order on Consent* (AOC) (U.S. EPA, 2004a) and the associated *Statement of Work* (SOW) (U.S. EPA, 2004b) with respect to completion of the Remedial Investigation/Feasibility Study (RI/FS) required under the AOC. The RI/FS scope of work includes completion of required data collection and documentation as outlined in the AOC and SOW.

Ernie Piper is the ARRC Project Coordinator and primary ARRC contact for this project. His contact information is as follows:

Alaska Railroad Corporation
327 West Ship Creek Avenue
Anchorage, AK 99501

Jacques Gusmano is the United States Environmental Protection Agency (U.S. EPA) Project Coordinator and the primary agency contact for this project. His contact information is as follows:

U.S. EPA Alaska Operations Office
222 West 7th Ave., #19
Anchorage, AK 99513

Chris Cosentini is the RETEC Project Manager and principal ARRC consultant for this project. As the RETEC Project Manager, Chris is available to assist ARRC with questions and concerns. Her contact information is as follows:

The RETEC Group, Inc.
1726 Cole Boulevard
Building 22, Suite 150
Golden, CO 80401

Stan Flagel is the RETEC Task Manager responsible to ARRC for oversight and management of the RI/FS. His contact information is as follows:

The RETEC Group, Inc.
3401 Minnesota Drive, Suite 300
Anchorage, AK 99503

The RI/FS project organization chart is depicted on Figure 1.

1.1 Project Description

The Alaska Railroad began operations in 1914. It formerly was owned and operated by various departments of the federal government including the former War Department, Department of Interior, and most recently, the Department of Transportation. The federal government transferred the railroad to the State of Alaska in 1985 (SAIC, 1996). The ARRC Anchorage Terminal Reserve that constitutes the "Site" under the AOC consists of approximately 600 acres of property in the lower Ship Creek valley. The Site includes an ARRC railyard facility that occupies approximately 313 of the 600 acres and includes a railroad track system, maintenance and repair buildings, shops, a refueling area, a tank car cleaning area, warehouses, and administrative offices (SAIC, 1996). The remaining approximately 287 acres consist of parcels that ARRC owns and leases to a variety of commercial and industrial businesses, and includes public streets and rights-of-ways. Leasing of most of the 287 acres began during the federal ownership (Booz, et al., 2002).

Currently, ARRC maintains a rail system for freight and passengers from Seward, Alaska to Fairbanks, Alaska, with spur lines to North Pole and Whittier. The railroad system is operated year-round. Elmendorf Air Force Base lies on the bluff north and northeast of the site and also borders the site to the east along Ocean Dock Road. Small commercial operations, some of which have known or suspected releases of hazardous substances, are situated up-valley (east) of the site, along the Ship Creek floodplain (SAIC, 1996).

ARRC and the U.S. EPA signed the AOC having an effective date of June 29, 2004. The SOW, which is attached to the AOC and an enforceable component of that order, sets forth the following general requirements:

1. Development of relevant and currently available site background information

2. Preparation of a conceptual scope of work for the RI, risk assessments, and FS

3. ARRC's commitment to implement the specific Interim Actions listed in the SOW and perform of additional Interim Actions consistent with the AOC

4. Reporting mechanisms

5. The option of an RI/FS iterative approach that may involve other parties responsible for site releases at some future point in the process

The AOC and SOW are consistent with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Contingency Plan (NCP).

1.2 Project Goals

ARRC's project goals for the RI/FS it will conduct at the site are summarized as follows:

- Meet the AOC/SOW requirements
- Streamline the AOC/SOW process to efficiently manage project costs and schedule
- Support stakeholder management information tools
- Utilize a site-specific risk-based approach to focus required remedial action to those areas that may require it
- Streamline the RI/FS process through engagement with the Alaska Department of Environmental Conservation (ADEC), oil companies, and other potential large lease holders where releases have occurred
- Support proactive stakeholder communications to achieve the above stated project goals

1.3 Remedial Investigation / Feasibility Study Project Team

The primary collaborative RI/FS project team includes representatives from ARRC, the U.S. EPA, The RETEC Group, Inc. (RETEC), and the Community Involvement Program (to be established). The RI/FS project organization chart is depicted on Figure 1.

1.4 Project Schedule

The project schedule is presented in the RI/FS Work Plan and includes the milestone and submittal deadlines for completion of the RI/FS investigation and subsequent reporting.

2 Project Communication Plan

Routine meetings between ARRC and the U.S. EPA are the primary tool used to facilitate information sharing and enable timely decision-making. The U.S. EPA and ARRC have agreed to continue meeting throughout the RI/FS process to discuss development and implementation of the RI/FS Work Plan. ARRC is committed to participating in public meetings as well as to providing information to support the U.S. EPA in implementing the Community Involvement Program.

ARRC's contractor, RETEC, and the U.S. EPA's contractor, CH2M Hill, have established a geographic information system working group as a forum for information sharing to ensure that data is presented in a manner useful to the agency.

Routine information regarding project progress, schedule, and problems encountered will be provided to the U.S. EPA in the form of monthly progress reports, in accordance with AOC requirements. The AOC states that beginning with the first full month following the effective date of the AOC, and throughout the period that the AOC is effective, ARRC shall provide the U.S. EPA with monthly progress reports. These progress reports are due on the tenth of each month, and will at a minimum (with respect to the preceding month) include the following:

1. A description of the actions taken to comply with the AOC during that month
2. The results of sampling, tests, and all other data received by the Respondent
3. A description of the work planned for the next two months with schedules relating such work to the overall project schedule for completion of the RI/FS
4. A description of any problems encountered or anticipated, any actual or anticipated schedule delays, and the solutions developed and implemented to address any actual or anticipated problems or delays.

2.1 Information and Data Management

RETEC maintains a project specific database, both electronic and hardcopy, for this RI/FS project. Hard copy project data and files will be maintained in the RETEC Anchorage, Alaska office. The electronic project database has been provided to the U.S. EPA. ARRC will continue to provide an updated database as new information becomes available.

The SOW requires preparation of a Data Management Plan as part of the RI/FS process. ARRC is providing this plan in the Quality Assurance Project Plan submitted in conjunction with the RI/FS Work Plan. The Data Management Plan covers such topics as requirements for project management systems and software, minimum data requirements, data format, and backup data management.

2.2 Document Review and Deliverable Standards

RETEC has a documented review process for ensuring quality control for all RI/FS project deliverables. Before a proposed report is sent to ARRC it will be reviewed (at a minimum) by the RETEC Project Manager and a RETEC technical editor for compliance with RETEC report quality assurance standards. ARRC will then review the report before it is sent to the U.S. EPA or other external entity.

All work plans and reports will be reviewed by the U.S. EPA, which typically will generate comments and provide those to ARRC. In addition, the U.S. EPA will provide the public with opportunities to review work plans and reports to ensure public involvement in the work being conducted consistent with the requirements of the National Contingency Plan and the AOC. The U.S. EPA will also be responsible for ensuring the distribution of project documents to their consultants and the Alaska Department of Environmental Conservation. Finally, in accordance with the AOC, ARRC will award a Technical Assistance Grant to a qualified community group (i.e., a non-profit group that could be affected by actual or potential releases from the site) to hire an independent technical advisor to review documents and provide assistance related to the purposed work.

2.3 Data Management and Quality Control

RETEC has implemented a unique quality control process for the ARRC RI/FS. All data will be reviewed and approved by the RETEC Data Quality Assurance Manager, Sue Milcan, before being entered into the project database and made available to the agency. Detailed quality control procedures are discussed in the Quality Assurance Project Plan submitted in conjunction with the RI/FS Work Plan.

3 References

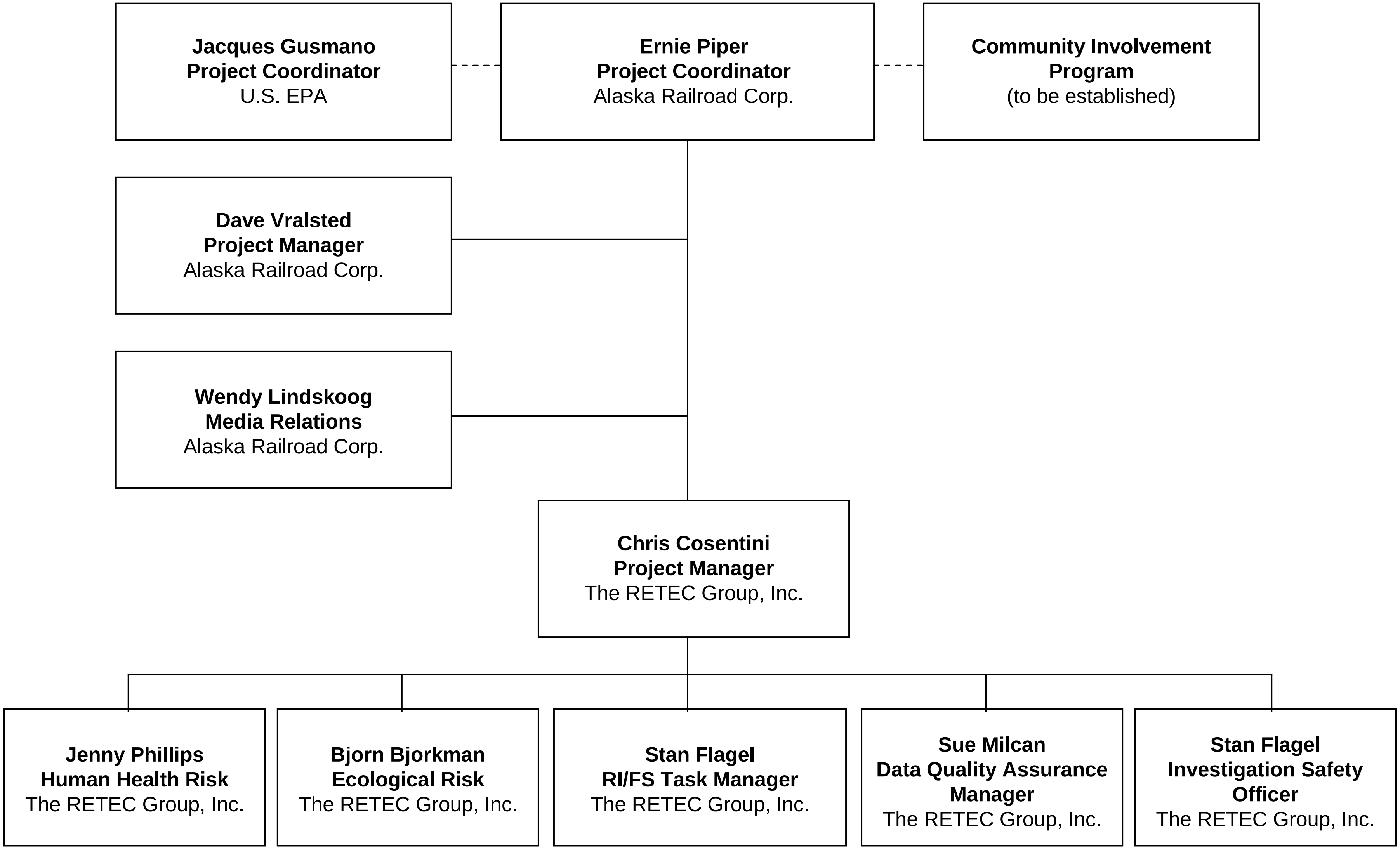
Booz, Allen, and Hamilton, 2002. *RCRA Facility Assessment Report*. Alaska Railroad Corporation Leased Properties. Prepared for U.S. EPA by Booz, Allen, and Hamilton. EPA Id No. AKD 98176-7403. July 16, 2002.

SAIC, 1996. *RCRA Facility Assessment Report*. Alaska Railroad Corporation. Prepared for U.S. Environmental Protection Agency by Science Applications International Corporation. EPA I.D. No. AKD 98176 7403. March 1996.

U.S. EPA, 2004a. *Administrative Order on Consent*. U.S. EPA CERLA Docket No. 10-2004-0065. June 29, 2004.

U.S. EPA, 2004b. *Statement of Work* – Administrative Order on Consent No. CERCLA 10-2004-0065, Alaska Railroad Corporation, Anchorage Terminal Reserve. May 17, 2004.

Figure



Project Management Plan
Alaska Railroad Corporation

Project Organization Chart

Anchorage, Alaska

Figure 1

Appendix B

Project-Specific Health and Safety Plan

RETEC

Project-Specific Health & Safety Plan
The RETEC Group, Inc.

Project Information

Project Name:	**Alaska Railroad Corp. – Anchorage Terminal Reserve, RI / FS Work Plan**
Client:	Alaska Railroad Corporation
Project Site Location:	Anchorage, Alaska
Project Site Address:	327 Ship Creek Ave., Anchorage, Alaska 99501
Date HASP Issued or Updated: (Note: HASP must be updated annually at a minimum)	June 13, 2005
Revision #:	-
Prepared By:	Amber Murray
RETEC Project Manager:	Chris Cosentini
RETEC Investigation (task) Manager:	Stan Flagel
RETEC Site Safety and Health Officer:	Bjorn Selvig or qualified alternate

Emergency Contacts

Contact	Telephone
Ambulance	9-1-1
Fire Department	9-1-1
Police	9-1-1
Hospital Name: Alaska Regional Hospital	907-276-1131
Poison Control	907-261-3193
State Agency (for reporting environmental releases): Alaska Department of Environmental Conservation	907-269-3063

(Site map and hospital route map included as Figures 5-1 and 7-1 of the HASP, respectively.)

RETEC Incident Reporting Contacts

Contact Priority	Name	Contact #
1	RETEC On-Site Manager (Task Mgr.)	Included in Section 7 of the Site-Specific Health and Safety Plan
2	RETEC Project Manager	
3	RETEC Corp. H&S Officer	

Note: Initiate contact in the order listed immediately after stabilizing the situation. Make verbal contact – do not leave messages. Initial RETEC contact person will contact client regarding incident.

PROJECT DESCRIPTION

Project Name/Location: Alaska Railroad Corporation
327 Ship Creek Ave.
Anchorage, Alaska 99501

Site Features (*terrain, utilities, structures*):

The ARRC executive and general offices are located at 327 West Ship Creek Avenue in Anchorage, Alaska on the north bank of Ship Creek. The area immediately surrounding the site is primarily industrial/commercial. The marine waters of Knik Arm (extension of Cook Inlet) are located approximately 0.4 miles to the west. The site consists of approximately 600 acres of property in the lower Ship Creek valley. The railyard facility itself occupies approximately 313 of the 600 acres and includes a railroad track system, maintenance and repair buildings, shops, a refueling area, a tank car cleaning area, warehouses, and administrative offices. Approximately 287 of the 600 acres consist of parcels that are leased to a variety of Anchorage commercial and industrial businesses, which includes public streets and rights of way.

The central business district of Anchorage is located on the bluff above Ship Creek to the south of the site; and the Government Hill residential, commercial, and light industrial district is located on the bluff due north of the Site. Elmendorf Air Force Base lies on the bluff north and northeast of the site and east of the site along Ocean Dock Road. Small commercial operations, some of which have known or suspected releases of hazardous substances, are situated up-valley (east) of the site, along the Ship Creek floodplain.

Scope of Work:

This Project-Specific Health and Safety Plan covers the tasks to be completed as part of the RI/FS field investigation at the Alaska Railroad Corp. site in Anchorage, Alaska. The scope of work for the RI/FS investigation includes (but may not be limited to) the following tasks: soil sampling, groundwater sampling, surface water/sediment sampling, borehole drilling, well installation, well development, and surveying. Hazards associated with these tasks and general site hazards are identified in the Site Specific Health and Safety Plan (HASP) prepared for the project. The HASP includes details regarding project training requirements, hazard recognition and safety precautions/measures, emergency contact information for the site/project, incident or near-miss reporting, railroad safety, decontamination, air monitoring, and personal protective equipment. Hazards and safety measures associated with the field activities proposed in the RI/FS Work Plan are covered in the HASP.

In addition, a Job Hazard Analysis (JHA) will be completed by the field team (i.e., field task manager and field crew) to be used along with this Project-Specific Health and Safety Plan. The JHA identifies specific tasks to be performed during the investigation, the hazards associated with the tasks, and the procedures or provisions to be used to eliminate or minimize the hazards. Additional JHAs may be drafted for new project tasks, as necessary. The HASP and respective project JHA(s) will be reviewed with the site crew before the project begins. Safety Task Analysis Reviews (STAR) will be completed at the start of each work day to identify those hazards associated with the work to be conducted that day and any changes in field conditions from those identified in the JHA.

Subcontractor(s):

Subcontractors to be used for the RI/FS field investigation will be determined upon submittal of the RI/FS Work Plan. All subcontractors selected for the investigation will be required to meet the required site training requirements and satisfy RETEC's subcontractor approval process. All subcontractors will be required to conduct field activities in accordance with the approved RI/FS Work Plan and the HASP. The client (ARRC) will be provided a list of all (any) subcontractors, including contact information, to be used for the RI/FS investigation prior to the beginning of the investigation.

Schedule:

The RI/FS field work will be conducted upon approval of the RI/FS Work Plan. In addition, the schedule for field activities will be dependent upon field conditions at the time the RI/FS Work Plan is approved for implementation. The field investigation will be conducted during a period or season

PROJECT DESCRIPTION

Project Name/Location:	Alaska Railroad Corporation 327 Ship Creek Ave. Anchorage, Alaska 99501
(weather permitting) when field activities can be conducted safely.	

WASTE MANAGEMENT PLAN

Waste Types and Description:	Solid: ☒ (Soils)	Sludge: ☐	Liquid: ☒ (Water)	Gas: ☐

Waste Management Plan:	
Solid	Disposal method to be determined in compliance with applicable local, State and Federal regulations and corporate polices.
Sludge	N/A
Liquid	Disposal method to be determined in compliance with applicable local, State and Federal regulations and corporate polices.
Gas	N/A

POTENTIAL CHEMICAL HAZARDS

Possible Chemicals to be Used during Investigation	MSDS Available
☒ Acids (HCl, H_2SO_4, or HNO_3)	☒
☒ Alcohols (Methanol or Isopropyl alcohol)	☒
☒ Dust-generating agents (Portland Cement, bentonite grout, soda ash, silica sand)	☒
☒ Gasoline	☒
☒ Gasoline Exhaust	☒
☒ Diesel Fuel	☒
☒ Diesel Exhaust	☒
☒ Detergents (Alconox, Simple Green)	☒
☐ Paints	☐
☐ Lubricants/Oils	☐
☒ Calibration Solutions/Gases	☒

☒ Dry Chemical Fire Extinguisher: Powder	☒
☐ Other (list):	☐

Note: Updated MSDS binder will be assigned to the field team and should always accompany the HASP. See the RETEC Site Safety and Health Officer for MSDS binder location on site.

CHEMICAL HAZARD DATA

Chemical of Concern for Task	Chemical Name	Carcinogen (Y/N)	Skin Absorp. Hazard (Y/N)	TWA			ACGIH STEL	IDLH	Routes of Exposure
				NIOSH REL	OSHA PEL	ACGIH TLV			
☒	PAHs	Yes	Yes	0.1 mg/m^3	0.05 mg/m^3	0.2 mg/m^3	NA	80 mg/m^3	I, C
☒	Diesel Fuel	No	Yes	NA	NA	100 ppm	NA	80 mg/m^3	I, G, C
☒	Gasoline	Yes	No	NA	NA	300 ppm	500 ppm	NA	I, S, G, C
☒	Benzene	Yes	Yes	0.1 ppm	1.0 ppm	0.5 ppm	2.5 ppm	500 ppm	I, S, G, C
☒	Toluene	No	No	100 ppm	200 ppm	50 ppm	NA	500 ppm	I, S, G, C
☒	Ethyl benzene	No	No	100 ppm	100 ppm	100 ppm	125 ppm	800 ppm	I, G, C
☒	Xylenes, Total	No	Yes	100 ppm	100 ppm	100 ppm	150 ppm	NA	I, S, G, C
☐	MTBE	No	Yes	NA	100 ppm	100 ppm	150 ppm	NA	I, S, G, C
☐	Carbon Monoxide	No	No	35 ppm	50 ppm	25 ppm	NA	NA	I
☐	Hydrogen Sulfide	No	No	10 ppm Ceiling = 10 min max	20 ppm (ceiling) 50 ppm (10 min max)	10 ppm	15 ppm (ACGIH)	100 ppm	I, C
☒	Lead (inorganic)	No	No	0.01 mg/m^3	0.05 mg/m^3	0.05 mg/m^3	NA	100 mg/m^3	I, G, C
☒	Naphtha	Yes	Yes	N/AP	100 ppm	10 ppm	15 ppm	250 ppm	I, S, G, C

TWA = Time-Weighted Average
STEL = Short Term Exposure Limit

IDLH = Immediately Dangerous To Life or Health
REL = Recommended Exposure Limit
OSHA = Occupational Safety and Health Administration
PEL = Permissible Expo sure Limit

TLV = Threshold Limit Value
Routes of exposure: I = inhalation, S = skin absorption, G = ingestion, C = skin contact
mg/m^3 = milligrams per cubic meter
NA = not applicable
ppm = parts per million

NIOSH = National Institute for Occupational Safety and Health

ACGIH = American Conference of Governmental Industrial Hygienists

SAFE WORK PROCEDURE SUMMARY

	Health and Safety Topics / Hazards Associated with Proposed Investigation Tasks	Pertinent Section of RETEC HASP
☒	Site / Project Training Requirements	Section 1
☒	Hazard Communication	Section 1
☒	Job Hazard Analysis	Section 2
☒	Incident Reporting and Notification	Section 7
☒	Site Control	Section 5
☒	General, Personal, Chemical, and Plan Hazards	Section 2
☒	PPE Selection	Section 3
☒	Decontamination	Section 6
☒	Emergency Response and Evacuation	Section 7
☒	Drum Handling/Sampling	Section 8
☒	Excavations and Trenching	Section 9
☒	Confined Space Entry	Section 10
☒	Lockout/Tagout	Section 11
☒	Fall Protection	Section 12
☒	Drilling Safety	Section 13
☒	Railroad Safety	Section 14
☒	Heat/Cold Stress	Section 2
☒	Hot Work Permits	Section 2
☒	Air Monitoring Requirements and Action Levels	Section 4
☒	Respiratory Protection	Section 3
☒	Precautions for Working Around Heavy Equipment	Section 2
☒	Electrical Safety	Section 2
☐	Other (list) :	

Note: *Check each procedure applicable to work and ensure the work is conducted in accordance with the pertinent procedures provided in the HASP.*

PERSONAL PROTECTIVE EQUIPMENT FOR TASK

MINIMUM LEVEL OF PROTECTION REQUIRED FOR EACH STEP IN THE TASK

Task	Level of Protection
Soil and Groundwater Sampling / Site Surveying	**Level D Protection** – Includes orange reflective traffic vest, orange hard hat, safety glasses (yellow-tinted not allowed), latex or nitrile gloves, and steel toe boots
Surface Water and Sediment Sampling	**Modified Level D Protection** – Includes U.S. Coast Guard approved personal flotation device, safety glasses (yellow-tinted not allowed), latex/nitrile/rubber gloves, and steel toe boots or steel toe hip waders (if sampling in shallow water)
Drilling and Well Installation	**Level D Protection** – Includes orange reflective traffic vest, orange hard hat, safety glasses (yellow-tinted not allowed), hearing protection, latex or nitrile gloves, and steel toe boots
Where Air Monitoring Results Exceed Action Levels Listed Below	**Level C Protection** – Upon reaching action levels listed below: orange reflective traffic vest, latex/nitrile/rubber gloves, orange hard hat, safety glasses (yellow-tinted not allowed), steel toe boots, half or full face respirator with VOC cartridges.

AIR MONITORING PROGRAM

Monitoring Parameters

☒ Organic Vapors
☐ Hydrogen Sulfide
☒ Combustible Gases
☒ Oxygen
☐ Carbon Monoxide
☐ Dust
☐ Other (list):

Personal Sampling

NIOSH/OSHA Method: Personal sampling as required by the RETEC Site Safety and Health Officer (SSHO)

Sampling Frequency: As determined by the SSHO

AIR MONITORING ACTION LEVELS FOR AN ORGANIC VAPOR MONITOR

Instrument: PID (10.2 , 10.6, or 11.7 eV lamp)

Reading above Background	Location	Duration of reading	Action	PPE
Background	Point of Operations/Release Source Point (excavations, lab work, or other waste/soil disturbing activities)	-----	Continue Periodic Monitoring of subsurface soil disturbing activities	Level D
>Background but <10 ppm	Point of Operations/Release Source Point (excavations, lab work, or other waste/soil disturbing activities)	<1 Minute	Perform continuous monitoring of Operator and Laborer Breathing Zone	Level D
>1 ppm but <10 ppm	Operator or Laborer Breathing Zone	>1 Minute	Provide half face respiratory protection. Perform continuous monitoring of Operator and Laborer breathing zone.	Level C
>10 but <50 ppm	Operator or Laborer Breathing Zone	>1 Minute	Provide full face respiratory protection. Perform continuous monitoring of Operator and Laborer breathing zone.	Level C
>50 ppm	Operator or Laborer Breathing Zone	Instantaneous	Evacuate the work area moving in an upwind direction. Contact SSHO.	NA

AIR MONITORING ACTION LEVELS FOR A MINIRAM DUST MONITOR

Reading above Background	Location	Duration	Action	PPE
Background	Operations/Release Source Point	-----	Continue periodic monitoring.	Level D
>Background but <1 mg/m^3 or visible emissions	Operator or Laborer Breathing Zone	>1 Minute	Continuous Monitoring of Operator and Laborer Breathing Zone. Initiate dust control measures	Level D
>1 mg/m^3 or continuous visible emissions	Operator or Laborer Breathing Zone	>1 minute	Discontinue operations and evacuate personnel until airborne dust can be controlled.	---------

ACTION LEVELS FOR THE COMBUSTIBLE GAS INDICATOR

Lower Explosive Limit (LEL)	Location	Action
<2.5% LEL	Point of Operations/General Work Area	Continue site operations and continue periodic monitoring. Add organic vapor monitoring for personnel protection.
2.5-5% LEL	Point of Operations/General Work Area	Continue site operations and perform continuous monitoring.
>10%LEL	Point of Operations/General Work Area	Shutdown operations, evaluate source, ventilate work area. Contact the SSHO for further instructions.

ACTION LEVELS FOR THE OXYGEN MONITOR

O_2 Reading	Location	Action
<19.5%	Operations/General Work Area	Evacuate the work area immediately. Contact the SSHO for further instructions.
19.5-23.5%	Operations/General Work Area	Continue site operations
>23.5%	Operations/General Work Area	Evacuate the work area immediately. Contact the SSHO for further instructions.

ACTION LEVELS FOR CARBON MONOXIDE MONITOR

CO Reading	Location	Action
<20 ppm	Operations/General Work Area	Continue site operations
>20 ppm	Operations/General Work Area	Continue site operations using engineering controls such as industrial fan or exhaust vent
>50 ppm	Operations/General Work Area	Evacuate the work area immediately. Contact the SSHO for further instructions

DECONTAMINATION

All non-dedicated, non-disposable equipment contacting potentially contaminated materials will require decontamination using Alconox or isopropyl alcohol and/or distilled water. All fluids generated during equipment decontamination processes will be contained for proper disposal in accordance with site protocols. See Section 6 of the HASP for further details regarding decontamination requirements.

DECONTAMINATION PROCEDURES (SEE SECTION 6 OF HASP)

Items to Decontaminate	Decon. Method	Detergent/Solution	Waste Management	
			Solid	Liquid
Augers/Split Spoon Samplers	Wash/Rinse	2% Alconox		X
Oil/Water Interface Probe	Wash/Rinse	Alcohol		X
pH, Conductivity, Turbidity, or Temperature Probes	Wash/Rinse	2% Alconox		X
Non-dedicated or Non-disposable Groundwater Sampling Equipment	Wash/Rinse	Alcohol		X
Surface Water or Sediment Sampling Equipment	Wash/Rinse	Alcohol		X
Surface Soil Sampling Equipment (e.g., bowl, spoon, spade, etc.)	Wash/Rinse	Alcohol		X
Personal	Wash/Rinse	Soap/Water		X

EXCLUSION ZONE

Minimum Size: To be determined by the SSHO and Task Manager.

JOB HAZARD ANALYSIS (JHA)

A Job Hazard Analysis (JHA) will be completed by the field team (i.e., field task manager and field crew) for the RI/FS field investigation, in accordance with the requirements outlined in the HASP, prior to conducting any field activities at the site. The completed JHA will be attached to this Project-Specific Health and Safety Plan for distribution to the field team. A blank JHA is provided in the HASP for completion.

New tasks to be conducted outside those identified in this Project-Specific Health and Safety Plan will require completion of a separate JHA (as necessary).

PERMITS REQUIRED FOR WORK

☐	Safe Work Clearance
☒	Hot Work Permit
☐	Vacuum Truck Permit
☐	Confined Space Entry Permit
☐	Pit Entry Permit
☐	Dead Line Permit

Prepared by: Amber Murray Revised by: NA Reviewed by: Stan Flagel / Chris Cosentini / Tom Dahl Date: June 22, 2005	**APPROVALS:**
	RETEC Task Manager Date 6/16/05
	RETEC SSHO Date 6/16/05
	RETEC Proj. Manager Chris Cosentini Date 6/21/05

Appendix C

RI/FS Sampling and Analysis Plan

RI/FS Sampling and Analysis Plan
Revision 1

Alaska Railroad Corporation
Anchorage Terminal Reserve

U.S. EPA Docket No. CERCLA 10-2004-0065
Anchorage, Alaska

Prepared by:

The RETEC Group, Inc.
c/o HCG
3401 Minnesota Drive, Suite 300
Anchorage, AK 99503

Prepared for:

Alaska Railroad Corporation
327 Ship Creek Avenue
Anchorage, Alaska 99501

Original: June 23, 2005
Revision 1: August 15, 2005

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Acronyms and Abbreviations

ADEC	Alaska Department of Environmental Conservation
AOC	area of concern
ARRC	Alaska Railroad Corporation
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CERCLA	Comprehensive Environmental Responsibility, Compensation, and Liability Act of 1981
COC	chain-of-custody
CSM	conceptual site model
DQO	data quality objectives
DRO	diesel range organics
EPH	extractable petroleum hydrocarbons
FS	Feasibility Study
GRO	gasoline range organics
HDPE	high-density polyethylene
L/min	liters per minute
LNAPL	light non-aqueous phase liquid
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SOP	RETEC Standard Operating Procedure
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TOC	total organic carbon
USCS	Unified Soil Classification System
UV	ultraviolet
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbons

1 Introduction

This Sampling and Analysis Plan (SAP) details the procedures and methods for conducting Remedial Investigation/Feasibility Study (RI/FS) activities for the Alaska Railroad Corporation (ARRC) site in Anchorage, Alaska, as proposed in the RI/FS Work Plan. This document was prepared in accordance with the requirements outlined in the *Guidance for Conducting Remedial Investigations and Feasibility Studies under the Comprehensive Environmental Responsibility, Compensation, and Liability Act of 1981* (CERCLA) (U.S. EPA, 1988) and the *Statement of Work* (U.S. EPA, 2004a) prepared under the *Administrative Order on Consent U.S. EPA Docket No. CERCLA 10-2004-0065* (U.S. EPA, 2004b) between the United States Environmental Protection Agency (U.S. EPA) Region 10 and ARRC.

Site background information including a summary of historical and current site operations, historical data, a partial list of potential sources and migration pathways, potential human and ecological receptors and exposure pathways, as well as the rationale for the proposed scope of work are all summarized in the RI/FS Work Plan. As such, this SAP details the following topics:

- Investigation objectives
- Analyte lists
- Investigation methods and procedures
- Health and safety

Investigation sample location figures, tables summarizing the proposed scope of work, and tables summarizing analyte lists, sample containers, and preservation requirements are provided in this document.

1.1 Investigation Objectives

The objective of this investigation is to collect data necessary to:

- Determine the nature and extent of contaminants, if present, in soil, groundwater, surface water, and sediment to assess potential risk to human health and the environment, and evaluate remedial action alternatives

- Refine the human health and ecological conceptual site models (CSMs), by identifying sources and source concentrations that may impact Ship Creek and human health, and quantifying fate and transport processes

- Calculate the potential risk to receptors from contaminants detected in soil, groundwater, surface water, and sediment

- Develop, screen, and evaluate remedial action alternatives

To identify the data required to satisfy these objectives, data quality objectives (DQOs) were developed for soil, groundwater and light non-aqueous phase liquid (LNAPL), surface water, and sediment, as summarized in the RI/FS Work Plan. The DQO process for planning data collection efforts was used to define the purpose of the data to be collected, determine how the data will be used, and determine the tolerable limit of uncertainty, in accordance with the *Guidance for the Data Quality Objectives Process for Hazardous Waste Site Investigations* (U.S. EPA, 2000).

The rationale for the proposed RI/FS investigation scope of work is presented in the RI/FS Work Plan along with the human health and ecological CSMs. The procedures and methods for conducting the proposed investigation scope of work are provided in this SAP.

1.2 Investigation Scope Summary

As described in the RI/FS Work Plan, the proposed investigation scope of work for the RI/FS includes the following tasks:

- Borehole drilling and soil sample collection
- Monitoring well installation and development
- Groundwater, spring, LNAPL (if present), sediment, and surface water sampling
- Field analytical data collection (if necessary) (e.g., immunoassay for polychlorinated biphenyls [PCBs])
- Slug testing
- A tidal influence study
- Fluid-level gauging
- Data collection, as required, to evaluate remedial action alternatives
- Groundwater well survey
- Soil cover evaluation
- Visual inspection of specific leased properties

The methods and procedures for completing these tasks are detailed in Section 2. In addition, Section 2 also outlines the investigation procedures for tasks such as field activity documentation, surveying, decontamination, investigation-waste disposal management, sample handling and shipping, and quality assurance sampling.

When possible, RETEC Standard Operating Procedures (SOPs) are referenced in this SAP to ensure consistent investigation methods, procedures, and documentation.

2 Investigation Methods and Procedures

This section summarizes the field methods and procedures that will be used during the RI/FS field investigation. When possible, RETEC SOPs are referenced in the following sections to ensure consistent investigation methods, procedures, and documentation. A copy of the referenced SOPs is provided in Appendices A-1 through A-10, as cited in the following subsections.

2.1 Investigation Analyte Lists

The investigation analyte list (Table 1) for the RI/FS was proposed in the RI/FS Work Plan. A supplemental analyte list (Table 2) including those constituents that will be investigated on a sample-specific basis, was also proposed in the RI/FS Work Plan. These analyte lists reflect the current hazardous substance list of target analytes for Superfund sites as defined in the following documents:

- **Volatile Organic Compounds (VOCs), Semivolatile Organic Compounds (SVOCs), Pesticides, and PCBs.** *USEPA Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, and Multi-Concentration* (U.S. EPA, 2004c)

- **Metals and Cyanide.** *USEPA Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, and Multi-Concentration* (U.S. EPA, 2005)

- **Dioxins and Furans.** *USEPA Analytical Operations/Data Quality Center Statement of Work for Analysis of Chlorinated Dibenzo-p-dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs), Multi-Media, Multi-Concentration* (U.S. EPA, 2002)

All soil, groundwater, sediment, and surface water samples collected during the RI/FS will be analyzed for the list of constituents summarized in Table 1. Some of those samples will also be analyzed for all or a subset of the constituents summarized in Table 2. Further details regarding samples to be analyzed for constituents on the supplemental analyte list are provided in the following sections.

A list of the laboratory container and preservation requirements for analysis of the constituents that appear on the investigation analyte lists is provided in Table 3. To ensure that samples collected during this investigation are analyzed for the proper list of constituents, each chain-of-custody (COC) completed will include a notation identifying the analytes specific to each sample. Sample handling and shipping procedures, including the completion of COCs, are addressed in further detail in Section 2.19.

2.2 Field Activity Documentation

All field activities will be recorded on the appropriate field forms, as described in the following sections, and compiled in a project field notebook on a daily basis. To ensure quality and consistency, all field forms will be reviewed by the field task manager. Daily Field Activity Logs or project field books will be used to record all field activities and document field personnel and visitors present. Health and safety topics including daily meetings and the client-copy of all COCs generated during the investigation will also be kept in the project field notebook. Photographs taken during the RI/FS field activities will be documented on a Field Photograph Log (Appendix B) and the pictures will be filed in an investigation photograph album.

A blank copy of all health and safety field forms to be used during this investigation is provided in the *Site-Specific Health and Safety Plan* (RETEC, 2005a).

2.3 Nomenclature for Site/Sample Identification

In order to facilitate proper identification of site locations, a project naming convention was developed for the RI/FS, as described in Section 2.3.1 of the *Quality Assurance Project Plan* (QAPP) (RETEC, 2005b).

All proposed RI/FS sample locations are depicted on Figures 1, 2, and 3. Preliminary site identifiers (e.g., A1 through A10) were depicted on these figures for ease in presenting the proposed scope of work. The actual site identifiers to be used for data in the project database and presenting data in future reports are provided in Table 4 for the soil and groundwater investigation, and Table 5 for the surface water and sediment investigation. As shown in Tables 4 and 5, there is a “preliminary site identifier” column that corresponds to the locations depicted on Figures 1, 2, and 3. Adjacent to the “preliminary site identifier” column there is a column titled “actual site identifiers.” The “actual site identifiers” will be used for all documentation for an individual location (e.g., boring log, groundwater sampling log, sample chain-of-custody, etc.) and will be used for all future reporting purposes.

All site identifiers consist of a prefix and suffix that correspond to the following logic, in accordance with the procedures outlined in the QAPP:

- **Prefix.** All sample locations have been assigned one of the following 6-character prefixes to aid in identifying the general area of each location:
    - NB001- Identifies locations within the North Bluff

  - ► NB002- Identifies locations within the North Bluff that are located within the Elmendorf Air Force Base OU-5 easement
  - ► SC001- Identifies surface water and/or sediment locations within Ship Creek
  - ► SC002- Identifies surface water and/or sediment locations outside Ship Creek
  - ► LP###- Identifies locations within a leased property (where the "###" is populated with the actual leased property number)
  - ► AR001- Identifies locations within the ARRC property boundary that are not on a designated (or leased) property

- **Suffix.** All sample locations have been assigned a suffix to identify the sample location type (i.e., monitoring well, drive-point well, spring/seep, surface water/sediment, and surface-soil-only locations), and to correspond to the preliminary site identifiers shown on the sample location figures. These suffixes were identified as follows:
  - ► MWB06 Identifies a new monitoring well ("MW") corresponding to the preliminary site identifier "B6"
  - ► DPB01 Identifies a new drive-point well ("DP") corresponding to the preliminary site identifier "B1"
  - ► SP01 Identifies a spring or seep ("SP") location
  - ► CR01 Identifies a surface water and/or sediment location within Ship Creek ("CR") corresponding to preliminary site identifier "S-S-1"
  - ► CSA01 Identifies a surface water and/or sediment location outside of Ship Creek ("CS") corresponding to preliminary site identifier "S-A-1"
  - ► SS01 Identifies a surface-soil-only ("SS") sample location

For example, the actual site identifier to be used for the proposed new monitoring well "A17" on leased property LP-127 (as it appears in Table 4) is as follows: "LP127-MWA17."

The actual site identifiers for all existing monitoring wells proposed for sampling are based on historical site nomenclature and are provided in Table 4.

In the event that a sample location is relocated in the field during the investigation, the prefix of the site identifier will be modified as necessary to reflect the new location. For example, if a monitoring well proposed for installation on leased property LP-112 is relocated to leased property LP-079, then the prefix would be changed to LP079.

2.4 Borehole Drilling, Soil Logging, and Soil Sample Collection

A total of 84 borings are proposed to be completed as wells (monitoring well or drive-point well), as summarized in Table 4 and shown on Figure 1. All proposed borehole drilling activities will be completed by a drilling contractor licensed in the state of Alaska. Prior to commencement of drilling, utility locates will be conducted for each proposed boring location in accordance with the procedures outlined in the *Site-Specific Health and Safety Plan* (RETEC, 2005a). A blank copy of the utility locate form to be used for this investigation, is provided in the *Site-Specific Health and Safety Plan* (RETEC, 2005a).

All borehole drilling will be conducted using either hollow-stem auger or direct-push drilling techniques. Soil sample collection is proposed at all boring locations to be completed by hollow-stem auger drilling, as summarized in Table 4. Thus, the following discussion applies to all hollow-stem auger drilling locations. A discussion of the direct-push drilling method is provided in Section 2.7.2.

Each hollow-stem auger borehole will be sampled every 2-feet from the ground surface to 5-feet into the Bootlegger Cove clay using a 2-foot split-spoon sampler, in accordance with SOP 210 (Appendix A-1). Because the thickness of the Bootlegger Cove clay is greater than 5 feet, the proposed drilling activities (i.e., 5-feet into the clay) will not result in the potential for cross contamination of the lower aquifer. Each soil sample retrieved will be field headspace-screened with a photoionization detector in accordance with SOP 310 (Appendix A-2). Borehole logging procedures conforming to modified ASTM 2488 standards will be used as guidance for lithologic data collection during this investigation. This guidance along with the respective Boring Log field form to be used for documentation, are provided in Appendix C.

Blow counts will be recorded on the Boring Log (Appendix C) for each sampler driven, in accordance with ASTM D1586-84. Each soil sample retrieved in the 2-foot split spoon samplers will be field screened using an ultraviolet (UV) light to induce hydrocarbon fluorescence, if present.

Fluorescence screening will be conducted under a UV light mounted inside a covered box with a viewing window. The soil sample will be viewed through the window to determine if the sample has fluorescence or not. This information will be recorded on the Fluorescence Log provided in Appendix B. All other borehole data collected will be recorded on a Boring Log in accordance with SOP 210 (Appendix A-1).

- Surface and subsurface soil samples will be collected from each proposed hollow-stem auger boring (new monitoring well) for laboratory analyses (Table 4) at the locations depicted on Figure 1. These surface and subsurface soil samples will be analyzed for the investigation analyte list provided in Table 1, with the exception of those collected within Area 3 (as identified in Table 4). At the May 19, 2005 Work Plan presentation meeting between U.S. EPA, Alaska Department of Environmental Conservation (ADEC), and ARRC, it was agreed that samples collected within Area 3 would be analyzed for a modified group of analytes. The Area 3 analyte list for both soil and groundwater will consist of benzene, toluene, ethylbenzene, total xylenes (BTEX), ethylene dibromide, 1,2-dichloroethane, lead, PAHs, and extractable petroleum hydrocarbons (EPH) and volatile petroleum hydrocarbons (VPH). . Select soil samples will also be analyzed for a subset of constituents from the supplemental analyte list (Table 2). The samples to be analyzed for constituents on the supplemental analyte list are identified in Table 4 along with the list of supplemental analytes relevant to each sample. A list of sample containers and required preservation methods to be used for this investigation is provided in Table 3. All samples to be analyzed will be collected in laboratory-supplied containers and will be handled and shipped to the receiving laboratory in accordance with the procedures outlined in Section 2.19.

- At proposed hollow-stem auger locations, the surface soil samples (to be collected for laboratory analyses) will be collected from the ground surface to 6 inches below ground surface (bgs). The subsurface soil samples (to be collected for laboratory analyses) will be collected from the 2-foot interval with the highest headspace reading between 6 inches bgs and the water table. If all headspace readings within this zone are zero, the proposed subsurface soil sample will be collected from the 2-foot interval immediately above the water table. Additional subsurface soil samples may be collected from any subsurface interval during the investigation, based on observations made by the field geologist (e.g., unusual staining, odor, texture, etc.).

- Subsurface soil samples will also be collected at eleven proposed locations, as identified in Table 4, and will be analyzed for geotechnical parameters including air-filled porosity, water-filled porosity, grain size, permeability, fraction of organic carbon, and soil dry-bulk density. These eleven sample locations are preliminary and the actual, or final, locations may vary based on field data collected during the investigation. The subsurface soil samples to be submitted for geotechnical analyses will be collected in 1-foot acetate sleeves or brass liners to minimize sample disturbance. These samples will be handled and shipped to the receiving laboratory in accordance with the procedures outlined in Section 2.19.

2.5 Surface Soil Sample Collection

Surface soil samples proposed at borehole locations will be collected using the drilling/sampling techniques described in the previous section. The surface soil samples proposed at non-borehole locations (SS-01 through SS-07, as identified in Table 4 and shown on Figure 1) will be collected from the ground surface to 0.5 feet bgs using a decontaminated trowel or shovel and a stainless steel bowl in accordance with SOP 210 (Appendix A-1).

A visual survey will be conducted at each of the proposed sample collection locations to identify areas of surface soil staining, odor, or stressed vegetation. If identified, these areas will be targeted for surface soil sample collection. If evidence of surface soil impacts is not observed, the surface soil sample will be collected from the proposed sample location (Figure 1), targeting areas of topographic depressions. The soil sample will be composited in a stainless steel bowl before filling the laboratory-supplied containers. The surface soil samples will be analyzed for the investigation analyte list (Table 1) and for EPH and VPH (Table 2).

2.6 Field Analyses

If real time field screening data are considered desirable for delineation of nature and extent of contaminants, field analytical techniques (e.g., immuno assays for PCBs or x-ray fluorescence [XRF] for metals) may be considered. Specific analytical procedures will be based on manufacturers instructions for the kit or instrument selected. Addenda to this SAP will be submitted to the U.S. EPA for review prior to data collection.

2.7 Well Construction and Installation

A total of 84 new wells (monitoring wells and drive-point wells) are proposed for this investigation, as summarized in Table 4 and depicted on Figure 1. These wells will be installed via hollow-stem auger drilling or direct-push drilling techniques, each of which is described further in the following subsections. Each proposed well will be located in the field a minimum distance of 50 feet from any surface water body to ensure the well produces groundwater from the formation.

2.7.1 Monitoring Well Installation via Hollow-Stem Auger Drilling

A total of 62 monitoring wells are proposed for installation via hollow-stem auger drilling techniques, as summarized in Table 4 and depicted on Figure 1. All hollow-stem auger drilling will be conducted as outlined in Section 2.4. These monitoring wells will be constructed of 2-inch diameter Schedule 40 polyvinyl chloride (PVC) casing with flush-threaded joints; No. 20 (0.020-inch) factory-slotted well screen; a water-tight lockable cap; and above-grade or flush-mount protective steel casing. The well screens will be set from approximately 5 feet above the highest water table (to be determined based on historical fluid-level data collected from surrounding area wells) to 10 feet below the water table. The well screens will be set 5 feet above the water table to allow for seasonal water table fluctuations and tidal influences. If the Bootlegger Cove clay is encountered in a borehole at a depth less than 10 feet below the water table, the well screen will be set from 5 feet above the water table to the contact of the unconsolidated sediments and the Bootlegger Cove clay. Thus, the subsequent riser and screen lengths for each new monitoring well will be determined in the field. Both above-grade and flush-mount well completion schematics are depicted on Figure 4.

None of the proposed monitoring wells will be screened into the Bootlegger Cove clay. Upon reaching total depth of the boring, the augers will be pulled back to the desired well completion depth and the borehole will be backfilled with packing sand to the contact of the Bootlegger Cove clay and the overlying sediments (Figure 4). This will ensure proper well screen placement and ensure the well is installed discretely within the Ship Creek alluvium.

The well filter pack for the new monitoring wells will consist of #10-20 silica sand placed from the bottom of the borehole (above the backfill described above) to approximately 2 feet above the top of the screened interval. The annular seal placed above the filter pack will consist of approximately 2 feet of hydrated bentonite pellets/chips. A bentonite/cement grout mixture, hydrated bentonite pellets/chips, or non-impacted soil cuttings (based on visual observation) will be placed in the space above the annular seal to approximately 1 foot bgs. Concrete will then be poured in the space above the grout to form a surface seal and set the steel protective casing. The volume of downhole material (e.g., sand, bentonite, grout, etc.) will be recorded during well installation and compared to the volume of the annular space to ensure that no bridging or excessive loss of material in void spaces has occurred. Protective concrete posts or bumpers may be installed around the new above-grade wells for added protection in high traffic areas to minimize the potential for well damage (Figure 4).

Monitoring well construction and installation details will be recorded on a Monitoring Well Completion Log in accordance with SOP 220, provided in Appendix A-3.

2.7.2 Drive-Point Well Installation via Direct-Push Drilling

A total of 22 drive-point wells are proposed for installation via direct-push drilling techniques, as summarized in Table 4 and depicted on Figure 1. These wells will be installed by direct push or percussion hammering on the metal drive-point well casing. This method of drive-point well installation will create no soil cuttings and limit subsurface ground disturbance. A schematic of the drive-point well completion is provided on Figure 4.

The proposed drive-point wells will be installed, or driven, to approximately 10 feet below the water table or the top of the Bootlegger Cove clay, whichever is encountered first. A nearby monitoring well (if available) will be gauged to determine the approximate depth to water in the area at the time of well installation, and a boring log from a nearby boring or well will be used to estimate the depth to the Bootlegger Cove clay at the proposed locations. This information will be used to determine the appropriate screen depth. The drive-point wells will be screened from approximately 5 feet above the water table to the total well completion depth. Each well will be constructed of 1 ¼ inch diameter schedule 40 galvanized or black iron pipe with 0.020-inch laser-slotted stainless steel screen. Each well will be completed with a water-tight lockable cap and above-grade or flush-mount protective steel casing. Concrete will be poured to form a surface seal for the well and set the steel protective casing. Protective concrete posts may be installed around the new above-grade drive-point wells for added protection in high traffic areas to minimize the potential for well damage (Figure 4).

Monitoring well construction and installation details will be recorded on a Monitoring Well Completion Log in accordance with SOP 220 (Appendix A-3).

2.8 Fluid-Level Gauging

Fluid-level data will be collected from the new and existing monitoring wells to provide groundwater elevation and LNAPL thickness data. Two fluid-level gauging events are proposed (i.e., fall 2005 and spring 2006) for the set of wells shown on Figure 1. Fluid-level gauging will be conducted in accordance with SOP 231 using an electric oil/water interface probe to within 0.01 feet. All fluid-level data collected will be documented on a Fluid Level Monitoring Log provided in SOP 231 (Appendix A-4).

The investigation fluid-level gauging effort will be conducted following completion and review of the tidal influence study results (see Section 2.10).

2.9 Monitoring Well Development

Upon completion, each new monitoring well will be development in accordance with SOP 221 (Appendix A-5). Each new monitoring will be surged (as described in SOP 221) prior to development.

A bailer or portable pump and disposable tubing will be used to evacuate water from the monitoring well. Groundwater quality parameters including pH, temperature, and conductivity will be collected during well development. The monitoring wells will be developed until pH, temperature, and conductivity have stabilized and the water is visually clear of suspended solids (American Society for Testing and Materials D 5092-90). All purge water generated during well development activities will be contained in 55-gallon drums for proper disposal, as described in Section 2.24. These drums will be labeled and handled in accordance with the procedures outlined in Section 2.24.

Field parameter data collected during monitoring well development will be recorded on a Monitoring Well Development Log in accordance with SOP 221 (Appendix A-5).

2.10 Tidal Influence Study

A tidal influence study is proposed to investigate the influence of daily tidal fluctuations on groundwater elevations, potential LNAPL thickness, and vertical gradients within the unconsolidated sediments. The test is designed to capture tidal influences over a 30-day period (i.e., one complete lunar cycle). Understanding tidal influences in the unconsolidated sediments is necessary to evaluate groundwater elevation data.

The proposed tidal influence study will include the following field activities to be conducted in accordance with the specifications of the field instrumentation:

- Calibration of the pressure transducers in accordance with manufacturers' instructions

- Installation of In-Situ miniTROLL (or equivalent) pressure transducers in the five monitoring wells (identified on Figure 3) in accordance with the manufacturers' instructions

- Programming of the pressure transducers to record pressure, in pounds per square inch, and temperature, in degrees Fahrenheit, every 20 minutes in accordance with the manufacturers' instructions

- Downloading of the pressure transducer data 24 hours after installation to verify proper setup and operation, and then again at the end of the 30 day data-collection period
- Removal and decontamination of the pressure transducers upon completion of data collection

Precipitation data for the site will be also obtained from one of four Automated Weather Observation Sites located in Anchorage, Alaska. This information will be used in evaluating the results of the tidal influence study.

2.11 Slug Testing

To determine the hydraulic conductivity in the unconsolidated material overlying the Bootlegger Cove clay, slug testing will be performed in accordance with SOP 224 (Appendix A-6) at a set of wells to be selected upon review of the field data collected during the investigation (e.g., boring logs). Pressure transducers and data loggers will be used to conduct the slug tests. All fluid-level data collected during slug testing will be recorded on the Slug Test Field Data Sheet in accordance with SOP 224 (Appendix A-6).

2.12 Groundwater Sample Collection

Two groundwater sample collection events are proposed (i.e., fall 2005 and spring 2006) for the set of wells shown on Figure 1. The proposed groundwater samples will be collected using a low-flow sample collection method. However, in the event of a slow recharge well or equipment failure, a bailing method may be used for groundwater sample collection. Both sample collection methods and procedures are described in the following subsections. If the well being sampled is newly installed and developed, groundwater sampling will not be conducted for a period of 24-hours following well development. If LNAPL is encountered in a well, a groundwater sample may be collected using an alternative sampling method (e.g., diffusion bag samplers).

All groundwater samples will be analyzed for the investigation analyte list provided in Table 1, with the exception of those collected within Area 3 (as identified in Table 4). At the May 19, 2005 Work Plan presentation meeting between U.S. EPA, ADEC, and ARRC, it was agreed that samples collected within Area 3 would be analyzed for a modified group of analytes. The Area 3 analyte list for both soil and groundwater will consist of BTEX, ethylene dibromide, 1,2-dichloroethane, lead, PAHs, and the fuel hydrocarbon fractions EPH and VPH. In addition, specific groundwater samples will also be analyzed for a subset of constituents from the supplemental analyte list (Table 2). The samples to be analyzed for constituents on the supplemental analyte list are identified in Table 4 along with the list of supplemental analytes relevant to each sample. A list of sample containers and required preservation methods to be used for this investigation with respect to specific analytes are summarized in Table 3.

Groundwater samples will also be collected for natural attenuation monitoring. The scope of this data collection will be assessed upon receipt and review of the groundwater analytical results (i.e., the investigation analyte list and supplemental analyte list results). As such, data collection details (e.g., number of samples and locations) proposed for evaluating natural attenuation will be outlined in the Preliminary Site Characterization RI Data Compilation Summary to be submitted to the U.S. EPA upon completion of the RI/FS field investigation and receipt of the groundwater analytical results. However, groundwater sample collection for natural attenuation monitoring will not be conducted at any proposed drive-point well. The list of proposed natural attenuation parameters and respective analytical methods, protocols, and holding times is provided in Table 6. The low-flow groundwater sample collection method is necessary for natural attenuation monitoring and is outlined in Section 2.12.2.

2.12.1 Bailing Method

Groundwater sampling via the bailing method will be conducted in accordance with SOP 230 (Appendix A-7) using disposable bottom-loading Teflon or high-density polyethylene (HDPE) bailers. Groundwater quality parameters including dissolved oxygen, pH, temperature, and conductivity will be collected during well purging prior to sample collection. Water quality meters will be calibrated as necessary prior to use in accordance with the procedures outlined in the instrument manual. Calibration procedures and results will be documented on the Equipment Calibration Form (Appendix B). Groundwater will be purged from the proposed monitoring well until the groundwater quality parameters have stabilized (i.e., the change between successive readings of temperature, pH and conductivity are less than 10 percent) or until three well-casing volumes (as determined via fluid-level gauging) have been evacuated. Field parameter data collected during groundwater sampling will be recorded on a Groundwater Sample Data Sheet in accordance with SOP 230 (Appendix A-7).

Following well purging, groundwater samples will be collected by lowering the bailer below the water table within the well casing and removing the full bailer from the well for sample collection. Water will be drained from the bottom of the bailer to fill the laboratory-supplied sample container(s) in accordance with the procedures outlined in SOP 230 (Appendix A-7). Water generated during monitoring well purging and sampling activities will be contained for proper disposal, as described in Section 2.24.

2.12.2 Low-Flow Sample Method

This method of groundwater sampling allows for the collection of a valid and representative groundwater sample from a monitoring well using a low-flow collection technique. The low-flow groundwater sample collection method is designed to reduce the influx of particulate matter into the well and groundwater sample to ensure a more representative analysis of groundwater quality, and to reduce aeration that can affect geochemical parameters. This method of groundwater sample collection will be conducted in accordance with the procedures outlined in SOP 235 (Appendix A-8).

As described in SOP 235, a static-water level will be measured in the well prior to well purging and collection of any samples. Purging must be performed for all groundwater monitoring wells prior to sample collection. The volume of water present in each well must be computed using two measurable lengths: length of the water column and monitoring well inside diameter. A low-flow, electric driven pump (e.g., bladder pump or peristaltic pump) will be used to purge and sample the well.

The inlet of the bladder pump or peristaltic pump tubing will be lowered into the well to a depth corresponding with the approximate midpoint of the screened interval of the aquifer, or 1-2 feet below the water level in the well, whichever is greater. A depth-to-water measurement device will be lowered into the well to monitor drawdown. The pump will be turned on at a flow rate of about 0.1 liter per minute (L/min). The flow rate will be adjusted up or down to maximize flow, yet ensure minimum drawdown. Draw down in the well should not exceed more than 0.5 feet.

Groundwater will be pumped from the well into a sealed, flow-through chamber containing the water quality probes to measure temperature, pH, and conductivity. Water quality meters will be calibrated as necessary prior to use in accordance with the procedures outlined in the instrument manual. Calibration procedures and results will be documented on the Equipment Calibration Form (Appendix B). Field parameters measurements will be recorded on the Groundwater Sample Data Sheet (Appendix A-7). After passing through the flow-through chamber, the water will be discharged into a container of known volume where the pumping rate will be measured with a watch. When the container is full, the water will be properly disposed of following the procedures outlined in Section 2.24.

Groundwater samples will be collected for laboratory analysis when the groundwater parameters have stabilized (i.e., the change between successive readings of temperature, pH, conductivity, and dissolved oxygen are less than 10 percent). Stabilization of water quality parameters is considered indicative of sampling groundwater from the formation and is considered an indicator of adequate well purging versus the removal of a standard volume of water. Following stabilization of the water quality parameters, the flow-through cell will be disconnected and groundwater will be collected in the appropriate laboratory-supplied sample container(s) in accordance with the procedures outlined in SOP 235 (Appendix A-8). Disposable tubing used for low-flow groundwater sample collection during the RI/FS will be dedicated to individual wells for use during future sample collection events (as necessary).

Water generated during monitoring well purging and sampling activities will be contained for proper disposal, as described in Section 2.24. The flow-through cell will be decontaminated in accordance with the procedures outlined in Section 2.23 between sample collection locations.

2.13 Groundwater Spring Sampling and Flow-Rate Estimation

If active, groundwater samples will be collected from six groundwater springs, as identified in Table 4 and shown on Figure 1. At each groundwater spring location, a temporary drivepoint (e.g., stainless steel pipe) will be advanced into the sediment to channel groundwater flow for sample collection. The laboratory-supplied sample containers will be filled directly from flow from the drivepoint. The temporary drivepoint device will be removed from groundwater spring location upon completion of sample collection activities. The device will be decontaminated prior to use at each location in accordance with the procedures outlined in Section 2.23. Each of the groundwater spring samples will be analyzed for the investigation analyte list (Table 1) and fuel hydrocarbons (i.e., DRO and GRO) (Table 2). Based on the results of the DRO and GRO analyses, samples may also be analyzed for EPH and VPH.

If the groundwater springs proposed for sample collection are active during the investigation, the flow rate from each active spring will also be estimated. To estimate the flow rate, groundwater from the spring will be captured in a container of known volume (e.g., a 1-gallon container or 5-gallon bucket) over a specific period of time (e.g., 1 minute). The volume of water captured over the specific period of time will be used to estimate the flow rate in gallons per minute. This information will be recorded on the Groundwater Sample Data Sheet (Appendix A-7).

2.14 LNAPL Sample Collection

If LNAPL is present in a well, a sample may be collected for physical property analyses (i.e., viscosity, specific gravity, surface tension, and interfacial tension) and for characterization via gas chromatography analysis.

LNAPL samples will be collected by lowering a bottom-loading Teflon or HDPE bailer through the LNAPL to the LNAPL/water interface. The bailer will then be removed from the well and any excess water collected in the bailer will be drained from the bottom of the bailer into an appropriate container for disposal. The remaining LNAPL will be drained from the bottom of the bailer into the appropriate sample container for shipment to the receiving laboratory.

2.15 Sediment Sample Collection

Sediment sample collection is proposed from 31 locations within and along Ship Creek for the RI/FS, as summarized in Table 5 and depicted on Figure 2. Sediment samples are proposed for collection from the uppermost 4 inches of sediment deposition and from 4 to 12 inches, as outlined in Table 5. These sediment samples will either be collected using a decontaminated shovel/trowel, Ponar-Eckman dredge, or a Shelby-tube sampling device depending upon sample depth collection, as described in SOP 260 (Appendix A-9).

Depending upon the depth of the water at the proposed sample locations at the time of sample collection, a boat may be necessary for sample collection. Each sediment sample collected will be described using the USCS. Additional characteristics including color and evidence of staining or odor will also be documented. The sediment lithologic descriptions will be recorded on a Sediment Sampling Form in accordance with SOP 260 (Appendix A-9).

As detailed in Table 5, all sediment samples will be analyzed for the investigation analyte list summarized in Table 1, pH, total organic carbon (TOC), and grain-size distribution. All sediment samples collected will also be analyzed for PCBs, as listed on the supplemental analyte list (Table 2). A listing of sample containers and required preservation methods to be used for this investigation with respect to specific analytes are summarized in Table 3.

VOC sample containers will be filled immediately upon retrieval of the sediment sample to minimize potential loss of the volatiles. The remaining sediment will then be composited in a stainless-steel bowl before filling the remaining sample containers.

2.16 Surface Water Sample Collection

Surface water sample collection is proposed from 14 locations within and along Ship Creek for the RI/FS, as summarized in Table 5 and depicted on Figure 2, during low-flow conditions within Ship Creek. The low-flow sampling will be conducted concurrently with the sediment sampling proposed in the previous section. However, at locations where surface water and sediment sample collection are proposed, the surface water sample will be collected first to avoid disturbance of the sediment and possible suspension of sediment in the sample.

The surface water sampling will be conducted in accordance with SOP 250 (Appendix A-10). Depending on site conditions, sample locations, and surface water flow conditions, hip waders or a boat will be used for water quality parameter and surface water sample collection.

Before sample collection, the width, length, and depth of the surface water bodies will be measured and recorded on the Surface Water Sampling Form (Appendix A-10), when possible. In addition, water quality parameter data including pH, dissolved oxygen, temperature, oxidation reduction potential, and conductivity, will be collected *in-situ* from the approximate midpoint of the vertical water column. These data will also be recorded on the Surface Water Sampling Form. Once the water quality parameter data have been collected, a surface water sample will be collected using a decontaminated sampling device consisting of a pole with an attached collection bottle.

The decontaminated sampling device will be submerged upside-down into the surface water body and rotated for sample collection at the approximate midpoint of the vertical water column. The sampling device will then be removed from the surface water body and the water contained within will be transferred immediately to the appropriate laboratory-supplied containers.

As detailed in Table 5, all surface water samples will be analyzed for the investigation analyte list summarized in Table 1, hardness, and the list of PCBs provided in Table 2. All surface water samples will be analyzed for filtered and unfiltered metals (i.e., total and dissolved metals) on the investigation analyte list summarized in Table 1. A listing of sample containers and required preservation methods to be used for this investigation with respect to specific analytes are summarized in Table 3.

2.17 Data Collection for Evaluating Remedial Action Alternatives

Additional site data may be required for identifying, screening, and evaluating remedial action alternatives. Because it is not possible at this time to anticipate what, if any, remedial action may be recommended for the site, data required to evaluate specific remedial technologies are not proposed in the RI/FS Work Plan or described in this SAP. However, if additional data are needed to evaluate remedial action alternatives, the activities associated with collection of such data will be described in the Preliminary Site Characterization RI Data Compilation Summary to be submitted upon the completion of RI/FS field investigation activities and preliminary data analysis.

If the proposed data collection necessary for evaluating remedial action alternatives includes methods or procedures outside those described in this document, an addendum will be prepared and submitted to the U.S. EPA for approval.

2.18 Field Quality Assurance Sampling

Quality assurance (QA) samples including field blanks, blind duplicates, trip blanks, equipment blanks, matrix spikes, and matrix spike duplicates will be collected and analyzed in accordance with the guidelines provided in the QAPP.

Field blanks are collected to analyze for potential airborne contaminants that may enter (or come into contact with) a sample or laboratory container during sample collection at a given location in the field. As such, these samples are collected by filling laboratory-supplied sample containers with de-ionized water in the field adjacent to a given sample collection location (e.g., at a monitoring well location from which a groundwater sample is proposed for collection).

The following summarizes the QA sampling requirements specified in the QAPP for each sample matrix:

- Soil – One field blank and one equipment blank will be collected for every 20 soil samples collected

- Groundwater – One field blank, blind duplicate, equipment blank, matrix spike, and matrix spike duplicate will be collected for every 20 groundwater samples collected

- Surface water – One field blank, blind duplicate, and equipment blank will be collected for every 20 surface water samples collected

- Sediment – One field blank and equipment blank will be collected for every 20 sediment samples collected

In addition, one trip blank will be placed in each cooler of soil, groundwater, surface water, or sediment samples being analyzed for VOCs only as part of the shipment to be sent to the receiving laboratory.

QA samples will be analyzed for the investigation analyte list (Table 1) and specific constituents from the supplemental analyte list (Table 2), when appropriate. A list of sample containers to be used for this investigation is provided in Table 3.

2.19 Sample Handling and Shipping

Following collection, all soil, groundwater, LNAPL, surface water, and sediment samples will be sealed in laboratory-supplied containers, or acetate sleeves, and each container/sleeve will be labeled with the following information:

- Project name

- Sample identification number and corresponding sample depth in feet (depths to be provided in parentheses following the applicable sample identification number for all soil and sediment samples)
- Date and time of collection
- Name of sampling technician
- Requested analyses
- Any method of preservation used

All soil, groundwater, surface water, and sediment samples collected for laboratory analyses will be packed on ice for sample preservation and transported in sealed coolers to the receiving laboratory. LNAPL samples collected for gas chromatography analysis and subsurface soil or sediment samples collected for geotechnical analyses will not require sample preservation during transport. Thus, these samples will be securely wrapped and shipped to the receiving laboratory in a secure box or cooler.

For each sample or set of samples shipped for laboratory analyses, a COC form will be completed to accompany the samples. The COC form will include the following information:

- Sample identification number and corresponding sample depth (depths to be provided in parentheses following the applicable sample identification number for all soil and sediment samples)
- Project name, location, and number
- Sample collection dates and times
- Name of sampling technician(s)
- Media type
- Number of containers per sample
- Signature or person relinquishing and receiving custody
- Requested analyses for each sample (investigation analyte list specific to each sample being submitted)
- Any method of preservation used

A copy of the completed COC form and any corresponding shipping receipt will be maintained in the project field notebook for documentation.

2.20 Groundwater Well Survey

A groundwater well survey will be conducted at the Site to identify those properties having existing groundwater wells that may be used for drinking water or other purposes (e.g., irrigation or dust control). This information will be used to identify and evaluate potential exposure pathways and assess any related potential risk to human receptors upon completion of the RI.

Some existing groundwater wells have already been identified for the leased properties, as reported in the SBR. However, to ensure a complete inventory of groundwater wells present at the Site, a survey of the leased properties will be conducted either by mail or by visits to those properties. This survey will be used to verify the existence or absence of groundwater wells present at the Site. In addition, off-site deep wells located near the Site will also be included for the RI Report.

2.21 Visual Inspection of SWMUs, AOCs, and Leased Properties

Visual inspection of 15 solid waste management units (SWMUs) and 3 areas of concern (AOCs) is proposed in Table 2-3 of the Work Plan to assess current conditions and identify any areas of potential surface soil contamination. The location of the SWMUs and AOCs to be inspected (Work Plan Table 2-3) are shown on Figure 1-2 of the Work Plan. The inspection of these units will include a visual survey of each area to identify any indication of surface soil impacts including visible staining, noticeable odors, or stressed vegetation, and to evaluate current waste or materials management practices within the SWMU or AOC. The results of the surveys will be documented and used to determine if further investigation is required as part of the RI/FS.

Visual inspection of six leased properties is also proposed for the RI, in accordance with the recommendation outlined in the SBR. The SBR stated that six specific leased properties being proposed for exclusion as potential source areas would require a property inspection to determine if any U.S. EPA-identified issues are still of concern, and to visually determine if other environmental issues exist. These six referenced leased properties include the following:

- LP-002 Consolidated Freightways
- LP-042 York Steel
- LP-072 Karen’s RV
- LP-115 Technic Services
- LP-124 Alma Corporation
- LP-128 Seamless Flooring Systems

The proposed inspections will include the following:

- **Site Information Review.** This will include a review of available existing information for the property (e.g., aerial photographs, historical spill records, analytical data, property maps, etc.). This information is already summarized in Appendix D of the SBR.

- **Site Visit/Reconnaissance.** This will be conducted to verify the results of the Site information review and to collect any additional information regarding the property otherwise unknown (e.g., unknown drum storage on property, areas of surface soil impacts not previously identified, etc.). The proposed Site reconnaissance involves a Site visit to visually and/or physically observe and identify any evidence of recognized environmental conditions.

- **Interview.** An interview with the property lessees will be conducted to provide additional information for the property (if available) and to verify the results of the Site information review. The results of the interview will be used to determine the potential existence of recognized environmental conditions on the subject property.

- **Reporting.** The results of the property inspections will be recorded, documented, and summarized in the RI Report.

2.22 Soil Cover Evaluation

An evaluation of the surface cover at the Site (e.g., parking lots, buildings, soil cover, and vegetative cover) will be conducted to estimate the size and distribution of areas of potential surface water runoff, areas of industrialized development, and areas of natural vegetative cover. To estimate the size and distribution of these areas, a review of existing aerial photographs of the Site will be completed. The results of the evaluation will be depicted on a surface cover figure to be included in the RI Report upon completion of the investigation.

2.23 Decontamination

Decontamination will be performed on all down-hole drilling and sampling equipment between sample locations. Hollow-stem augers, drill rods, drill bits, and other down-hole equipment will be decontaminated before arrival at the site, on site before the first sampling effort, between each borehole or sampling location, and before equipment leaves the site. The down-hole equipment used during hollow-stem auger drilling will be steam-cleaned using potable water. All decontaminated equipment will be stored on the drill rig or drilling support trailer for transport to subsequent drilling or sample collection locations.

Stainless steel sampling utensils and oil/water interface probes will be decontaminated at each sample location before sampling by washing with isopropyl alcohol and rinsing with distilled or de-ionized water. All decontamination water will be contained for disposal, as discussed in the following section.

Equipment blanks will be collected as described in Section 2.18 to evaluate the effectiveness of the decontamination procedures.

2.24 Investigation-Derived Waste Management

Investigation-derived waste includes soil cuttings generated during drilling activities; water or LNAPL generated during equipment decontamination, monitoring well development, and monitoring well purging activities; and disposable personal protective equipment (PPE) and sampling equipment.

Investigation-derived soils will be contained in 55-gallon drums for sampling prior to disposal. Based on the analytical results of the sampling, soils will either be stored on site to be used as fill material (i.e., only those soils meeting the required criteria for said use) or transported to Alaska Soil Recycling (a permitted waste disposal facility) in Anchorage for disposal. All 55-gallon drums filled with investigation-derived soils will be labeled in the field with a non-hazardous waste sticker and marked with the following information using a paint pen:

- Drum number (e.g., starting with 1)
- Project name
- Borehole/well/location ID
- Date soils were generated
- Contents (e.g., soil, water, or PPE/equipment)

Drums filled with investigation-derived soils will be stored at the location where the soils were generated, or transported to a drum staging area on site. All drums stored at specific sample locations will be removed within 30 days of completion of the field investigation (i.e., field activities).

Investigation-derived water or LNAPL will also be contained in 55-gallon drums for sampling prior to disposal. Based on the analytical results of the sampling, groundwater will either be treated on-site (e.g., carbon treatment) or transported off site to a permitted waste disposal facility for disposal. Heavily contaminated investigation-derived disposable PPE and sampling equipment (e.g., oil-soaked material) will be contained in 55-gallon drums prior to disposal at an appropriate facility. Typical investigation-derived disposable PPE and sampling equipment (e.g., gloves, Tyvek, paper towels, sealable bags, bailers, tubing, etc.) that is not heavily contaminated will be contained in garbage bags for disposal at the appropriate facility.

A Drum Inventory Sheet (Appendix B) will be completed to catalog each drum filled during the investigation. The Drum Inventory Sheet will include the drum number and the information recorded on the drum itself (as outlined above). The completed Drum Inventory Sheets will be maintained in the project field notebook along with other completed investigation field forms for drum tracking purposes.

2.25 Surveying

Each surface soil sample location, soil boring location, new monitoring well, surface water, and sediment sample location will be surveyed via a surveyor licensed within the state of Alaska. Ground surface elevation will be measured at each surface soil sample location, soil boring location, and new monitoring well. In addition, the measuring point elevation will be determined for each new monitoring well. Surface water and sediment sample locations will be surveyed for horizontal control only as vertical positioning can vary based on surface water flow conditions and resultant sediment deposition or scour.

The measuring point and ground surface elevations will be surveyed to within 0.01 feet. Horizontal coordinates will be surveyed to within 0.1 feet.

3 Health and Safety

The field activities associated with this investigation will be conducted in accordance with the guidelines outlined in the *Site-Specific Health and Safety Plan* (RETEC, 2005a) and the *Project-Specific Health and Safety Plan* provided in the RI/FS Work Plan. All personnel involved in the investigation (including any subcontractors to RETEC) will be required to review and comply with the *Site-Specific Health and Safety Plan* (RETEC, 2005a) and the *Project-Specific Health and Safety Plan* prior to the start of the field investigation.

Prior to conducting any field activities at the site, all RETEC investigation personnel will be required to (1) complete the RETEC On-Track Safety Training, (2) complete the ARRC On-Track Safety Roadway Worker Protection Training, (3) comply with all site health and safety requirements and protocols, and (4) attend a preliminary site safety orientation to identify the hazards specific to working on the ARRC site. In addition, all field personnel will attend daily safety meetings or project-specific tailgate safety meetings to discuss safety topics specific to the fieldwork being performed that day. To perform field activities on site, all field personnel must wear an orange hard hat, safety glasses (yellow-tinted glasses are not allowed), steel-toed boots, and an orange reflective traffic safety vest. All field investigation personnel must also provide the site operations manager with a copy of their current Occupational Safety and Health Administration (OSHA) 40-hour training certificate and/or OSHA 8-hour refresher-training certificate. While on site, all field investigation personnel are required to have available their Contractor Orientation Course completion card and a government-issued photo identification.

All health and safety topics including daily meetings will be documented and compiled in the project field notebook.

4 References

RETEC, 2005a. *Site-Specific Health and Safety Plan, Alaska Railroad Corporation, Anchorage, Alaska*. RETEC: Golden, Colorado Office. June 13, 2005.

RETEC, 2005b. *Quality Assurance Project Plan, Alaska Railroad Corporation, Anchorage, Alaska*. RETEC: Golden, Colorado Office. June 6, 2005.

U.S. EPA, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA.* EPA/540/G-89/004. OSWER Directive 9355.3-01. October, 1988.

U.S. EPA, 2000. *Guidance for the Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4*, Office of Environmental Information, EPA/600/R-96/055. August, 2000.

U.S. EPA, 2002. *USEPA Analytical Operations/Data Quality Center Statement of Work for Analysis of Chlorinated Dibenzo-p-dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs), Multi-Media, Multi-Concentration.* Document DLM01.4. January, 2002.

U.S. EPA, 2004a. *Statement of Work* – Administrative Order on Consent No. CERCLA 10-2004-0065, Alaska Railroad Corporation, Anchorage Terminal Reserve. May 17, 2004.

U.S. EPA, 2004b. *Administrative Order on Consent*. U.S. EPA CERLA Docket No. 10-2004-0065. June 29, 2004.

U.S. EPA, 2004c. *USEPA Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration.* Document SOM01.0. October, 2004.

U.S. EPA, 2005. *USEPA Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration.* Document ILM06.X, 1st Draft. March, 2005.

Tables

Table 1
Investigation Analyte List

List of Constituents and Respective Analytical Methods	Reporting Limit for Aqueous Samples (µg/L)	Reporting Limit for Solid Samples (mg/kg)
Volatile Organic Compounds (8260B)		
1,1,1-Trichloroethane	1	0.025
1,1,2,2-Tetrachloroethane	0.5	0.05
1,1,2-Trichloroethane	1	0.025
1,1-Dichloroethane	1	0.025
1,1-Dichloroethene	1	0.025
1,2,3-Trichlorobenzene	1	0.05
1,2,4-Trichlorobenzene	1	0.05
1,2-Dibromo-3-chloropropane	2	0.1
1,2-Dibromoethane	1	0.025
1,2-Dichlorobenzene	1	0.025
1,2-Dichloroethane	0.5	0.025
1,2-Dichloropropane	1	0.025
1,3-Dichlorobenzene	1	0.025
1,4-Dichlorobenzene	0.5	0.025
2-Butanone	10	0.25
2-Hexanone	10	0.25
4-Methyl-2-pentanone	10	0.25
Acetone	10	0.25
Benzene	0.4	0.013
Bromochloromethane	1	0.025
Bromodichloromethane	0.5	0.025
Bromoform	1	0.025
Bromomethane	3	0.1
Carbon Disulfide	2	0.1
Carbon Tetrachloride	1	0.025
Chlorobenzene	0.5	0.025
Chloroethane	1	0.01
Chloroform	1	0.025
Chloromethane	1	0.025
cis-1,2-Dichloroethene	1	0.025
cis-1,3-Dichloropropene	0.5	0.025
Dibromochloromethane	0.5	0.025
Dichlorodifluoromethane	1	0.025
Ethylbenzene	1	0.025
Isopropylbenzene	1	0.025
m,p-Xylene	2	0.05
Methyl tert-Butyl Ether	5	0.04
Methylene Chloride	5	0.1
o-Xylene	1	0.025
Styrene	1	0.025

Table 1
Investigation Analyte List

List of Constituents and Respective Analytical Methods	Reporting Limit for Aqueous Samples (µg/L)	Reporting Limit for Solid Samples (mg/kg)
Tetrachloroethene	1	0.025
Toluene	1	0.05
trans-1,2-Dichloroethene	1	0.025
trans-1,3-Dichloropropene	1	0.025
Trichloroethene	1	0.025
Trichlorofluoromethane	1	0.025
Vinyl Chloride	1	0.025
Semivolatile Organic Compounds (8270C)		
2,4,5-Trichlorophenol	10	0.25
2,4,6-Trichlorophenol	10	0.25
2,4-Dichlorophenol	10	0.25
2,4-Dimethylphenol	10	0.25
2,4-Dinitrophenol	70	2
2,4-Dinitrotoluene	10	0.25
2,6-Dinitrotoluene	10	0.25
2-Chloronapthalene	10	0.25
2-Chlorophenol	10	0.25
2-Methylnaphthalene	10	0.25
2-Methylphenol	10	0.25
2-Nitroaniline	10	0.25
2-Nitrophenol	10	0.25
3,3'-Dichlorobenzidine	10	0.25
3-Nitroaniline	10	0.25
4,6-Dinitro-2-methylphenol	50	2
4-Bromophenyl-phenylether	10	0.25
4-Chloro-3-methylphenol	10	0.25
4-Chloroaniline	10	0.25
4-Chlorophenyl-phenylether	10	0.25
4-Methylphenol	20	0.3
4-Nitroaniline	10	0.5
4-Nitrophenol	50	1
Acenaphthene	10	0.25
Acenaphthylene	10	0.25
Anthracene	10	0.25
Benzo(a)anthracene	10	0.25
Benzo(a)pyrene	10	0.25
Benzo(b)fluoranthene	10	0.25
Benzo(g,h,i)perylene	10	0.25
Benzo(k)fluoranthene	10	0.25
bis(2-Chloroethoxy) methane	10	0.25
bis(2-Chloroethyl) ether	10	0.25

Table 1
Investigation Analyte List

List of Constituents and Respective Analytical Methods	Reporting Limit for Aqueous Samples (µg/L)	Reporting Limit for Solid Samples (mg/kg)
bis-(2-Ethylhexyl)phthalate	10	0.25
Butylbenzylphthalate	10	0.25
Chrysene	10	0.25
Dibenzo(a,h)anthracene	10	0.25
Dibenzofuran	10	0.25
Diethylphthalate	10	0.25
Dimethylphthalate	10	0.25
Di-n-butylphthalate	10	0.25
Di-n-octylphthalate	10	0.25
Fluoranthene	10	0.25
Fluorene	10	0.25
Hexachlorobenzene	10	0.25
Hexachlorobutadiene	10	0.25
Hexachlorocyclopentadiene	30	1
Hexachloroethane	10	0.25
Indeno(1,2,3-cd)pyrene	10	0.25
Isophorone	10	0.25
Naphthalene	10	0.25
Nitrobenzene	10	0.25
N-Nitroso-di-n-propylamine	10	0.25
N-Nitrosodiphenylamine	10	0.25
Pentachlorophenol	50	1
Phenanthrene	10	0.25
Phenol	10	0.25
Pyrene	10	0.25
Metals and Cyanide (6010B/6020, 7470A/7471A, 9010/9012A)		
Aluminum	100	2
Antimony	1	0.1
Arsenic	10	1.8
Barium	3	0.3
Beryllium	1	0.1
Cadmium	2	0.2
Calcium	1000	30
Chromium	4	0.4
Cobalt	1	0.5
Copper	6	0.6
Iron	1000	10
Lead	1	0.2
Magnesium	1000	30
Manganese	2	0.2
Nickel	2	0.2

Table 1
Investigation Analyte List

List of Constituents and Respective Analytical Methods	Reporting Limit for Aqueous Samples (µg/L)	Reporting Limit for Solid Samples (mg/kg)
Potassium	1000	100
Selenium	10	0.5
Silver	2	0.1
Sodium	1000	100
Thallium	1	0.02
Vanadium	20	3
Zinc	25	1
Mercury (7470A)	0.2	0.04
Cyanide (4500-CN C,E)	5	0.06

Notes:

1. Groundwater samples will be analyzed for dissolved metals on the investigation analyte list. Surface water samples will be analyzed for dissolved and total metals on the investigation analyte list.

µg/L = micrograms per liter

Table 2
Supplemental Analyte List

List of Constituents and Respective Analytical Methods	Reporting Limit for Aqueous Samples (µg/L)	Reporting Limit for Solid Samples (mg/kg)
Pesticides (8081A)		
4,4'-DDD	0.03	0.002
4,4'-DDE	0.03	0.002
4,4'-DDT	0.03	0.002
Aldrin	0.05	0.0015
alpha-BHC	0.03	0.0015
alpha-Chlordane	0.03	0.0015
beta-BHC	0.1	0.0015
delta-BHC	0.03	0.0015
Dieldrin	0.03	0.002
Endosulfan I	0.03	0.0015
Endosulfan II	0.03	0.002
Endosulfan sulfate	0.03	0.002
Endrin	0.03	0.002
Endrin aldehyde	0.05	0.002
Endrin ketone	0.03	0.002
gamma-BHC (Lindane)	0.03	0.0015
gamma-Chlordane	0.03	0.0015
Heptachlor	0.01	0.002
Heptachlor epoxide	0.03	0.002
Methoxychlor	0.03	0.002
Toxaphene	0.1	0.05
Polychlorinated biphenyls (8082)		
Aroclor-1016	0.1	0.05 soil 0.02 sed.
Aroclor-1221	0.1	0.05 soil 0.04 sed.
Aroclor-1232	0.1	0.05 soil 0.02 sed.
Aroclor-1242	0.1	0.05 soil 0.02 sed.
Aroclor-1248	0.1	0.05 soil 0.02 sed.
Aroclor-1254	0.1	0.05 soil 0.02 sed.
Aroclor-1260	0.1	0.05 soil 0.02 sed.
Total PCBs	0.1	0.05 soil 0.04 sed.
Dioxins/Furans (8290)		
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	50 pg/L	5 ng/kg
1,2,3,4,6,7,8-HpCDF	50 pg/L	5 ng/kg
1,2,3,4,7,8,9-HpCDF	50 pg/L	5 ng/kg
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	50 pg/L	5 ng/kg
1,2,3,4,7,8-HxCDF	50 pg/L	5 ng/kg

Table 2
Supplemental Analyte List

List of Constituents and Respective Analytical Methods	**Reporting Limit for Aqueous Samples (µg/L)**	**Reporting Limit for Solid Samples (mg/kg)**
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	50 pg/L	5 ng/kg
1,2,3,6,7,8-HxCDF	50 pg/L	5 ng/kg
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	50 pg/L	5 ng/kg
1,2,3,7,8,9-HxCDF	50 pg/L	5 ng/kg
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	50 pg/L	5 ng/kg
1,2,3,7,8-Pentachlorodibenzofuran	50 pg/L	5 ng/kg
2,3,4,6,7,8-HxCDF	50 pg/L	5 ng/kg
2,3,4,7,8-PeCDF	50 pg/L	5 ng/kg
2,3,7,8-TCDD	10 pg/L	1 ng/kg
2,3,7,8-Tetrachlorodibenzofuran	10 pg/L	1 ng/kg
OCDD	100 pg/L	10 ng/kg
OCDF	100 pg/L	10 ng/kg
Fuels (AK101/102/103, WADOE - EPH/VPH)		
Gasoline Range Organics (GRO)	50	1
Diesel Range Organics (DRO)	100	5
Extractable Petroleum Hydrocarbons	200	10
Volatile Petroleum Hydrocarbons	50	1

Notes:

1. Units are parts per billion (µg/L) or parts per million (mg/kg) unless otherwise specified.

VPH = volatile petroleum hydrocarbons
EPH = extractable petroleum hydrocarbons
pg/L = picograms per liter
ng/kg = nanograms per kilogram
sed. = sediment

Table 3
Sample Container, Preservation, and Hold-Time Requirements

Analysis	Laboratory Analytical Method	Sample Container		Preservative		Holding Time	
		Soild	**Aqueous**	**Solid**	**Aqueous**	**Solid**	**Aqueous**
Volatile Organic Compounds	8260B	4 oz Glass Jar	3 - 40 ml VOA Vials	4^{o}C, MeOH	4^{o}C, zero headspace, HCl	14 days	14 days
Semivolatile Organic Compounds	8270C	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C	4^{o}C	14 days to extraction, 40 days from extraction to analysis	7 days to extraction, 40 days from extraction to analysis
Pesticides	8081A	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C	4^{o}C		
Polychlorinated biphenyls (PCBs)	8082	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C	4^{o}C		
Dioxins and Furans	8290	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C	4^{o}C	30 days to extraction, 45 days from extraction to analysis	30 days to extraction, 45 days from extraction to analysis
Metals	6010B/6020 & 7471A/7470A	8 oz Glass Jar	1 -1 Liter Poly	4°C recommended	4^{o}C, HNO3	6 months (28 days for Hg)	6 months (28 days for Hg)
Cyanide	9010/9012A/4500-CN	4 oz Glass Jar	1 - 250 ml Poly	4^{o}C	4^{o}C, NaOH	28 days	14 days
Gasoline Range Organics	AK101	4 oz Glass Jar	3 - 40 ml VOA Vials	4^{o}C, MeOH	4^{o}C, zero headspace, HCl	28 days	14 days
Diesel Range Organics	AK102	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C	4^{o}C, HCL	14 days to extraction, 40 days from extraction to analysis	7 days to extraction, 40 days from extraction to analysis
Extractable Petroleum Hydrocarbons	EPH	8 oz Glass Jar	2 - 1 Liter Ambers	4^{o}C	4^{o}C, HCL		
Volatile Petroleum Hydrocarbons	VPH	4 oz Glass Jar	3 - 40 ml VOA Vials	4^{o}C, MeOH	4^{o}C, zero headspace, HCl	28 days	14 days

Table 4
Soil and Groundwater Investigation Details

															Groundwater Analyses		Soil Analyses		
Groundwater Investigation Area	**Soil Investigation Area**	**Nearest Property ID**	**Preliminary Site Identifier**	**Actual Site Identifier**	**New or Existing Well**	**Drilling Method (HS/DP)**	**Surface Soil Sample Only**	**Proposed Soil Samples[1]**	**Geotech. Subsurface Soil Sample[2]**	**Fluid Level Gauging**	**Proposed Groundwater Sample**	**Tidal Influence Study**	**Category[3] (A,B,C,D)**	**Rationale**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Additional Analyses[6]**
Tank Farm	3	LP-060 North Star	A-1	LP060-MWA01	New	HS	-	X	X	X	X	-	E	1) Investigation of potential migration of analytes from LP-060 to south and west (BTEX) 2) Groundwater flow data 3) LNAPL occurrence data	BTEX, Ethylene dibromide, 1,2-Dichloroethane, Lead, PAHs	EPH/VPH	BTEX, Ethylene dibromide, 1,2-Dichloroethane, Lead, PAHs	EPH/VPH	X
Tank Farm	3	LP-101 C4 Swan Bay - Barge Docking	A-2	LP101-MWA02	New	HS	-	X	X	X	X	X	E	1) Investigation of potential source migration off-site from Area 3 (BTEX) 2)Infill data in area with limited information 3) Groundwater flow data 4) LNAPL occurrence data 5) Tidal influence closest to inlet	BTEX, Ethylene dibromide, 1,2-Dichloroethane, Lead, PAHs	EPH/VPH	BTEX, Ethylene dibromide, 1,2-Dichloroethane, Lead, PAHs	EPH/VPH	X
Tank Farm	3	LP-084 Swan Bay Holding	A-3	LP084-DPA03	New	DP	-	-	-	X	X	-	E	1) Investigation of analytes migration off-site and south to Ship Creek from Tank Farm Areas (BTEX) 2) Groundwater flow data 3) LNAPL occurrence data	BTEX, Ethylene dibromide, 1,2-Dichloroethane, Lead, PAHs	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	A-4	RY065-MWA04	New	HS	-	X	X	X	X	X	E	1) Investigation of potential source on west side of railyard and migration of analytes offsite to the west railyard; 2) Groundwater flow; 3) Tidal influence	X	EPH/VPH	X	EPH/VPH	X
N. of Ship Creek	6	RY-065 Railyard	A-5	AR001-MWA05	New	HS	-	X	-	X	X	-	A	1) Investigation of potential sources on west side of railyard 2) Migration of analytes south to Ship Creek 3) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	6	RY-065/LP-049 Railyard/ Wrightway Auto	A-6	AR001-DPA06	New	DP	-	-	-	X	X	-	B	1) Investigation of potential sources on west side of railyard 2) Migration of analytes off-site and south to Ship Creek water supply well on property 3) Groundwater flow data 4) LNAPL thickness data based on observed oil seeps along Ship Creek mentioned in RFA	X	EPH/VPH	-	-	-
N. of Ship Creek	6	LP-049 Wrightway Auto	A-7	LP049-MWA07	New	HS	-	X	-	X	X	-	B	1) Investigation of potential sources from former USTs at LP-049 2) Migration of analytes south to Ship Creek 3) Groundwater flow data 4) LNAPL thickness data based on observed oil seeps along Ship Creek mentioned in RFA	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	6	LP-120 KAPP	A-8	LP120-MWA08	New	HS	-	X	-	X	X	-	A,B	1) Investigation of potential sources at LP-120 with multiple swmus Migration of analytes south to Ship Creek and ponds. 3) Soil samples for PCBs 4) Groundwater flow data 5) LNAPL occurrence data	X	EPH/VPH PCB	X	EPH/VPH PCB	-

Table 4
Soil and Groundwater Investigation Details

Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	Actual Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Fluid Level Gauging	Proposed Groundwater Sample	Tidal Influence Study	Category[3] (A,B,C,D)	Rationale	Groundwater Analyses		Soil Analyses		
															Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
N. of Ship Creek	6	LP-120 KAPP	A-9	LP120-MWA09	New	HS	-	X	-	X	X	-	A,B	1) Investigation of potential sources at LP-120 multiple SWMUs 2) Migration of analytes south to Ship Creek and ponds. 3) Soil samples PCBs for extent 4) Groundwater flow data 5) LNAPL occurrence data	X	EPH/VPH PCB	X	EPH/VPH PCB	-
N. of Ship Creek	6	LP-131 Alaska Sheet Metal	A-10	LP131-MWA10	New	HS	-	X	-	X	X	-	B	1) Investigation of potential sources at LP-131(eletrical equipment repair - Former Westinghouse site) 2) Migration of analytes south to Ship Creek. 3) Soil sampling should be located vicinity of swmus and aoc identified in RFA 4) Groundwater flow data	X	EPH/VPH PCB	X	EPH/VPH PCB	-
N. of Ship Creek	5	LP-069 Dean's Automotive	A-11	AR001-DPA11	New	DP	-	-	-	X	X		B,D	1) Investigation of potential sources at LP-069 (pools of oil reported) 2) Migration of analytes south to Ship Creek, well located downgradient 3) Groundwater flow data 4) LNAPL occurrence data	X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-069 Dean's Automotive	A-12	AR001-MWA12	New	HS	-	X	-	X	X	-	D	1) Investigation of potential sources at LP-069 (pools of oil reported) 2) Migration of analytes south to Ship Creek. 3) Investigate area near old pump house. Unknown potential source 4) Groundwater flow data 5) LNAPL occurrence data	X	EPH/VPH PCB	X	EPH/VPH PCB	-
N. of Ship Creek	5	LP-090	A-13	AR001-MWA13	New	HS	-	X	-	X	X	-	D	1) Investigation of potential upgradient sources 2) migration of analytes south to Ship Creek although nothing identified at upgradient property 3) Infill random soil sample in the vicinity of sediment and surface water sampling 4) Groundwater flow data	X	EPH/VPH PCB	X	EPH/VPH PCB	-
N. of Ship Creek	5	LP-991 Artic Cooperage	A-14	LP137-EMW3	Existing	-	-	-	-	X	X	-	B	1) Investigation of potential sources at LP-991(re-refining and other oil storage), extensive dataset on site. RI designed to identify downgradient and off-site migration 2) Migration of analytes south to Ship Creek. 3) Groundwater flow data 4) LNAPL occurrence data center of study on Whitney Rd. plume	X	EPH/VPH PCB	-	-	-

Table 4
Soil and Groundwater Investigation Details

															Groundwater Analyses		Soil Analyses		
Groundwater Investigation Area	**Soil Investigation Area**	**Nearest Property ID**	**Preliminary Site Identifier**	**Actual Site Identifier**	**New or Existing Well**	**Drilling Method (HS/DP)**	**Surface Soil Sample Only**	**Proposed Soil Samples[1]**	**Geotech. Subsurface Soil Sample[2]**	**Fluid Level Gauging**	**Proposed Groundwater Sample**	**Tidal Influence Study**	**Category[3] (A,B,C,D)**	**Rationale**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Additional Analyses[6]**
N. of Ship Creek	5	LP-034 CDF	A-15	LP991-EMW2	Existing	-	-	-	-	X	X	-	B	1) Investigation of potential sources at LP-034 and LP-137 (interest associated with location between Artic Coop. and Laidlaw) 2) Migration of analytes south to Ship Creek. RFA identified groundwater as Area of Concern (AOC) due to proximity to Artic Cooperage and Laidlaw. 3) Groundwater flow data 4) LNAPL occurrence data center of study on Whitney Rd. plume	X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-127 Post Rd. Co-Tenancy	A-16	LP127-MWA16	New	HS	-	X	-	X	X	-	A,B	1) Investigation of potential sources at LP-127 (PCBs removed, possible TCE from unknown source) 2) Migration of analytes south to Ship Creek, wells on south boundary of the property 3) Groundwater flow data 4) LNAPL occurrence data south of study on Whitney Rd. plume	X	EPH/VPH PCB	X	EPH/VPH PCB	-
N. of Ship Creek	5	LP-127 Post Rd. Co-Tenancy	A-17	LP127-MWA17	New	HS	-	X	-	X	X	-	A,B	1) Investigation of potential sources at LP-127 (PCBs removed, possible TCE from unknown source) 2) Migration of analytes south to Ship Creek, wells to be located on south boundary of the property 3) Groundwater flow data 4) LNAPL occurrence data south of study on Whitney Rd. plume	X	EPH/VPH PCB	X	EPH/VPH PCB	-
N. of Ship Creek	5	LP-127 Post Rd. Co-Tenancy	A-18	LP127-MWA18	New	HS	-	X	-	X	X	-	A,B	1) Investigation of potential sources at LP-127 (PCBs removed, possible TCE from unknown source) 2) Migration of analytes south to Ship Creek, wells on south boundary of the property 3) Groundwater flow data 4) LNAPL occurrence data	X	EPH/VPH PCB	X	EPH/VPH PCB	-
N. of Ship Creek	5	LP-040/LP-085 Walsky Constructions Equipment	A-19	LP085-MWA19	New	HS	-	X	-	X	X	-	A	1) Investigation of potential sources on west side property (former waste oil UST) 2) Migration of analytes south to Ship Creek (possibly TCE and PCE) 3) Groundwater flow data 4) LNAPL occurrence data	X	EPH/VPH PCB	X	EPH/VPH PCB	-

Table 4
Soil and Groundwater Investigation Details

															Groundwater Analyses		Soil Analyses		
Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	Actual Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Fluid Level Gauging	Proposed Groundwater Sample	Tidal Influence Study	Category[3] (A,B,C,D)	Rationale	Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
N. of Ship Creek	5	LP-085/LP-134 CBS Hw/HW Alaska	A-20	AR001-MWA20	New	HS	-	X	-	X	X	-	A	1) Investigation of potential sources on east side property (former gasoline UST) 2) Migration of analytes south to Ship Creek (BTEX, GRO, mostly attenuated at this time) 3) Groundwater flow data 4) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	LP-105 Saturn Construction	A-21	AR001-MWA21	New	HS	-	X	-	X	X	-	D	1)Investigation of potential up gradient sources 2)Migration of analytes south to Ship Creek 3) Random infill soil and gw sampling 4) Groundwater flow data 5) LNALP occurrence data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-006 Joe's Body Paint	A-22	AR001-MWA22	New	HS	-	X	-	X	X	-	C	1) Investigation of potential sources at LP-006 2) Migration of analytes south to Ship Creek 3) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-063 Denali Leasing	A-23	LP063-MWA23	New	HS	-	X	-	X	X	-	D	1) Investigation of potential up gradient sources 2) Migration of analytes south to Ship Creek 3) Random infill soil and gw sampling 4) Groundwater flow data 5) LNALP occurrence data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-050 Alaska Crate and Pallet	A-24	LP050-MWA24	New	HS	-	X	-	X	X	-	A	1) Investigation of potential upgradient sources (location downgradient of LP-024) 2) Migration of analytes south to Ship Creek 3) Random infill soil and gw sampling 4) Groundwater flow data	X	EPH/VPH PCB	X	EPH/VPH PCB	-
N. of Ship Creek	4	LP-024 Prescott	A-25	AR001-MWA25	New	HS	-	X	-	X	X	-	A	1) Investigation of potential upgradient sources (location downgradient of LP-024) 2) Migration of analytes south to Ship Creek 3) Random infill soil and gw sampling 4) Groundwater flow data	X	EPH/VPH PCB	X	EPH/VPH PCB	-
N. of Ship Creek	4	LP-017 Polar Equipment	A-26	AR001-MWA26	New	HS	-	X	-	X	X	-	A,D	1) Investigation of potential sources at LP-017. Well places authoritatively donwgradient of site. 2) Migration of analytes south to Ship Creek. 3) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-056 Steel Fabricator	A-27	LP056-MWA27	New	HS	-	X	-	X	X	-	A,D	1) Investigation of potential sources at LP-056 (water supply from deep aquifer) 2) Migration of analytes south to Ship Creek. Locate boring by visual inspection in area near swmu 56-4 3) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	-

Table 4
Soil and Groundwater Investigation Details

Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	Actual Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Fluid Level Gauging	Proposed Groundwater Sample	Tidal Influence Study	Category[3] (A,B,C,D)	Rationale	Groundwater Analyses		Soil Analyses		
															Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
N. of Ship Creek	4	LP-056 Steel Fabricator	A-28	LP056-MWA28	New	HS	-	X	-	X	X	-	A,D	1) Investigation of potential sources at LP-056 (water supply from deep aquifer) 2) Migration of analytes south to Ship Creek. Locate boring by visual inspection in area near swmu 56-4 3) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-110 Bob Benson Trucking	A-29	AR001-DPA29	New	DP	-	-	-	X	X	-	A	1) Investigation of potential upgradient sources (former Std Steel and LP-110) 2) Migration of analytes south to Ship Creek. 3) Groundwater flow data	X	EPH/VPH	-	-	-
S. of Ship Creek	-	LP-057 Railyard Office Building	B-1	AR001-DPB01	New	DP	-	-	-	X	X	-	D	1) Investigation of potential upgradient sources on south side of creek 2) Migration of analytes north to Ship Creek 3) Infill gw data 4) Groundwater flow data	X	EPH/VPH	-	-	-
S. of Ship Creek	-	LP-057 Railyard Office Building	B-2	LP057-DPB02	New	DP	-	-	-	X	X	-	D	1) Investigation of potential upgradient sources on south side of creek 2) Migration of analytes north to Ship Creek 3) Infill gw data 4) Groundwater flow data	X	EPH/VPH	-	-	-
S. of Ship Creek	6	LP-071 BDK Partnership	B-3	AR001-DPB03	New	DP	-	-	-	X	X	-	D	1) Investigation of potential upgradient sources on south side of creek 2) Migration of analytes north to Ship Creek 3) Infill gw data 4) Groundwater flow data	X	EPH/VPH	-	-	-
S. of Ship Creek	6	LP-075 Ulu Factory	B-4	AR001-DPB04	New	DP	-	-	-	X	X	-	D	1) Investigation of potential upgradient sources on south side of creek 2) Migration of analytes north to Ship Creek 3) Infill gw data 4) Groundwater flow data	X	EPH/VPH	-	-	-
S. of Ship Creek	6	LP-058 Comfort Inn	B-5	LP058-DPB05	New	DP	-	-	-	X	X	-	D	1) Investigation of potential upgradient sources on south side of creek 2) Migration of analytes north to Ship Creek 3) Infill gw data 4) Groundwater flow data	X	EPH/VPH	-	-	-
S. of Ship Creek	6	LP-129 Statewide Door and Glass	B-6	AR001-MWB06	New	HS	-	X	X	X	X	X	D	1) Investigation of potential upgradient sources on south side of creek 2) Migration of analytes north to Ship Creek 3) Infill soil and gw data 4) Groundwater flow data 5) Tidal study data	X	EPH/VPH	X	EPH/VPH	X
S. of Ship Creek	6	LP-128 Seamless Flooring	B-7	AR001-MWB07	New	HS	-	X	X	X	X	-	D	1) Investigation of potential upgradient sources on south side of creek 2) Migration of analytes north to Ship Creek 3) Infill soil and gw data 4) Groundwater flow data 5) Hydraulic conductivity	X	EPH/VPH	X	EPH/VPH	X

Table 4
Soil and Groundwater Investigation Details

Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	Actual Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Fluid Level Gauging	Proposed Groundwater Sample	Tidal Influence Study	Category[3] (A,B,C,D)	Rationale	Groundwater Analyses		Soil Analyses		
															Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
S. of Ship Creek	6	LP-013 Alaska Floor-Wall	B-8	AR001-MWB08	New	HS	-	X	-	X	X	-	D	1) Investigation of potential upgradient sources on south side of creek 2) Migration of analytes north to Ship Creek 3) infill soil and gw data 4) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	6	LP-135 Rowan Pacific Decorators	B-9	LP022-MW24	Existing	-	-	-	-	X	X	-	D	1) Investigation of potential upgradient sources on south side of creek 2) Migration of analytes north to Ship Creek 3) Groundwater flow data	X	EPH/VPH	-	-	-
S. of Ship Creek	6	LP-113 AAA Moving	B-10	LP055-MW3	Existing	-	-	-	-	X	X	-	D	1) Investigation of potential upgradient sources on south side of creek 2) Migration of analytes north to Ship Creek 3) Groundwater flow data	X	EPH/VPH	-	-	-
S. of Ship Creek	5	LP-055 Altex Distributing	B-11	LP055-MWB11	New	HS	-	X	-	X	X	-	B	1) Investigation of potential sources from up gradient ruptured AST (1964) (previous sampling indicates potential BTEX source to SE) 2) Migration of analytes north to Ship Creek. Sample from existing well if present. Install drive point if well not found. 3) Groundwater flow data 4) LNAPL occurrence data - downgradient of 1964 ruptured diesel AST	X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	5	LP-022 ML&P	B-12	LP022-MWB12	New	HS	-	X	X	X	X	-	A,B	1) Investigation of potential sources from LP-022 (previous sampling indicates potential BTEX source to SE) 2) Migration of analytes north to Ship Creek. Sample from existing well if present. Install drive point if well not found. 3) Groundwater flow data 4) LNAPL occurrence data - downgradient of 1964 ruptured diesel AST	X	EPH/VPH	X	EPH/VPH	X
S. of Ship Creek	5	LP-048 Air Van Lines	B-13	LP048-DPB13	New	DP	-	-	-	X	X	-	D	1) Investigation of potential sources on south side of creek 2) Migration of analytes north to Ship Creek. Well to be located north side of LP-048 3) Groundwater flow data	X	EPH/VPH	-	-	-
S. of Ship Creek	5	LP-109 Beat's Walking	B-14	LP109-MWB14	New	HS	-	X	-	X	X	-	D	1) Investigation of potential sources on south side of creek (minor potential - some rusty drums not much else) 2) Migration of analytes north to Ship Creek. 3) Infill soil and gw 4) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	-

Table 4
Soil and Groundwater Investigation Details

															Groundwater Analyses		Soil Analyses		
Groundwater Investigation Area	**Soil Investigation Area**	**Nearest Property ID**	**Preliminary Site Identifier**	**Actual Site Identifier**	**New or Existing Well**	**Drilling Method (HS/DP)**	**Surface Soil Sample Only**	**Proposed Soil Samples[1]**	**Geotech. Subsurface Soil Sample[2]**	**Fluid Level Gauging**	**Proposed Groundwater Sample**	**Tidal Influence Study**	**Category[3] (A,B,C,D)**	**Rationale**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Additional Analyses[6]**
S. of Ship Creek	5	LP-092 Odom	B-15	LP092-MW11	Existing	-	-	-	-	X	X	-	D	1) Investigation of potential sources on south side of creek 2) Migration of analytes north to Ship Creek. 3) Infill groundwater 4) Groundwater flow data	X	EPH/VPH	-	-	-
S. of Ship Creek	4	LP-092 Odom	B-16	LP092-MW44	Existing	-	-	-	-	X	X	-	D	1) Investigation of potential sources on south side of creek 2) Migration of analytes north to Ship Creek. 3) Infill groundwater 4) Groundwater flow data	X	EPH/VPH	-	-	-
S. of Ship Creek	4	LP-125 L&J Cabs	B-17	AR001-MWB17	New	HS	-	X	-	X	X	-	A	1) Investigation of potential sources (four former USTs) 2) Migration of analytes north to Ship Creek. 3) Infill soil and gw 4) Groundwater flow data 5) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	4	LP-072 Karens RV	B-18	LP072-DPB18	New	DP	-	-	-	X	X	-	A,D	1) Investigation of potential sources (former USTs) 2) Migration of analytes north to Ship Creek. 3) Infill groundwater 4) Groundwater flow data 5) LNAPL occurrence data	X	EPH/VPH	-	-	-
S. of Ship Creek	4	LP-083 Pruhs	B-19	LP083-MWB19	New	HS	-	X	-	X	X	-	A	1) Investigation of potential sources (above ground oil/water separator) 2) Migration of analytes north to Ship Creek. 3) Groundwater flow data 4) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	4	LP-082 Summit Paving	B-20	LP082-DPB20	New	DP	-	-	-	X	X	-	D	1) Investigation of potential upgradient sources. Confirm results form previous investigation of soil contamination from ponds. 2) Migration of analytes north to Ship Creek 3) Infill groundwater data 4) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	C-1	RY065-MWC01	New	HS	-	X	-	X	X	-	E	1) Investigation of potential upgradient sources 2) Off-site migration of analytes to south 3) Infill groundwater data 4) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	C-2	RY065-MWC02	New	HS	-	X	-	X	X	-	E	1) Instigation of potential source (swmu 39) 2) Migration of analytes off-site of south boundary from railyard. 3) Groundwater flow data.Drive point located downgradient of swmu 39	X	EPH/VPH	X	EPH/VPH	-

Table 4
Soil and Groundwater Investigation Details

Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	Actual Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Fluid Level Gauging	Proposed Groundwater Sample	Tidal Influence Study	Category[3] (A,B,C,D)	Rationale	Groundwater Analyses		Soil Analyses		
															Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
N. of Ship Creek	2	RY-065 Railyard	C-3	RY065-MWC03	New	HS	-	X	-	X	X	-	E	1) Instigation of potential source (swmu 39) 2) Migration of analytes off-site from south boundary of railyard. 3) Groundwater flow data.Drive point located downgradient of swmu 39	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	C-4	LP008-MWC04	New	HS	-	X	X	X	X	X	E	1) Investigation of potential upgradient sources and background data 2) Off-site migration of analytes to south 3) Infill gw/soil data 4) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	X
N. of Ship Creek	5	RY-065 Railyard	C-5	RY065-DPC05	New	DP	-	-	-	X	X	-	A	1) Investigation of potential source (Well located north of LP-108 in the vicinity of AOCs 4 and 5, and SWMU 28) 2)Off-site migration of analytes along south boundary of railyard. 3) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	5	RY-065 Railyard	C-6	RY065-DPC06	New	DP	-	-	-	X	X	-	A	1) Investigation of potential source (Well located north of LP-108 in the vicinity of AOCs 4 and 5 former USTs, and swmu 28) 2) Off-site migration of analytes along south boundary of railyard. 3) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-079 Alaska Pride Bakery	C-7	RY065-MWC07	New	HS	-	X	-	X	X	-	D	1) Investigation of potential source (Well located upgradient of LP-079, LNAPL observed) 2) Off-site migration of analytes along south boundary of railyard 3) infill soil and gw data 4) Groundwater flow data 5) LNAPL occurrence data (NE of Whitney Rd. product study area) 6) Potential impacts related to AOC-6	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	RY-065 Railyard	C-8	RY065-MWC08	New	HS	-	X	-	X	X	-	D	1)Investigation of potential source 2) Migration of analytes along south boundary of railyard. 3) Infill soil data from east side of railyard. 4) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	C-9	RY065-MWC09	New	HS	-	X	X	X	X	X	E	1) Investigation of potential source 2) Off-site migration of analytes along south boundary of railyard. 3) Infill soil data from east side of railyard. 4) Groundwater flow data 5) Tidal influence - furthest west point	X	EPH/VPH	X	EPH/VPH	X

Table 4
Soil and Groundwater Investigation Details

															Groundwater Analyses		Soil Analyses		
Groundwater Investigation Area	**Soil Investigation Area**	**Nearest Property ID**	**Preliminary Site Identifier**	**Actual Site Identifier**	**New or Existing Well**	**Drilling Method (HS/DP)**	**Surface Soil Sample Only**	**Proposed Soil Samples[1]**	**Geotech. Subsurface Soil Sample[2]**	**Fluid Level Gauging**	**Proposed Groundwater Sample**	**Tidal Influence Study**	**Category[3] (A,B,C,D)**	**Rationale**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Additional Analyses[6]**
N. of Ship Creek	2	RY-065 Railyard	C-10	RY065-MWC10	New	HS	-	X	X	X	X	-	E	1) Investigation of potential source 2) Off-site migration of analytes along south boundary of railyard. 3) Infill soil data from east side of railyard. 4) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	X
N. of Ship Creek	2	RY-065 Railyard	C-11	RY065-DPC11	New	DP	-	-	-	X	X	-	E	1) Investigation of potential source (downgradient of seep samples with hits of TCE) 2) Migration of analytes along south boundary of railyard. 3) Infill soil data from east side of railyard. 4) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	C-12	RY065-MWC12	New	HS	-	X	-	X	X	-	E	1) Investigation of potential source (downgradient of seep samples with hits of TCE), also downgradient of snow dumping area 2) Off-site migration of analytes along south boundary of railyard. 3) Infill soil data from east side of railyard. 4) Groundwater flow data	X	EPH, VPH, PCB	X	EPH, VPH, PCB	-
N. of Ship Creek	2	RY-065 Railyard	D-1	RY065-MWD01	New	HS	-	X	X	X	X	-	E	1) Investigation of potential upgradient and off-site source 2) Migration of analytes from north and background data. 3) infill soil and gw location Well (located in the vicinity of swmu 41 but not considered source) 4) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	X
N. of Ship Creek	2	RY-065 Railyard	D-2	RY065-DPD02	New	DP	-	-	-	X	X	-	E	1) Investigation of potential upgradient and off-site source 2) Migration of analytes from north and background data. 3) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	D-3	RY065-DPD03	New	DP	-	-	-	X	X	-	E	1) Investigation of potential upgradient and off-site source 2) Migration of analytes from north and background data. 3) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	D-4	RY065-TP01	Existing	-	-	-	-	X	X	-	E	1) Investigation of potential upgradient and off-site source (use existing well TP01) 2) Migration of analytes from north and background data. 3) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	D-5	RY065-TP03	Existing	-	-	-	-	X	X	-	E	1) Investigation of potential upgradient and off-site source (use existing well TP03) 2) Migration of analytes from north and background data. 3) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	D-6	RY065-MWD06	New	HS	-	X	-	X	X	-	E	1) Investigation of potential upgradient and off-site source 2) Migration of analytes from north and background data. (Well to be located in upgradient of AOC 2 and 3) 3) Groundwater flow data.	X	EPH/VPH	X	EPH/VPH	-

Table 4
Soil and Groundwater Investigation Details

															Groundwater Analyses		Soil Analyses		
Groundwater Investigation Area	**Soil Investigation Area**	**Nearest Property ID**	**Preliminary Site Identifier**	**Actual Site Identifier**	**New or Existing Well**	**Drilling Method (HS/DP)**	**Surface Soil Sample Only**	**Proposed Soil Samples[1]**	**Geotech. Subsurface Soil Sample[2]**	**Fluid Level Gauging**	**Proposed Groundwater Sample**	**Tidal Influence Study**	**Category[3] (A,B,C,D)**	**Rationale**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Additional Analyses[6]**
N. of Ship Creek	2	RY-065 Railyard	D-7	NB001-DPD07	New	DP	-	-	-	X	X	-	E	1) Investigation of potential upgradient and off-site source 2) Migration of analytes from north and background data. Well located in the vicinity of swmu 35. 3) Groundwater flow data	X	EPH, VPH, Herbicides	-	-	-
N. of Ship Creek	2	RY-065 Railyard	D-8	NB001-MWD08	New	HS	-	X	-	X	X	-	E	1) Investigation of potential upgradient and off-site source (Well located in the vicinity of swmu 16 oil storage tank cars) 2) Migration of analytes from north. 3) infill soil and gw data 4) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	D-9	NB001-DPD09	New	DP	-	-	-	X	X	-	E	1) Investigation of potential upgradient and off-site source (Well located in the vicinity of swmu 37 soil stockpile) 2) Migration of analytes from north. 3) Infill gw data 4) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	D-10	NB001-DPD10	New	DP	-	-	-	X	X	-	E	1) Investigation of potential upgradient and off-site source 2) Migration of analytes from north and background data. 3) Infill gw data 4) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	D-11	RY065-BMW2	Existing	-	-	-	-	X	X	-	E	1) Investigation of potential upgradient and off-site source (Sample well BMW2 if it exists. Drive point well will be installed if well is not usable) 2) migration of analytes from north. 3) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	D-12	NB001-DPD12	New	DP	-	-	-	X	X	-	E	1) Investigation of potential upgradient and off-site source (Well located in the vicinity of swmu 40) 2) Migration of analytes from north and background data. 3) Infill gw data 4) Groundwater flow data	X	EPH, VPH, Pesticides	-	-	-
N. of Ship Creek	2	RY-065 Railyard	D-13	RY065-MW1	Existing	-	-	-	-	X	X	-	E	1) Investigation of potential upgradient and off-site source (Sample well MW1 if it exists. Drive point well will be installed if well is not usable) 2) Migration of analytes from north and background data. 3) Groundwater flow data	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	E-1	RY065-MWE01	New	HS	-	X	-	X	X	-	E	1) Infill well on west side of railyard primarily for additional analytical. Location to be based on visual inspections 2) Groundwater flow data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	E-2	RY065-MWE02	New	HS	-	X	-	X	X	-	E	1) Infill well near fueling rack for additional soil and groundwater analytical data 2) Groundwater flow data 3) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-

Table 4
Soil and Groundwater Investigation Details

Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	Actual Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Fluid Level Gauging	Proposed Groundwater Sample	Tidal Influence Study	Category[3] (A,B,C,D)	Rationale	Groundwater Analyses		Soil Analyses		
															Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
N. of Ship Creek	2	RY-065 Railyard	E-3	RY065-MWE03	New	HS	-	X	-	X	X	-	E	1) Infill well near fueling rack for additional soil and groundwater analytical data 2) Groundwater flow data 3) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	E-4	RY065-MWE04	New	HS	-	X	-	X	X	-	E	1) Infill well near fueling rack for additional soil and groundwater analytical data 2) Groundwater flow data 3) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	E-5	RY065-MWE05	New	HS	-	X	-	X	X	-	E	1) Infill gw and soil data in the vicinity AOC 2 and 3 (former fueling area and AST) 2) Groundwater flow data 3) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	E-6	RY065-MWE06	New	HS	-	X	-	X	X	-	E	1) Infill gw and soil data in the vicinity AOC 2 and 3 (former fueling area and AST) 2) Groundwater flow data 3) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	LP-069 Dean's Automotive	E-7	LP069-MWE07	New	HS	-	X	-	X	X	-	C	1) Investigate as potential source area - LNAPL reported 2) Infill well to investigate LP-069 swmus 3) Soil and groundwater analytical 4) Groundwater flow data 5) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	LP-069 Dean's Automotive	E-8	LP069-MWE08	New	HS	-	X	-	X	X	-	C	1) Investigate as potential source area - LNAPL reported 2) Infill well to investigate LP-069 swmus 3) Soil and groundwater analytical 4) Groundwater flow data 5) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	LP-069 Dean's Automotive	E-9	LP069-MWE09	New	HS	-	X	-	X	X	-	C	1) Investigate as potential source area - LNAPL reported 2) Infill well to investigate LP-069 swmus 3) Soil and groundwater analytical 4) Groundwater flow data 5) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	5	LP-078	E-10	LP078-MWE10	New	HS	-	X	-	X	X	-	C	1) Investigate as potential source area - LNAPL reported 2) Infill well to investigate LP-069 swmus 3) Soil and groundwater analytical 4) Groundwater flow data 5) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	4	LP-052 Patrick M. Hickey	E-11	LP052-MWE11	New	HS	-	X	-	X	X	-	C	1) Investigate as potential source area - LNAPL reported 2) Infill well to investigate LP-052/069 swmus soil and gw 3) Groundwater flow data 4) LNAPL occurrence data	X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	4	LP-026 Alaska Teamster	E-12	LP026-MWE12	New	HS	-	X	-	X	X	-	C	1) Infill well to investigate LP-026as potential source. Well to be located in the vicinity of AOC26-1. 2) Groundwater flow data 3) LNAPL occurrence data - vicinity of Whitney Rd. Plume	X	EPH/VPH	X	EPH/VPH	-

Table 4
Soil and Groundwater Investigation Details

															Groundwater Analyses		Soil Analyses		
Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	Actual Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Fluid Level Gauging	Proposed Groundwater Sample	Tidal Influence Study	Category[3] (A,B,C,D)	Rationale	Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
S. of Ship Creek	4	LP-112 Whitney Express	E-13	LP112-MWE13	New	HS	-	X	-	X	X	-	C	1) Infill well as part of Whitney Rd. plume 2) Groundwater flow data 3) LNAPL occurrence data - vicinity of Whitney Rd. Plume	X	EPH/VPH	X	EPH/VPH	-
S. of Ship Creek	4	LP-094 Alaska Basic Industries	E-14	AR001-DPE14	New	DP	-	-	-	X	X	-	C	1) Infill well for investigation of potential upgradient gw source associated with soil treatment facility at LP-94 . 2) Migration of analytes north on to site. 3) Groundwater flow data 4) LNAPL occurrence data	X	EPH/VPH	-	-	-
N. of Ship Creek	4	LP-018 LH Construction	E-15	LP018-MWE15	New	HS	-	X	-	X	X	-	A	1) Infill well for investigation of potential upgradient sources (not much associated with LP-018) 2) infill soil and gw east side of property 3) Migration of analytes south from railyard. 4) Groundwater flow data	X	EPH/VPH PCB	X	EPH/VPH PCB	-
N. of Ship Creek	4	LP-031 Keystone Services	E-16	LP031-MWE16	New	HS	-	X	X	X	X	-	A	1) Infill well for investigation of potential upgradient sources (not much associated with LP-031) 2) infill soil and gw east side of property+M4 3) Migration of analytes south from railyard. 4) Groundwater flow data	X	EPH/VPH PCB	X	EPH/VPH PCB	X
N. of Ship Creek	3	LP-019 Tesoro Terminal #1	E-17	AR001-MWE17	New	HS	-	X	-	X	X	-	E	1) Well on west boundary of LP-019 to investigate upgradient sources 2) Migration of analytes from south LP-019 to west 3) Groundwater flow data +O101	BTEX, Ethylene dibromide, 1,2-Dichloroethane, Lead, PAHs	EPH/VPH	BTEX, Ethylene dibromide, 1,2-Dichloroethane, Lead, PAHs	EPH/VPH	-
N. of Ship Creek	3	LP-019 Tesoro Terminal #1	E-18	AR001-MWE18	New	HS	-	X	-	X	X	-	E	1) Well on west boundary of LP-019 to investigate upgradient sources 2) Migration of analytes from south LP-019 to west 3) Groundwater flow data 4) LNAPL occurrence data	BTEX, Ethylene dibromide, 1,2-Dichloroethane, Lead, PAHs	EPH/VPH	BTEX, Ethylene dibromide, 1,2-Dichloroethane, Lead, PAHs	EPH/VPH	-

Table 4
Soil and Groundwater Investigation Details

														Groundwater Analyses		Soil Analyses		
Groundwater Investigation Area	**Soil Investigation Area**	**Nearest Property ID**	**Preliminary Site Identifier**	**Actual Site Identifier**	**New or Existing Well**	**Drilling Method (HS/DP)**	**Surface Soil Sample Only**	**Proposed Soil Samples[1]**	**Geotech. Subsurface Soil Sample[2]**	**Fluid Level Gauging**	**Proposed Groundwater Sample**	**Tidal Influence Study**	**Category[3] (A,B,C,D)**	**Rationale**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Investigation Analyte List[4]**	**Supplemental Analyte List[5]**	**Additional Analyses[6]**
N. of Ship Creek	6	LP-049 Wrightway Auto	E-19	LP049-MWE19	New	HS	-	X	-	X	X	-	B	1) Investigation of potential sources from former USTs at LP-049; 2) Migration of analytes south to Ship Creek; 3) Groundwater flow data 4)+O97 LNAPL thickness data based on observed oil seeps along Ship Creek mentioned in RFA	X	EPH/VPH	X	EPH/VPH	-
N. of Ship Creek	2	RY-065 Railyard	E-20	RY065-MWE20	New	HS	-	X	-	X	X	-	E	1) Investigation of potential source (swmu 69/65) former tank car steaming area 2) Migration of analytes along south boundary of railyard. 3) Groundwater flow data. 4) LNAPL occurrence data	X	EPH/VPH PCB	X	EPH/VPH PCB	-
N. of Ship Creek	5	LP-991 Arctic Cooperage	E-21	LP991CHMW2	Existing	-	-	-	-	X	X	-	B	1) Sample in plume for evaluating natural attenuation 2) Determine monitored natural attenuation sampling locations 3) Groundwater flow data. 4) LNAPL occurrence data	X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-991 Arctic Cooperage	E-22	LP991CHMW4	Existing	-	-	-	-	X	X	-	B	1) Sample in plume for evaluating natural attenuation 2) Determine monitored natural attenuation sampling locations 3) Groundwater flow data. 4) LNAPL occurrence data	X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-137 Laidlaw Transit	E-23	LP991-MW3	Existing	-	-	-	-	X	X	-	B	1) Sample in plume for evaluating natural attenuation 2) Determine monitored natural attenuation sampling locations 3) Groundwater flow data. 4) LNAPL occurrence data	X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-134 HW Alaska LLC	E-24	LP134-MW3	Existing	-	-	-	-	X	X	-	A	1) Sample in plume for evaluating natural attenuation 2) Determine monitored natural attenuation sampling locations 3) Groundwater flow data. 4) LNAPL occurrence data	X	EPH/VPH	-	-	-
N. of Ship Creek	5	LP-991 Arctic Cooperage	E-25	LP991CHMW1	Existing	-	-	-	-	X	X	-	B	1) Sample in plume for evaluating natural attenuation 2) Determine monitored natural attenuation sampling locations 3) Groundwater flow data. 4) LNAPL occurrence data	X	EPH/VPH	-	-	-
Tank Farm	3	LP-004, LP-019, LP-025, LP-103	SS-01 SS-02 SS-03 SS-04	AR001-SS01 AR001-SS02 AR001-SS03 AR001-SS04	-	-	X	-	-	-	-	-	E	Surface soil samples to be collected to evaluate conditions at specified SWMUs or AOCs based on request from U.S. EPA.	-	-	BTEX, Ethylene dibromide, 1,2-Dichloroethane, Lead, PAHs	EPH/VPH	-

Table 4
Soil and Groundwater Investigation Details

Groundwater Investigation Area	Soil Investigation Area	Nearest Property ID	Preliminary Site Identifier	Actual Site Identifier	New or Existing Well	Drilling Method (HS/DP)	Surface Soil Sample Only	Proposed Soil Samples[1]	Geotech. Subsurface Soil Sample[2]	Fluid Level Gauging	Proposed Groundwater Sample	Tidal Influence Study	Category[3] (A,B,C,D)	Rationale	Groundwater Analyses		Soil Analyses		
															Investigation Analyte List[4]	Supplemental Analyte List[5]	Investigation Analyte List[4]	Supplemental Analyte List[5]	Additional Analyses[6]
N. of Ship Creek	6	LP-120 KAPP	SS-05 SS-06 SS-07	LP120-SS05 LP120-SS06 LP120-SS07	-	-	X	-	-	-	-	-	-	Surface soil samples to be collected to evaluate conditions at specified SWMUs or AOCs based on request from U.S. EPA.	-	-	X	EPH/VPH	-
S. of Ship Creek	6	LP-049 Wrightway Auto	SP-60	NB003-SP60	-	-	-	-	-	-	X	-	-	Previous seep migration from LP-049	X	EPH/VPH	-	-	-
N. of Ship Creek	2	RY-065 Railyard	SP-01, SP-24, SP-35, SP-40, and SP-48 (Groundwater Springs)	NB001-SP01 NB001-SP24 NB002-SP35 NB002-SP40 NB002-SP48	-	-	-	-	-	-	X	-	E	1) Investigation of potential upgradient sources and background 2) Migration of analyte from north. 3) Evaluate spring/groundwater interaction 4) Groundwater flow data	X	EPH/VPH	-	-	-

Notes:

1. Includes surface and subsurface soil sampling.
2. Geotech. = geotechnical analyses including air-filled porosity, water-filled porosity, grain size, permeability, and soil dry-bulk density
3. Categories:
   A = Actively managed /NFA/Little interest in RFA
   B = Work started but incomplete dataset
   C = Interest in site and/or work requested but not started
   D = Not much interest in site but little or no information available
   E = Industrial Area - only interst is potential for off-site migration.
4. Includes all constituents on the Investigation Analyte List, with the exception of samples proposed in Area 3. Specific analyses proposed for samples collected in Area 3 are identified within the table. Groundwater samples will be analyzed for dissolved metals on the Investigation Analyte List.
5. Includes constituents specified as a subset of the Supplemental Analyte List:
   DRO = diesel range organics
   GRO = gasoline range organics
   PCB = polychlorinated biphenyls
6. Additional analyses to be performed on a subsurface soil sample and will include the following geotechnical parameters: air-filled porosity, water-filled porosity, grain size distribution, permeability, and soil dry bulk density.

AOC = area of concern
AST = above ground storage tank
BTEX = benzene, toluene, ethylbenzene, and total xylenes
DP = direct push drilling method
GW = groundwater
HS = hollow-stem auger drilling method
LNAPL = light non-aqueous phase liquid
RFA = RCRA Facility Assessment
swmu = solid waste management unit
TCE = trichloroethylene
UST = underground storage tank

Table 5
Sediment and Surface Water Investigation Details

Sediment Investigation Area	Preliminary Site Identifier	Actual Site Identifier	Investigation Rationale	Location/Description	Nearest Leased Property ID	Comments	Sediment Sample Collection Depth		Surface Water Sample	Access to Location	Sediment Sampling Method	Sediment Sample Analyses[1]			Surface Water Analysis[1]		
							0" - 4"	4" - 12"				Investigation Analyte List	Supplemental Analyte List[2]	Additional Analyses[3]	Investigation Analyte List	Supplemental Analyses	Conventional Analyses[4]
Off-Channel Areas Sediment Investigation																	
KAPP Pond	S-A-1	SC002-CSA01	Area with known residual contamination: determine if residual contamination present	West pond, center	LP-120	-	X	X	-	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-A-2	SC002-CSA02		Central pond, center		-	X	X	X	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
	S-A-3	SC002-CSA03		East pond, center		-	X	X	-	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH	-	-	-
Wastewater Pond	S-B-1	SC002-CSB01	Area with known and suspected upgradient source areas; evidence of sheening; high ecological value; but no existing data	North end of pond	LP-069, 052, 123, 090, 991, and 034	Deepest part of pond	X	X	X	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
	S-B-2	SC002-CSB02		South end, old outlet		Located near inactive outlet of pond	X	X	-	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-B-3	SC002-CSB03		East arm of pond		Eastern lobe of pond, downgradient of LP-991	X	X	-	Boat	Hand auger	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-B-4	SC002-CSB04		West end of marshy area		-	X	X	X	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
	S-B-5	SC002-CSB05		E end of marshy area		Downgradient of LP-991	X	X	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-B-6	SC002-CSB06		Channel below outfall		Marshy areas below storm water outfall	X	X (if available)	X	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
Railroad Ditch	S-C-1	SC002-CSC01	No existing data; potential source areas upgradient	East end of ditch	LP-098, 116, 137, 043, 127	-	X	X (if available)	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-C-2	SC002-CSC02		Mid section of ditch		-	X	X (if available)	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-C-3	SC002-CSC03		West end of ditch		-	X	X (if available)	X	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
Railroad Avenue Marsh	S-D-1	SC002-CSD01	Area with upgradient source areas, evidence of contamination, high ecological value, but no existing data	Relict channel, West end	LP-024, 076, 036, 029, 066, and 056	Possible past discharge channel for marsh	X	X	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-D-2	SC002-CSD02		West end of marshy area		Main body of marsh	X	X	X	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
	S-D-3	SC002-CSD03		East end of marshy area		Near point of water seepage to Ship Creek	X	X	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
	S-D-4	SC002-CSD04		Ditch area		Downgradient of evidence of contamination	X	X	X (if available)	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
Area E Misc. Area	S-E-1	SC002-CSE01	Confirmation samples in areas downgradient of past source areas.	Old Std Steel ditch	Std Steel NPL site	PCBs reported in 1980s.	X	X	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-E-2	SC002-CSE02		Relict channel, below Cotenancy	LP-127	Prior PCB source area located nearby (LP-127)	X	X	X (if available)	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
	S-E-3	SC002-CSE03		Relict channel, below Alaska Sheet Metal	LP-042, LP-131	Downgradient of properties with possible past release	X	X	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	-	-	-
Ship Creek Sediment and Surface Water Investigation																	
Ship Creek	S-S-1	SC001-CR01	Existing data needs to be complemented with sediment collected from defined "worst case" depositional zones. Unclear if prior data did this. Surface water data to provide better temporal coverage.	Lower channel (center) bl. RR	-	Lower intertidal area. No data available	X	-	-	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-S-2	SC001-CR02		Tidal channel, near C St. bridge	-	Lower tidal zone of creek, below all discharges	X	-	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
	S-S-3	SC001-CR03		Tidal channel, below dam	-	Upper tidal zone	X	-	-	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-S-4	SC001-CR04		Backwater area above dam	-	Key accumulation zone for fines	X	X (if available)	-	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-S-5	SC001-CR05		Sandy area above dam	-	Sand accumulation zone behind dam	X	-	X	Walk-in	Hand auger	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field

Table 5
Sediment and Surface Water Investigation Details

Sediment Investigation Area	Preliminary Site Identifier	Actual Site Identifier	Investigation Rationale	Location/Description	Nearest Leased Property ID	Comments	Sediment Sample Collection Depth		Surface Water Sample	Access to Location	Sediment Sampling Method	Sediment Sample Analyses[1]			Surface Water Analysis[1]		
							0" - 4"	4" - 12"				Investigation Analyte List	Supplemental Analyte List[2]	Additional Analyses[3]	Investigation Analyte List	Supplemental Analyses	Conventional Analyses[4]
Ship Creek Cont.	S-S-6	SC001-CR06	Existing data needs to be complemented with sediment collected from defined "worst case" depositional zones. Unclear if prior data did this. Surface water data to provide better temporal coverage.	Main channel below Area 2	-	Below potential source areas B and C	X	-	-	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-S-7	SC001-CR07		Main channel near RR bridge	-	Above potential source area B	X	-	-	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-S-8	SC001-CR08		Main channel above Post Rd.	-	Possible accumulation zones in upper creek	X	-	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
	S-S-9	SC001-CR09		Main channel below Area 4	-	Below potential source area D	X	-	-	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	-	-	-
	S-S-10	SC001-CR10		Main channel above Std Steel	-	Above potential source area D and E	X	-	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
	S-S-12	SC001-CR12	Evaluate conditions in channel below outfall from KAPP pond and downgradient of LP-120	Main channel below KAPP dam and outfalls	-	Below migration from LP-120 and KAPP pond outfall. Also below ARRC/MOA stormwater outfall.	X	-	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
	S-S-13	SC001-CR13	Evaluate seep approximately 200 feet downgradient of Wrightway Auto (LP-049)	Seep south of Wrightway Auto (LP-049)	LP-049	-	X (if available)	X (if available)	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field
Ship Creek Background	SC-11	SC-11	Current conditions in upgradient Ship Creek	Main channel above Reeve Blvd. bridge	-	Background (upstream) of site	X	-	X	Walk-in	By hand	X	PCB	TOC, Grain-Size, pH	X	PCBs	Hardness, Field

Notes:
1. Surface water samples will be analyzed for dissolved and total metals on the Investigation Analyte List.
2. Includes constituents specified as a subset of the Supplemental Analyte List.
3. Additional analyses will be conducted for sediment samples: total organic carbon (TOC), grain-size distribution, and pH.
4. Surface water samples will be analyzed for hardness by laboratory analysis. "Field" analyses to include: temperature, dissolved oxygen, conductivity, pH and oxidation-reduction potential

KAPP = Knik Arm Power Plant
NPL = National Priorities List
PCB = polychlorinated biphenyls
RR = railroad
TOC = total organic content

Table 6
Proposed Natural Attenuation Performance Monitoring Parameters and Analytical Methods/Protocols

Data Requirement	EPA/ASTM Method	Laboratory Reporting Limit (mg/L)	Field or Lab	Minimum Sample Size	Number of Containers Per Sample	Container Type/Size	Sample Preservation	Holding Time
Dissolved Oxygen	EPA 360.1	NA	Field	NA	NA	NA	NA	NA
Temperature	NA	NA	Field	NA	NA	NA	NA	NA
Conductivity	NA	NA	Field	NA	NA	NA	NA	NA
pH	EPA 150.1	NA	Field	NA	NA	NA	NA	NA
Oxidation/Reduction Potential	NA	NA	Field	NA	NA	NA	NA	NA
Nitrate/Nitrite	EPA 300.0	1	Lab	100 ml	1	poly/glass	H_2SO_4 to pH<2	28 days
Sulfate	EPA 300.0	0.1	Lab	100 ml	1	poly/glass	Cool, 4^{o}C	28 days
Sulfide	EPA 376.2	0.1	Lab	100 ml	1	poly/glass	Zinc Acetate & NaOH	7days
Ferrous Iron (field filtered)	SW-846 6020	1	Lab	100 ml	1	poly	HNO_3 to pH<2	6 months
Dissolved Manganese (field filtered)	SW-846 6020	0.002	Lab	100 ml	1	poly	HNO_3 to pH<2	6 months
Alkalinity	SM20 2320B	10	Lab	100 ml	1	poly/glass	Cool, 4^{o}C	14 days
Dissolved Gases (O_2,CO,CO_2,CH_4^+)	MS GC-Thermal	NA	Lab	40 ml	2	VOA vial	Cool, 4^{o}C	14 days

Notes:

NA = Not applicable
Field = Field measurement
poly = Polyethylene sample container
glass = Glass sample container

Figures

LEGEND

▬ ▬ ▬	ANCHORAGE TERMINAL RESERVE BOUNDARY
Area 4	INVESTIGATION STUDY AREA
D11 ⌖	EXISTING MONITORING WELL
D12 ⌖	PROPOSED NEW MONITORING WELL
A29 ●	PROPOSED DRIVE POINT WELL (NO SOIL SAMPLE COLLECTED)
SS-01 ▲	PROPOSED SURFACE SOIL SAMPLE LOCATION
SP35 ♀	PROPOSED GROUNDWATER SAMPLE (SPRING)
▲	EXISTING SOIL SAMPLE LOCATION
⌖	EXISTING GROUNDWATER SAMPLE LOCATION

PROPOSED SAMPLING IDENTIFICATION:

A	PROPOSED TRANSECT 1 WELL AND SOIL SAMPLE LOCATION ON NORTH SIDE OF SHIP CREEK
B	PROPOSED TRANSECT 2 WELL AND SOIL SAMPLE LOCATION ON THE SOUTH SIDE OF SHIP CREEK
C	PROPOSED TRANSECT 3 WELL AND SOIL SAMPLE LOCATION ON THE SOUTH BOUNDARY OF THE RAILYARD
D	PROPOSED TRANSECT 4 WELL AND SOIL SAMPLE LOCATION ON THE NORTH BOUNDARY OF THE RAILYARD
E	PROPOSED INFILL WELL AND SOIL SAMPLE LOCATION

NOTES:

1) SURFACE AND SUBSURFACE SOIL SAMPLING IS PROPOSED AT ALL NEW MONITORING WELL LOCATIONS.
2) GROUNDWATER SAMPLING IS PROPOSED AT ALL EXISTING WELLS, PROPOSED NEW MONITORING WELLS, AND PROPOSED DRIVE-POINT WELLS DEPICTED ON THIS FIGURE.

RETEC

Privileged and confidential attorney-client communication and attorney work product prepared in anticipation of litigation. Do not copy or distribute without prior consent of ARRC attorneys.

200 0 400
1"=400'

RI / FS Sampling and Analysis Plan

Alaska Railroad Corporation, Anchorage Terminal Reserve, Anchorage, Alaska

DATE: 08/12/05
DRWN: E.S.S./DEN

PROPOSED MONITORING WELL,
DRIVE POINT WELL,
GROUNDWATER AND SOIL SAMPLE
LOCATION MAP

FIGURE 1

File: ARRC-RI-FS-WP-SAP_1.DWG Layout: FIGURE 1 User: eschwartz Plotted: Aug 16, 2005 – 9:17am Xref's:

LEGEND

▬ ▬ ▬	ANCHORAGE TERMINAL RESERVE BOUNDARY
▨	NORTH BLUFFS ECOLOGICAL ZONE
▨	SHIP CREEK INVESTIGATION AREA
Area A	FOCUSED SEDIMENT AND SURFACE WATER INVESTIGATION AREA
S-D-1 ◆	SEDIMENT SAMPLE LOCATION
S-D-2 ◈	SEDIMENT AND SURFACE WATER SAMPLE LOCATION (IF SURFACE WATER IS PRESENT)
S-S-9 ▽	SHIP CREEK SEDIMENT SAMPLE LOCATION
S-S-10 ▽	SHIP CREEK SEDIMENT AND SURFACE WATER SAMPLE LOCATION
⇨	ARRC STORMWATER DISCHARGE
◆	EXISTING SEDIMENT SAMPLE LOCATION
▽	EXISTING SURFACE WATER SAMPLE LOCATION

NOTES:
1) SAMPLE TO BE COLLECTED FROM BOTTOM OF CHANNEL, NOT FROM CUT SIDEWALLS.
2) SAMPLE TO BE COLLECTED FROM SOUTH SIDE - NOT NEAR OUTFALL.
3) SAMPLE WILL HAVE A DEPTH COMPONENT IF SEDIMENT ACCUMULATION IS SIGNIFICANT.
4.) MAP SHOWS ONLY LOCATION OF MUNICIPAL OR ARRC MANAGED STORMWATER OUTFALLS ASSOCIATED WITH ARRC RAILYARD DRAINAGE SYSTEM. ADDITIONAL MUNICIPAL OUTFALLS EXIST (SEE RETEC (2005) PRELIMINARY SHIP CREEK HABITAT SURVEY.

File: ARRC–RI–FS–WP–SAP_2.DWG Layout: FIGURE 2 User: eschwartz Plotted: Aug 16, 2005 – 9:19am Xref's:

RETEC

Privileged and confidential attorney-client communication and attorney work product prepared in anticipation of litigation. Do not copy or distribute without prior consent of ARRC attorneys.

200 0 400
1"=400'

RI / FS Sampling and Analysis Plan

Alaska Railroad Corporation, Anchorage Terminal Reserve, Anchorage, Alaska

PROPOSED SEDIMENT AND SURFACE WATER SAMPLE LOCATIONS

DATE: 08/12/05
DRWN: E.S.S./DEN

FIGURE 2

LEGEND

— - - —	ANCHORAGE TERMINAL RESERVE BOUNDARY
Area 4	INVESTIGATION STUDY AREA
D11 ⌖	EXISTING MONITORING WELL PROPOSED FOR GAUGING
D12 ⌖	NEW MONITORING WELL PROPOSED FOR GAUGING
A29 ●	NEW DRIVE POINT WELL PROPOSED FOR GAUGING
C9 ▣	WELL PROPOSED FOR TIDAL INFLUENCE STUDY
▲	EXISTING SOIL SAMPLE LOCATION
⌖	EXISTING GROUNDWATER SAMPLE LOCATION

NOTE:

1) ADDITIONAL EXISTING MONITORING WELLS (NOT DEPICTED ON THE FIGURE) MAY BE GAUGED AS PART OF THE RI/FS.

200 0 400
1"=400'

RETEC

Privileged and confidential attorney-client communication and attorney work product prepared in anticipation of litigation. Do not copy or distribute without prior consent of ARRC attorneys.

RI / FS Sampling and Analysis Plan

Alaska Railroad Corporation, Anchorage, Alaska

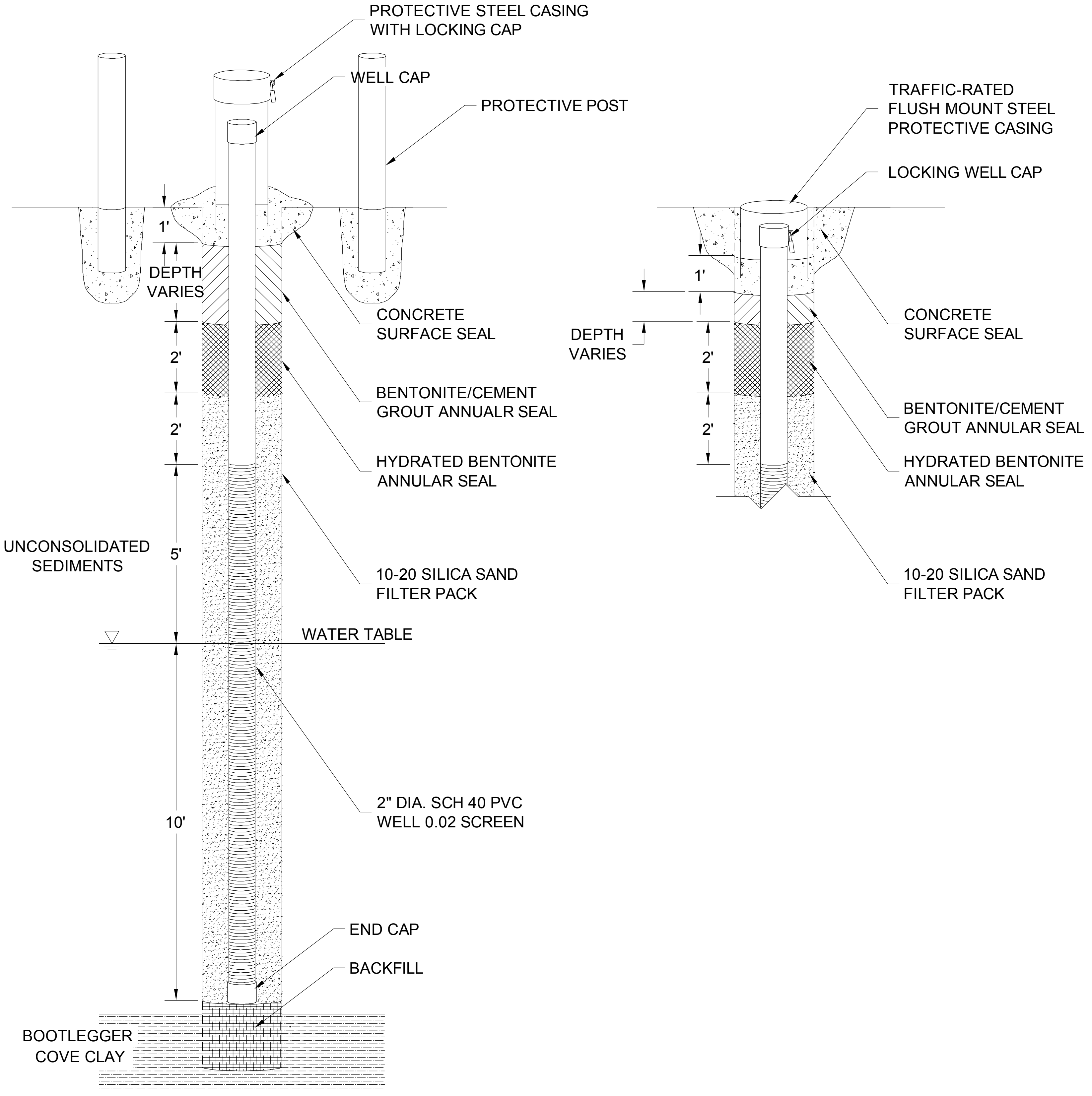
DATE: 06/17/05 DRWN: E.S.S./DEN

PROPOSED FLUID-LEVEL GAUGING AND TIDAL INFLUENCE STUDY LOCATION MAP

FIGURE 3

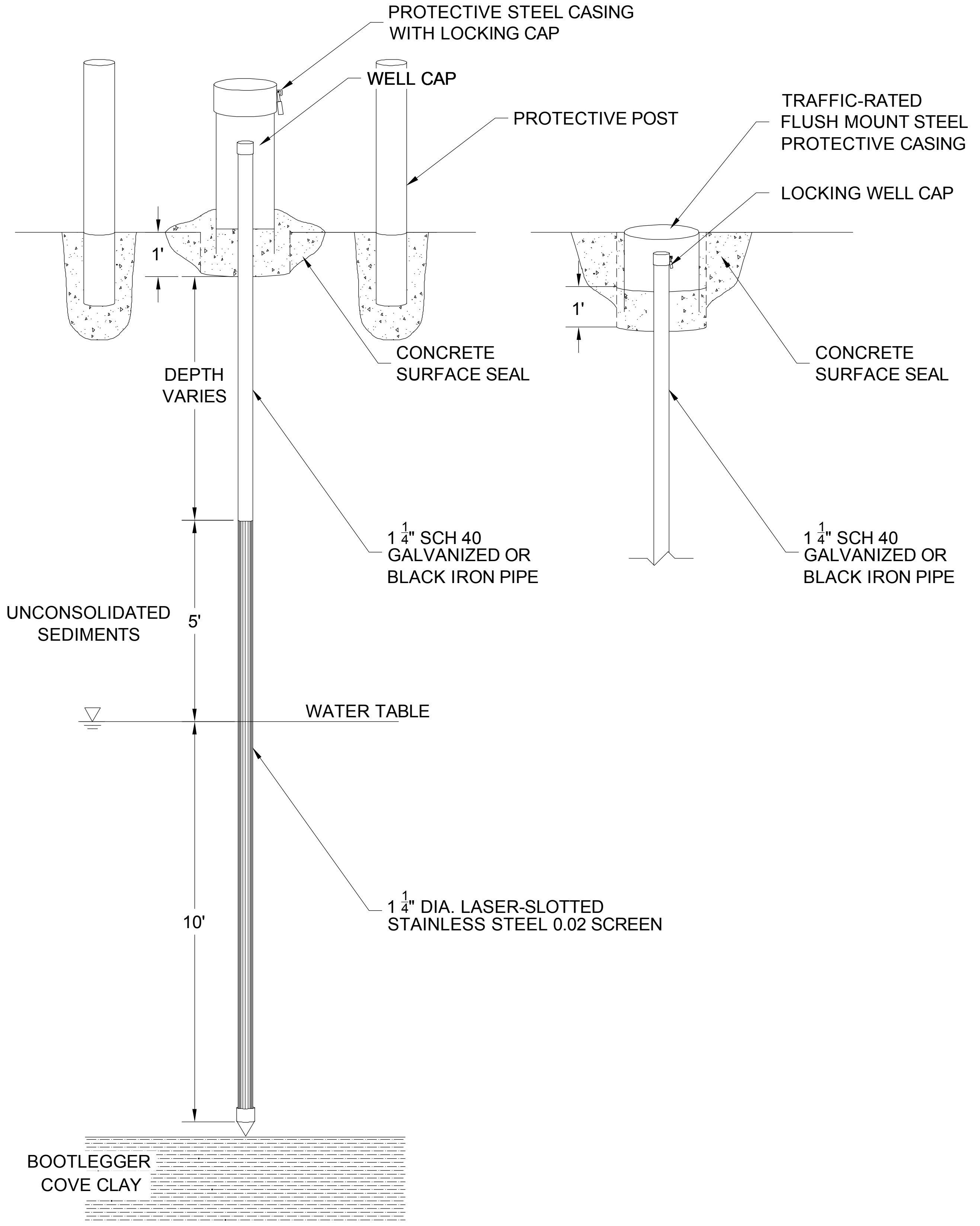
File: M:\ARRC\DWGS\DWGS\ARRC-RI-FS-WP-SAP_3.DWG Layout: FIGURE 3 User: eschwartz Plotted: Jun 17, 2005 - 2:12pm Xref's:

PROPOSED MONITORING WELL


ABOVE GRADE COMPLETION

FLUSH MOUNT COMPLETION

PROPOSED DRIVE POINT WELL


ABOVE GRADE COMPLETION

FLUSH MOUNT COMPLETION

File: M:\ARRC\DWGS\DWGS\ARRC-RI-FS-WP-SAP_4.DWG Layout: FIGURE 2 User: eschwartz Plotted: Jun 17, 2005 - 2:13pm Xref's:

RETEC

NOT TO SCALE

RI / FS Sampling and Analysis Plan Alaska Railroad Corporation, Anchorage, Alaska	**WELL COMPLETION SCHEMATICS**
DATE: 06/17/05 DRWN: E.S.S./DEN	**FIGURE 4**

Appendix A

RETEC Standard Operating Procedures (SOPs)

RETEC Standard Operating Procedure

(SOP) 210

Soil Sample Collection

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 210 describes methods used to obtain soil samples for physical testing, stratigraphic correlations, and chemical analysis. Soil samples are obtained in conjunction with surface sampling, test pit excavation, soil boring, and monitoring well installation programs. These procedures provide specific information for determining the physical makeup of the surface and subsurface environment, as well as how to estimate the extent and magnitude of soil contamination, if present. RETEC SOP 210 will discuss sampling of the surface material with hand tools and sampling of the subsurface material by augers and split spoons, and within test pits by backhoes and hand tools.

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, Job Hazard Analysis, Safety Task Analysis Review, or Site-Specific Health & Safety Plan will take precedence over the procedures described in this document.

2.0 Responsibilities

The project geologist/engineer will be responsible for the proper use and maintenance of all types of equipment used for obtaining soil samples. The geologist/engineer will determine the location, total depth, and overall size of each surface sample collection point and test pit, and the location and depth of all subsurface borings based on the project specific sampling plan. The project geologist/engineer will be responsible for locating any subsurface utilities or structures, and disseminating this information to the contractor prior to commencing the sampling program. The location of overhead utilities and obstructions relative to the sampling locations will also be noted. In addition, a Safety Task Analysis Review will be conducted to assess any other potential health and safety hazards associated with soil sample collection.

It shall be the responsibility of the project geologist/engineer to observe all activities pertaining to soil sampling and subsurface investigations to ensure that all the standard procedures are followed properly, and to record all pertinent data on a field log or field book. The collection, handling, and storage of all samples will be the responsibility of the geologist/engineer.

It is the responsibility of the contractor to provide safe and well-maintained equipment for obtaining subsurface samples in borings and for decontamination of the equipment. Test pit construction, split-spoon sampling, and subsurface augering will be conducted by the contractor. In addition, the contractor will be responsible for containment of cuttings, if required.

3.0 Health and Safety

This section presents the generic hazards associated with soil sampling techniques and is intended to provide general guidance in preparing site-specific health and safety documents. The Site-Specific Health & Safety Plan, Job Hazard Analyses, and Safety Task Analysis Reviews will address additional requirements and will take precedence over this document. Note that sample collection usually requires Level D personal protection unless there is a potential for airborne exposures to site contaminants.

Health and safety hazards include but are not limited to the following:

Test Pit Excavation

- Heavy equipment operation
- Cave-in (trench/excavation work)
- Hazardous materials (exposure and/or release)
- Utilities (underground)
- High noise levels
- Air quality (i.e., chemical, dust, explosive conditions)
- Uneven walking/working surfaces

Hollow Stem Auger Drilling

- Heavy equipment operation
- Pinch points
- Rotating parts
- Loose clothing
- Heavy lifting
- Air quality (i.e., chemical, dust, explosive conditions)
- Hazardous materials (exposure and release)
- Pressurized lines
- High noise levels
- Utilities (underground or overhead)
- Hoisting
- Overhead hazards
- Hand hazards

Rotary Drilling (Mud/Air)

- Same as above

- Increased noise hazard
- Increased dust hazard (air rotary)
- Cyclones/Diverters (pressurized lines should be anchored with whip-stops)
- Investigation derived waste containment
- Blow protect inspection/replacement
- Sample collection (i.e., there are increased hazards when taking samples from air rotary rigs resulting from overhead hazards (cyclones), pressurized lines, increased noise, and air quality at sample collection outlets. Field personnel must be aware of these hazards and initiate engineered controls to limit these hazards.)

If site/project conditions warrant the use of other drilling techniques, hazards associated with these techniques will be evaluated by amendment in the site-specific Health & Safety Plan, Job Hazard Analyses, or Safety Task Analysis Reviews. Drill rig inspections, if applicable, will be completed prior to initiating soil sampling.

4.0 Supporting Materials

In addition to materials provided by the contractor, the geologist/engineer will provide:

- Sample bottles/containers and labels
- Boring or test pit logs
- Field notebook
- Chain-of-custody forms
- Depth-measurement device
- Stakes and fluorescent flagging tape
- Decontamination solution
- Camera for photographing sections
- Sampling equipment (e.g., knives, trowels, shovels, hand augers, aluminum foil, etc.)
- Plastic garbage bags

- Material Safety Data Sheets (MSDSs) for any chemicals or site specific contaminants
- A copy of the site-specific Health and Safety Plan

5.0 Methods and Procedures

Specific sampling equipment and methodology will be dictated by characteristics of the soil to be sampled, type of soil samples required, and by the analytical procedures to be employed. Soil samples obtained at the surface may be collected using a shovel, trowel, or hand auger. A hand auger can be used to extract shallow soil samples up to 10 feet below the surface. Sampling to obtain uniform coverage within a specified area will often require the use of an area grid. These considerations will be followed based upon project specific requirements.

There are two types of samples that may be required by the project sampling plan, grab or composite. A grab sample is collected from a specific location or depth and placing it in the appropriate sample container. A composite sample consists of several discrete locations (or depths) mixed to provide a homogeneous, representative sample. To ensure that the sample is representative, the soil volume and collection method from each discrete location should be as identical as possible. It should be noted that samples analyzed for volatile organic compounds cannot be composited since it is necessary to expose the soil to the atmosphere prior to transfer into the sample container.

The sampling depth interval in borings is typically one sample for every five feet with additional samples taken at the discretion of the project geologist/engineer when significant color, textural, or odor changes are encountered. Deviations in the standard operating procedure will be covered in the project specific sampling plans.

Most subsurface explorations by RETEC will be on privately owned land, often an industrial facility. Prior to commencing subsurface exploration, RETEC will work with the facility manager to locate any subsurface utilities or structures and discuss any pertinent health and safety issues. Utility companies, (electric, gas, water, phone, sewer, etc.) who may have equipment or transmission lines buried in the vicinity, will also be notified. Many regions have organizations, which represent all utilities for these notification purposes. Allow enough time after notification (typically three working days) for the utilities to respond and provide locations of any equipment, which may be buried on site. Overhead lines must also be kept in consideration when a drilling rig is used. As a rule of thumb, the rig and derrick should be at least 25 feet away from overhead lines unless special shielding and grounding are provided. In addition, consult the site-specific health and safety documentation.

5.1 General Applications

General locations shall be mapped by the field geologist/engineer using a stationary structure as the reference point. Specific locations for test pits and sampling locations will be documented by survey or by using topographic maps and/or plans. A preliminary log of the test pit, or boring shall be prepared in the field by the field geologist/engineer. A sketch of the test pit may be necessary to depict the strata encountered. Before measuring the depth to groundwater, if encountered, the field geologist/engineer will allow sufficient time for stabilization of the water table in the excavation or boring. All information shall be recorded on the field log or the field book.

5.2 Surface Sampling

Prior to surface sampling, remove all surface materials that are not to be included in the sample such as rocks, twigs, and leaves. For sample collection taken within the upper two to three feet, use a shovel or trowel. A hand auger may be used for depths of up to 10 feet. When using the hand auger, auger the hole to the required depth, then slowly remove the auger and collect the soil sample from the auger flight or auger bucket at the point corresponding to the required depth. A tube sampler can be attached to the auger rods after augering to the desired depth, inserted into the open borehole, and then advanced into the soil at the base of the boring. If sampling is in sandy or non-cohesive soil, a shovel may be necessary to collect samples. Sample logging is described in Section 5.5.

Photographs of specific geologic features or sample location may be required for documentation purposes. A scale or item providing a size perspective should be placed in each photograph. The frame number and picture location shall also be documented in the field book. All equipment shall be decontaminated following RETEC SOP 120 between sample locations unless otherwise specified in the project specific sampling plan.

5.3 Test Pit Excavation and Sampling

Test pits shall be excavated in compliance with applicable safety regulations. Walls should be cut as near vertical as possible to facilitate stratigraphic logging. Field personnel will not enter an open test pit deeper than four feet without shoring or benching present. Samples shall be collected from the backhoe bucket with a trowel or from the side of the test pit wall (depending upon the depth of the test pit and the safety precautions in place). The size, depth, and orientation of the test pit shall be recorded on the test pit log (Figure 1). Sample logging is described in Section 5.5.

Photographs of specific geologic features or sample location may be required for documentation purposes. A scale or item providing a size perspective should be placed in each photograph. Frame numbers and picture locations shall also be documented in the field book.

The test pit shall be inspected and the test pit log reviewed to ensure that all the appropriate and/or required data and samples have been collected. All test pits will be backfilled to original grade and compacted. All equipment shall be decontaminated following RETEC SOP 120 and guidance provided in the Health and Safety Plan between sample locations unless otherwise specified in the project specific sampling plan. Avoid using flammable liquids for decontamination purposes.

5.4 Subsurface Sampling

Note: RETEC employees conducting these operations must have completed a drilling safety course.

Borings are typically advanced by two methods: rotary drilling and augering. The casing shall be of the flush-joint or flush-couple type and of sufficient size to allow for soil sampling, coring, and/or well installation. All casing sections shall be straight and free of any obstructions. Hollow-stem augers or solid-flight augers with casing may be used according to specific project requirements. Rotary drilling with water, mud, or air may be used in dense or indurated formations to advance to the required sample depth where a split spoon sampler or a coring device will be used to obtain the sample. Re-circulated water shall not be used when casing is being driven unless specified in project specific sampling plans and/or directed and properly documented by the field geologist/engineer. If re-circulated water is used, all loose material within the casing shall be removed by washing to the required sampling depth using a minimum amount of water. Care should be taken to limit re-circulation of the wash water to those times when the water supply is extremely limited or unavailable. The amount of water used should be documented in the project field book or on the field form.

Generally subsurface soil samples shall be obtained using a split-tube type sampler (split spoon), however, other devices (Shelby tubes, continuous samples, core, etc.) may be used as specified in the project specific sampling plan. Split-spoons come in a variety of sizes with the most standard having a 2-inch OD, a 1 3/8-inch ID and a 24-inch long barrel with an 18-inch sample capacity. Split spoons shall be equipped with a check valve at the top and a flap valve or basket-type retainer at the bottom. Samples shall be obtained using the standard penetration test (SPT), which allows for qualitative determination of mechanical properties and aids in identification of material type. The number of hammer blows shall be recorded on the boring log (Figure 2) for each six-inch drive distance.

The soil sampler shall be opened immediately upon removal from the casing. If the recovery is inadequate (i.e., most of the penetrated material was not retained inside the soil sampler), a note will be made on the boring log stating that "no recovery" was possible at that depth. In the event that gravels or other material prevent penetration by the split spoon, samples may be collected from the auger flights. Slowly remove the auger and collect the sample at the point corresponding to the required depth. Samples collected in this manner must be documented on the boring log. Sample logging is described in Section 5.5.

Photographs of specific geologic features or sample location may be required for documentation purposes. A scale or item providing a size perspective should be placed in each photograph. The frame number and picture location shall also be documented in the field book. All equipment will be decontaminated following RETEC SOP 120 between sample locations and sample depths unless otherwise specified in the project specific sampling plan.

Upon completion of the boring, backfill may be required. The backfill may consist of native material, hydrated bentonite chips/pellets, Portland cement/bentonite grout, or other low permeability material as specified in the project specific sampling plan. All applicable state/federal regulations concerning plugging of boreholes should be reviewed prior to the commencement of field activities.

5.5 Sample Logging

To ensure consistent descriptions of soil or rock material, the following criteria should be included on the sampling logs:

- Soil or rock type
- Depth ranges, recorded in feet
- Grain size
- Roundness
- Sorting
- Moisture
- Color
- Degree of oil contamination
- Remarks

Examples of soil types would be gravel, sand, silt, or clay. Soil types should be based on the Unified Soil Classification System (USCS). Figure 3 shows the USCS table. Examples of rock types include limestone, shale, claystone, siltstone, and sandstone. Soil/rock classifications determined in the field may be subject to change based upon laboratory tests. Factors to consider before changing a field determination include the expertise of the field geologist/engineer and laboratory personnel, representative character of the tested sampling, labeling errors, etc. Any changes made after this consideration shall be discussed and incorporated in the project report.

Grain size, roundness, and degree of sorting should also be included on the log if they are discernable. In addition to composition, blow counts and the length of the sample recovered should also be recorded on the sampling log. The degree of sample moisture should be described as dry, moist, and wet.

The color(s) or range of color(s) of the soil or rock type should be defined. If a Munsell color chart is used, the number designation of the color will also be recorded in the description. A notation of the degree of oil contamination should be included on the sample log. The contamination should be noted as high (30 %), medium (10-30 %), low (1-10 %), or none. Other classifiers may include odor (low to high) and mottling (low to high).

Remarks should include anything pertinent to the sample description or sample collection that is not described above. Other information to be placed on the logs as appropriate is:

- PID readings (with associated calibration information)
- Appearance of contamination (consistency)
- Degree of fracturing or cementation in the rock
- Drilling equipment used (rod size, bit type, pump type, rig manufacturer and model, etc.)
- Special problems and their resolution (hole caving, recurring problems at a particular depth, sudden tool drops, excessive grout takes, drilling fluid losses, lost casing, etc.)

Dates for start and completion of borings

- Depth of first encountered free water
- Definitions of special abbreviations used on log

5.6 Sample Handling

Specific procedures pertaining to the handling and shipment of samples shall be in accordance with RETEC SOP 110. A clean pair of gloves and decontaminated sampling tools will be used when handling the samples during collection to prevent cross contamination. A representative sample will be placed in the sampling container. Sample containers (jars or bags) shall be labeled with the following information:

- Client or project name, or unique identifier, if confidential
- Unique sample description (i.e., test pit, boring, or sampling point number and horizontal/vertical location)
- Sample collection date and time
- Sampler's name or initials
- Analyses to be performed

These data shall be recorded on the field logs and/or field book. Larger bulk samples shall be placed in cloth bags with plastic liners or plastic five-gallon buckets. Sample bags shall be marked with the information listed above.

6.0 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) requirements include, but are not limited to, blind field duplicates, blind rinsate blanks, and blind field blanks. These samples will be collected on a frequency of one QA/QC sample per 20 field samples or a minimum of one QA/QC sample per day unless otherwise specified in the project specific sampling plan.

7.0 Documentation

Documentation may consist of all or part of the following:

- Test pit or boring log
- Sample log sheets
- Field log book
- Chain-of-custody forms
- Shipping receipts
- Health & Safety forms (Job Hazard Analysis, Safety Task Analysis Review, and/or Site Specific Health & Safety Plan amendments)
- PID calibration records

All documentation shall be placed in the project files and retained following completion of the project.

8.0 References

Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, EPA/600/4-89/034, published by National Water Well Association, 1991.

RCRA Ground Water Monitoring Technical Enforcement Guidance Document, published by National Water Well Association, 1986.

A Compendium of Superfund Field Operations, EPA 540/P-87/001, published by the Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, US EPA, 1987.

Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies, EPA/600/R-92/128, published by the Environmental Research Center, 1992.

Figure 1 Test Pit Log

The RETEC Group
Test Pit Log

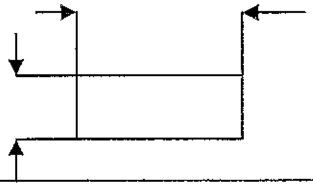
TEST PIT: TP-
SHEET:

PROJECT:	**LOCATION:**	**CONTRACTOR:**
PROJECT NO.:	**EQUIPMENT USED:**	
DATE:	**TOTAL DEPTH (ft.):**	

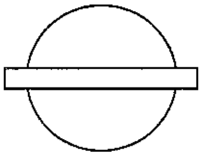
START TIME:	**FINISH TIME:**	**LOGGED BY:**

Depth Range	**Sample Type and Number**	**USCS**	**Depth (ft.)**	**Soil and Rock Description and Comments**
			1	
			2	
			3	
			4	
			5	
			6	
			7	
			8	
			9	

TEST PIT PLAN



NORTH



Groundwater		
Date	Time (hours after completion)	Depth (ft.)

Comments:

Figure 2 Boring Log

The RETEC Group	**BORING LOG**	BORING SHEET OF

PROJECT		CONTRACTOR	MONUMENT
PROJECT #		DRILLER	RISER
LOCATION		RIG TYPE	SCREEN
TOTAL DEPTH		METHOD	FILTER PACK
DATE		CASING ID	SEAL
START	FINISH	BORING ID	GROUT
LOGGED BY DMS		BIT TYPE	GROUND ELEV.

SAMPLE TYPE AND NUMBER	BLOWS PER 6 INCH	DEPTH RANGE	% REC	DEPTH FEET	SAMPLE DESCRIPTION CLASSIFICATION SCHEME________________

GROUNDWATER DEPTH (FT)	DATE/TIME
REMARKS	

Figure 3 Field Guide and USCS Classification Table

FIELD GUIDE AND USCS CLASSIFICATION TABLE

SAND

SOIL TYPE	SPT, N Blows/ft.	Relative Density, %	FIELD TEST
VERY LOOSE SAND	4	0 – 15	Easily penetrated with ½ " reinforcing rod pushed by hand.
LOOSE SAND	4 – 10	15 – 35	Easily penetrated with ½ " reinforcing rod pushed by hand.
MEDIUM DENSE SAND	10 – 30	35 – 65	Penetrated a foot with ½ " reinforcing rod driven with 5-lb hammer.
DENSE SAND	30 – 50	65 – 85	Penetrated a foot with ½ " reinforcing rod driven with 5-lb hammer.
VERY DENSE SAND	50	85 – 100	Penetrated only a few inches with ½ " reinforcing rod driven with 5-lb hammer.

CLAY

CLAY CONSISTENCY	THUMB PENETRATION	SPT, N BLOWS/ FT.	Undrained Shear Strength c (PSF)	Unconfined Compressive Strength (PSF)
			TORVANE	Pocket Penetrometer
VERY SOFT	Easily penetrated several inches by thumb. Exudes between thumb and fingers when squeezed in hand.	<2	250	500
SOFT	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 – 4	250 – 500	500 – 1000
MEDIUM STIFF	Can be penetrated over ¼ " by thumb with moderate effort. Molded by strong finger pressure.	4 – 8	500 – 1000	1000 – 2000
STIFF	Indented about ¼ " by thumb but penetrated only with great effort.	8 – 15	1000 – 2000	2000 – 4000
VERY STIFF	Readily indented by thumbnail.	15 – 30	2000 – 4000	4000 – 8000
HARD	Indented with difficulty by thumbnail.	>30	>4000	>8000

Unified Soil Classification System (USCS)

		MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS		> 300	> 11.8	-
COBBLES		75 – 300	2.9 – 11.8	-
GRAVEL	COARSE	75 – 19	2.9 - .75	-
	FINE	19 – 4.8	.75 - .19	¾ " – No. 4
SAND	COARSE	4.8 – 2.0	.19 - .08	No. 4 – No. 10
	MEDIUM	2.0 - .43	.08 - .02	No. 10 – No. 40
	FINE	.43 - .08	.08 - .003	No. 40 – No. 200
FINES	SILTS	< .08	< .003	< No. 200
	CLAYS	< .08	< .003	< No. 200

Table Title

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL – GRADED GRAVELS, GRAVEL – SAND MIXTURES, LITTLE OR NO FINES.
			GP	POORLY – GRADED GRAVELS, GRAVEL – SAND MIXTURES, LITTLE OR NOT FINES.
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND – SILT MIXTURES.
			GC	CLAYEY GRAVELS, GRAVEL – SAND – CLAY MIXTURES.
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SAND (LITTLE OR NO FINES)	SW	WELL – GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES.
			SP	POORLY – GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES.
		SANDS WITH FINES APPRECIABLE AMOUNT OF FINES)	SM	SILTY – SANDS, SAND – SILT MIXTURES
			SC	CLAYEY SANDS, SAND – CLAY MIXTURES.
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY.
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY, CLAYS, LEAN CLAYS.
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY.
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	MH	INORGANIC SITLS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS.
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS.
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS.

RETEC Standard Operating Procedure (SOP) 310
Headspace Screening

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 310 describes the basic techniques for using headspace analysis to screen for volatile organics in contaminated soils using a portable Photo Ionization Detector (PID) or Flame Ionization Detector (FID).

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, Job Hazard Analysis (JHA), Safety Task Analysis Review (STAR), or Site-Specific Health and Safety Plan (HASP) will take precedence over the procedures described in this document.

2.0 Responsibilities

The project manager/task manager is responsible for overseeing work activities to ensure that field screening is performed and documented in accordance with the methods described here and in the project-specific sampling plan. In addition, a STAR will be conducted to assess any potential hazards associated with headspace screening. Copies of STAR forms are available in the Site-Specific HASP.

3.0 Health and Safety

This section presents the generic hazards associated with headspace screening and is intended to provide general guidance in preparing site-specific health and safety documents. The Site-Specific HASP, JHAs, and STARs will address additional requirements and will take precedence over this document. Note that headspace screening usually requires Level D personal protection unless there is a potential for airborne exposure to site contaminants. Under circumstances where potential airborne exposure is possible respiratory protective equipment may be required based on personal air monitoring results. Upgrades to Level C will be coordinated with your Site Safety and Health Officer (SSHO) or Environment, Health, and Safety (EHS) Coordinator.

Health and safety hazards and corresponding precautions include, but are not limited to, the following:

- Dermal contact with contaminated soil. Personnel should treat all soil as potentially contaminated and wear chemically impervious gloves. Minimize skin contact with soil by using sampling instruments such as stainless steel spades or spoons. Do not touch any exposed skin with contaminated gloves.

- Inhalation hazards. Appropriate air monitoring should be conducted to ensure that organic vapor concentrations in the breathing zone do not exceed action levels as specified in the Site-Specific HASP. When ambient temperatures are low enough to require warming samples using the vehicle heater, the vehicle's windows should be opened enough to prevent the build-up of any organic vapors. Use the PID or FID to verify the airborne concentrations in the vehicle remain below applicable action levels. Note that many volatile organic compounds (VOCs) are flammable and all precautions must be observed to eliminate any potential ignition sources.

- Shipping limitations. Follow applicable regulations when shipping FID/PID equipment. When shipping an FID by air, the hydrogen tank must be bled dry. Calibration gas canisters are considered dangerous goods and must be shipped according to IATA and DOT regulations. Consult your EHS Coordinator and check with your shipping company to determine the correct shipping procedures.

4.0 Supporting Materials

The following materials must be on hand in good operating condition and/or in sufficient quantity to ensure that proper field analysis procedures may be followed.

- Calibrated PID/FID instrument
- Top-sealing "Zip-Loc" type plastic bags – *or* – 16 ounces of soil or "mason-" type glass jars and aluminum foil
- Project field book and/or boring logs
- PPE as specified in the Site-Specific HASP
- Material Safety Data Sheets (MSDSs) for any chemicals or site-specific contaminants
- A copy of the Site-Specific HASP

5.0 Methods and Procedures

5.1 Preparation

Review available project information to determine the types of organic vapors that will likely be encountered to select the right instrument. The two basic types of instruments are FIDs and PIDs.

FIDs work well with organic compounds that have relatively lightweight molecules, but may have problems detecting halogenated compounds or heavier organic compounds; FIDs can detect methane for example. Since the FID uses a flame to measure organic compounds, ensure that work is conducted in an atmosphere, which is free of combustible vapors. If ambient temperatures are below 40°F, the flame of the FID may be difficult to light.

When using a PID, select an instrument that can measure the ionization potential of the anticipated contaminants of concern. PIDs work well with a range of organic compounds and can detect some halogenated hydrocarbons; PIDs cannot detect methane. The correct ultraviolet (UV) light bulb must be selected according to the types of organic vapors that will likely be encountered. The energy of the UV light must equal or exceed the ionization potential of the organic molecules that the PID will measure. The NIOSH *Pocket Guide to Chemical Hazards* is one source for determining ionization potentials for different chemicals. Bulbs available for PIDs include 9.4 eV, 10.6 (or 10.2) eV, and 11.7 eV bulbs. The 10.6 eV bulb is most commonly used as it detects a fairly large range of organic molecules and does not burn out as easily as the 11.7 eV bulb. The 9.4 eV bulb is the most rugged, but detects only a limited range of compounds. Under very humid or very cold ambient conditions, the window covering the UV light may fog up, causing inaccurate readings. Ask your EHS coordinator about correction factors when high humidity conditions exist.

After selecting the correct instrument, calibrate the PID/FID according to the manufacturer's instructions. Record background/ambient levels of organic vapors measured on the PID/FID after calibration and make sure to subtract the background concentration (if any) from your readings. Check the PID/FID readings against the calibration standard every 20 readings or at any time when readings are suspected to be inaccurate, and recalibrate, if necessary. Be aware that, after measuring highly contaminated soil samples, the PID/FID may give artificially high readings for a time.

5.2 Top-Sealing Plastic Bag

Place a quantity of soil in a top-sealing plastic bag and seal the bag immediately. The volume of soil to be used should be determined by the project manager or field task manager. The volume of soil may vary between projects but should be consistent for all samples collected for one project. Ideally, the bag should be at least 1/10th-filled with soil and no more than half-filled with soil. Once the bag is sealed, shake the bag to distribute the soil evenly. If the soil is hard or clumpy, use your fingers to gently work the soil (through the bag) to break up the clumps. Do not use a sampling instrument or a rock hammer since this may create small holes in the plastic bag and allow organic vapors to escape. Alternatively, the sample may be broken up before it is placed in the bag. Use a permanent marker to record the following information on the outside of the bag:

- Site identification information (i.e., borehole number)
- Depth interval
- Time the sample was collected
- For example: "SS-12, 2-4 ft, @1425"

Headspace should be allowed to develop before organic vapors are measured with a PID/FID. The amount of time required for sufficient headspace development will be determined by the project-specific sampling plan and the ambient temperature. Equilibration time should be the same for all samples to allow an accurate comparison of organic vapor levels between samples. However, adjustments to equilibration times may be necessary when there are large variations in ambient temperature from day to day. When ambient temperatures are below 32°F, headspace development should be within a heated building or vehicle. When heating samples, be sure there is adequate ventilation to prevent the build-up or organic vapors above action levels.

Following headspace development, open a small opening in the seal of the plastic bag. Insert the probe of a PID/FID and seal the bag back up around the probe as tightly as possible. Alternatively, the probe can be inserted through the bag to avoid loss of volatiles. Since PIDs and FIDs are sensitive to moisture, avoid touching the probe to the soil or any condensation that has accumulated inside of the bag. Since the PID/FID consumes organic vapors, gently agitate the soil sample during the reading to release fresh organic vapors from the sample. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case, headspace data should be discounted. Record the highest reading on the field form or in the field notebook as described in Section 7.

5.3 Jar and Aluminum Foil (Alternate Method)

Half-fill a clean glass jar with the soil sample to be screened. Quickly cover the jar's opening with one to two sheets of clean aluminum foil and apply the screw cap to tightly seal the jar. Allow headspace development for at least ten minutes. Vigorously shake the jar for 15 seconds, both at the beginning and at the end of the headspace development period. Where ambient temperatures are below 32°F (0°C), headspace development should be within a heated area. When heating samples be sure there is adequate ventilation to prevent the build-up of organic vapors above action levels.

Subsequent to headspace development, remove the jar lid and expose the foil seal. Quickly puncture the foil seal with the instrument sampling probe, to a point about one-half of the headspace depth. Exercise care to avoid uptake of water droplets or soil particulates. As an alternative, use a syringe to withdraw a headspace sample, and then inject the sample into the instrument probe or septum-fitted inlet. This method is acceptable contingent upon verification of methodology accuracy using a test gas standard. Following probe insertion through the foil seal or sample injection to probe, record the highest meter response on the field form or in the field notebook. Using foil seal/probe insertion method, maximum response should occur between two and five seconds. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case, headspace data should be discounted.

6.0 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) will include the collection of duplicate samples. In general, one duplicate will be collected per 20 samples. Organic vapor concentrations measured in the primary and duplicate samples should be similar within plus or minus 20 percent. The frequency of headspace duplicate collection will be determined by the project manager/task manager. The PID/FID instrument must be calibrated according to the manufacturer's instructions before beginning screening, and checked or recalibrated every 20 analyses or when readings are suspected to be inaccurate. Record ambient organic vapor levels in the field notebook and on the field form. Periodically check ambient organic vapor levels. If ambient levels have changed more than 20 percent, recalibrate the PID/FID. Make sure readings are not collected near a vehicle exhaust or downwind of the drill rig exhaust. If grossly contaminated soil is encountered, decontaminate sampling instruments between samples and/or change contaminated gloves to avoid cross contaminating less contaminated samples.

7.0 Documentation

All data generated (results and duplicate comparisons) will be recorded in the field notebook and/or on the field form. Any deviation from the outlined procedure will also be noted. Field conditions (ambient temperature, wind, etc.) should also be recorded in the field notebook.

Readings may be recorded in a field notebook, on a boring log, or on an appropriate form specific to the project. The form should include the following information:

- When the PID/FID was calibrated (date/time) and calibration standard used
- Background/ambient concentrations measured after PID/FID calibration
- Location of sample (i.e., bore-hole number)
- Depth interval of sample measured
- Lithology of material measured
- PID/FID reading and units of measure

Note that if PID/FID measurements are recorded on a boring log, it is not necessary to duplicate information in the column where the PID/FID readings are recorded (e.g., borehole number, depth interval, lithology type).

All documentation will be stored in the project files and retained following completion of the project.

RETEC Standard Operating Procedure (SOP) 220
Monitoring Well Construction and Installation

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 220 establishes the method for installing observation standpipes or monitoring wells. These wells are installed to determine the depth to groundwater, monitor groundwater fluctuations, and/or obtain samples of groundwater for laboratory testing. Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, Job Hazard Analysis (JHA), Safety Task Analysis Review (STAR), or Site-Specific Health & Safety Plan (HASP) will take precedence over the procedures described in this document.

2.0 Responsibilities

It is the responsibility of the project geologist/engineer to directly supervise the construction and installation of each monitoring well by the contract driller to ensure that the well installation specifications outlined in the project plan are adhered to and to record all pertinent data on the approved forms. The project geologist/engineer will also be responsible for ensuring that all applicable permits and registrations are obtained prior to and after construction by RETEC, the contract driller, or other responsible party.

3.0 Health and Safety

This section presents the generic hazards associated with well construction and installation and is intended to provide general guidance in preparing site-specific health and safety documents. The Site-Specific HASP, JHAs, and STARs will address additional requirements and will take precedence over this document. Note that well construction and installation usually requires Level D personal protection unless there is a potential for airborne exposures to site contaminants.

Health and safety hazards include, but are not limited to, the following:

- Heavy equipment operation
- Pinch points
- Rotating parts
- Loose clothing
- Heavy lifting
- Air quality (i.e., chemical, dust, silica, explosive conditions)
- Hazardous materials (exposure and release)
- Pressurized lines

- High noise levels
- Utilities (underground or overhead)
- Hoisting
- Overhead hazards
- Hand hazards
- Investigation – derived waste containment

If site/project conditions change, hazards associated with the changes will be evaluated by amendment in the Site-Specific HASP, JHAs, or STARs. Drill rig inspections, if applicable, will be completed prior to initiating drilling activities.

4.0 Supporting Materials

The list below identifies types of equipment which may be used for the construction and installation of the monitoring wells. The requirements for screen/riser pipe (length, gauge, and type), sand, bentonite/grout, and material manufacturers shall be addressed in the project specific sampling plan.

Materials to be provided by the contract driller include:

- Drill rig
- Decontamination equipment (e.g., steam cleaner, high-pressure cleaner, buckets, brushes, etc.)
- Weighted calibrated tape
- Screen/riser pipe with flush-threaded couplings including riser and bottom caps (e.g., PVC, fiberglass, galvanized, or stainless steel)
- Clean, silica sand
- Bentonite chips, pellets, or powder
- Cement grout, grout tub, grout pump, and tremie pipe
- Cement for protective pad
- Locking steel protective casing
- Miscellaneous items specified in the project plan (e.g., centralizers, sediment traps, bumper posts, containers for cuttings and fluids, etc.)

Materials provided by the geologist/engineer may include:

- Weighted calibrated tape
- Personal protective equipment
- Field book and field forms
- Camera

5.0 Methods And Procedures

Specific drilling, sampling, and installation equipment and methodology will be dictated by the geologic characteristics of the site, the types of contaminants being monitored, and local and state regulations.

5.1 Drilling

Drilling of the monitoring well borehole may be accomplished by a variety of methods. The hollow-stem, continuous flight auger is one of the most widely used methods for installing monitoring wells in unconsolidated soils. No drilling fluids are used and the disturbance to geologic materials penetrated is minimal. Solid-stem, continuous flight auger use is limited to consolidated sediments or to fine grained unconsolidated sediments. Augering methods are limited to boreholes less than 150 feet deep. The cable tool method is useful in relatively shallow unconsolidated and consolidated formations. Disadvantages to this method are that water must be used until the water table is reached, soil samples at depth are not easily obtainable, and it is very slow. Rotary methods use air or fluids during the drilling process to maintain an open hole and to remove cuttings. Clean water must be used for water-rotary drilling and care must be taken with mud-rotary techniques so that the drilling muds do not affect collection of representative groundwater samples.

In most projects, air rotary methods will be used in dense formations and augering will be used in loose formations. Soil sampling will be performed at the appropriate depth by removing the solid-stem auger or rotary-drill stem, or by sampling within the hollow-stem auger. All drilling and soil sampling procedures will be done in accordance with SOP 210. Prior to initiating drilling activities and between drilling locations and sampling depths, the drilling equipment will be cleaned and decontaminated in accordance with SOP 120.

5.2 Well Construction and Installation

In the case of rotary drilling, the borehole will be blown free of material prior to well installation. With hollow-stem augers, after the removal of the plug, the augers shall be raised approximately six inches above the bottom of the borehole, rotated slowly and returned to the bottom of the hole to facilitate removal of all material within the auger.

Backfilling of the borehole with native cuttings or clean sand to the well screen tip elevation shall be required if the tip is to be above the bottom of the borehole. A heavy plumb bob or a calibrated tape shall be used to determine the depth of the boring and the depth to the top of the backfill.

The well screen and riser pipe shall then be assembled. The riser pipe/screen shall be connected by flush-threaded joints. No solvent or anti-seize compound shall be used on the joints. The length of the screened area and the gauge of the screen or slots shall be determined by the inspecting geologist depending upon the grain-size distribution of the sediments. The assembled screen and riser, or its constituent parts, shall be steam cleaned prior to installation. The riser and screen shall be carefully placed in the borehole to ensure that it is centered in the hole and is true, straight, and vertical throughout. Centering can be accomplished with well centralizers.

The annular space surrounding the screened section of the monitoring well and two feet above the top of the screen shall be filled with clean silica sand. The well screen shall have a bentonite seal placed on top of the sand. The bentonite seal shall be approximately two feet thick to prevent vertical flow within the boring from affecting the screened area.

The remaining length of the borehole shall be backfilled or tremmied with grout to within two feet of the ground surface. This grouting may consist of a bentonite/cement mixture made to required specification. The steel guard-pipe shall be placed around the riser. "Weep" holes will be drilled in the riser and the guard-pipe at separate locations. The borehole around the guard-pipe shall be dug out to a depth of two feet and a one foot radius which will be filled with concrete. Bumper posts may be necessary depending upon the location of the well. All completed wells will have identification numbers clearly painted on the cap and guard pipe with bright colored paint.

5.3 Telescoping Well Construction

On sites where the presence of Non-Aqueous Phase Liquids (NAPLs) is of concern or the groundwater between different aquifers is to be isolated, the construction of telescoped wells may be necessary. This method allows the construction of monitoring wells which prevent inter- aquifer fluid mixing or the vertical displacement of NAPL. Situations which may require telescoped wells include the construction of wells into aquifers hydro-stratigraphically below impacted aquifers or simply the construction of wells through a perched aquifer without creating a vertical hydraulic conduit.

Similar to conventional wells, construction of telescoped wells can be accomplished using a variety of drill rig types including hollow-stem auger, air-rotary, and mud-rotary rigs. Telescoping well construction is initiated by "keying" a large diameter, outer steel casing into a stratigraphic horizon of low-permeability at the base of the upper impacted aquifer. Typically, the boring for the outer casing should be two-inches greater than the outside diameter of the inner casing to allow sufficient annular space for tremmie or pressure grouting (discussed below). The boring should extend a minimum of 18 inches, if possible, into the keying horizon to ensure an adequate seal. The boring should never breach the keying horizon under any circumstances. Once the boring is completed the casing can be set in one of two ways. The casing may be placed to the bottom of the boring, or the casing can be depressed with the drill rig about six-inches beyond the total depth of the boring. The latter should only be done if it is known that depressing the casing will not breach the keying horizon.

The drill rig must be capable of hoisting sections of large-diameter steel casings (standard casing length is 21 feet). If more than one section of casing is required, the driller must also have welding capabilities for connecting casing sections. Multiple section casings must be welded straight, otherwise the casing string will not reach to the bottom of the boring. Also, borings which are drilled too fast, can "corkscrew." Such borings will not accept long casing strings.

Grouting of the casing should be done by either tremmie-grouting or pressure-grouting the annular space inside of the casing to expel any fluids which could be vertically displaced into the lower aquifer(s). The grout should then be allowed a minimum of 24-hours to cure. Once the grout is cured, a smaller diameter drill pipe is used to bore through the grout to facilitate placement of a monitor well at the desired depth. The well is then constructed as described in Section 4.2. If another casing is necessary to seal an additional aquifer (triple-cased well), the outer casing is drilled out to the next keying horizon and process is repeated.

5.4 Drilling Fluids and Cuttings

If drilling fluids are used, no chemical additives will be mixed into the fluid to alter viscosity or lubricating properties. Fresh water for drilling will be obtained from a source not impacted by site contaminants (e.g., municipal water supply). A sample of the fresh water will be collected during the course of well installation and analyzed for parameters defined for the groundwater samples.

Spent fluids, if used, and cuttings will be contained and disposed of in a manner consistent with the project specific sampling plan.

5.5 Decontamination

Equipment and tools used during drilling activities will be cleaned prior to work startup. If the pre-drilling inspection reveals the presence of contamination such as visible chemical residue, an additional decontamination will be conducted to remove the residue. All equipment and tools used during drilling will be cleaned prior to leaving the site. Cleaning of drilling equipment and tools will comply with the procedures detailed in SOP 120.

6.0 Quality Assurance/Quality Control

A series of measurements shall be taken during the installation of each monitoring well. These measurements shall include:

- Screen length
- Riser pipe length
- Total well depth
- Depth to stabilized water level.

Other data include type and length of casing, diameter of the respective components, thickness and different types of filter pack and grouting materials, and elevation of the top of the guard pipe and ground surface after surveying is complete. All data shall be recorded on site onto the groundwater monitoring well completion form (Figure 1). All wells shall be surveyed and referenced onto the appropriate site map.

7.0 Documentation

Documentation may consist of all or part of the following:

- Boring log
- Sample log sheets
- Well completion log
- Field log book
- Chain-of-custody forms
- Shipping receipts
- Health and Safety forms (JHAs, STAR, and/or Site Specific HASP amendments)
- PID calibration records

All documentation shall be placed in the project files and retained following completion of the project.

8.0 References

Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, EPA 600/4-89/034, published by National Water Well Association, 1989.

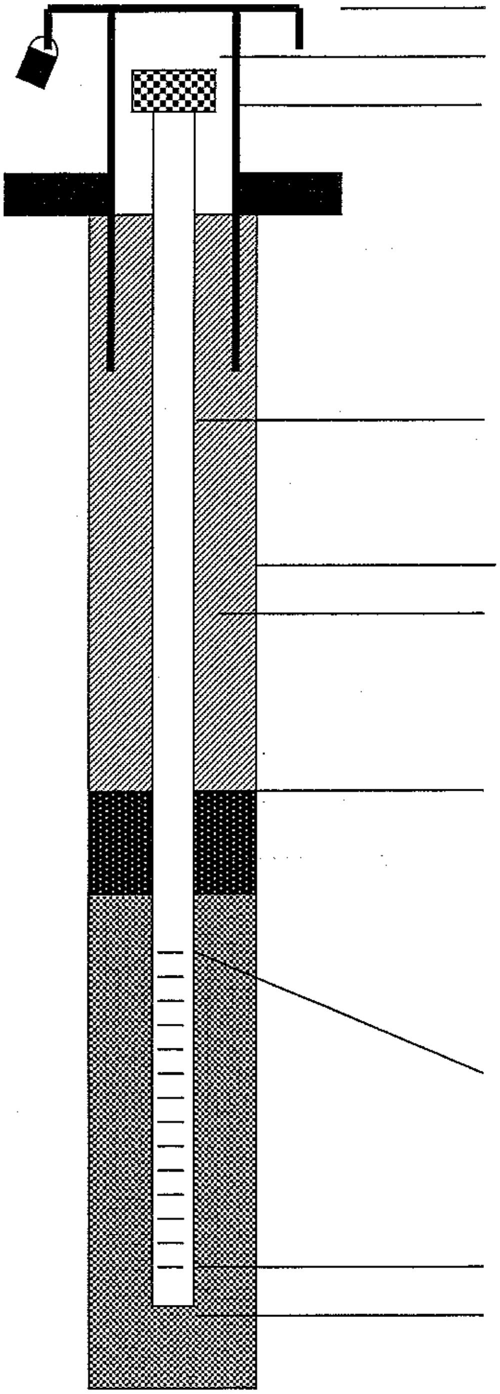
RCRA Ground Water Monitoring Technical Enforcement Guidance Document, published by National Water Well Association, 1986.

A Compendium of Superfund Field Operations, EPA 540/P-87/001, published by the Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, US EPA, 1987.

Figure 1 Well Completion Form

The RETEC Group
Well Completion Log

Date of Installation__________________ Monitoring Well No.__________________
Drilling Company__________________
Field Engineer__________________



Elevation of Top of Protective Casing__________
Elevation of Top of Riser Pipe__________
I.D. of Protective Casing__________
Type of Protective Casing__________
Ground Surface Elevation__________

I.D. of Riser Pipe__________
Type of Riser Pipe__________
____

Diameter of Borehole__________
Type of Backfill__________
____

Grout Ratio__________

Depth to Top of Seal__________
Type of Seal__________
____

Depth to Top of Sandpack__________
Type of Sandpack__________
____

Depth to Top of Screen__________
I.D. of Well Screen__________
Type of Well Screen__________
____

Depth to Bottom of Screen__________
Depth to Bottom of Sediment Trap__________
Depth to Bottom of Borehole__________

<u>Groundwater Levels</u>
Initial During Drilling__________
Upon Completion of Well__________

Figure 1

RETEC Standard Operating Procedure (SOP) 231
Water-Level Measurements

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 231 describes the measurement of water levels in groundwater monitoring wells or piezometers. Water-level measurements are fundamental to groundwater and solute transport studies. Water-level data are used to indicate the directions of groundwater flow and areas of recharge and discharge, to evaluate the effects of manmade and natural stresses on the groundwater system, to define the hydraulic characteristics of aquifers, and to evaluate stream-aquifer relations. Measurements of the static-water level are also needed to estimate the amount of water to be purged from a well prior to sample collection.

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, Job Hazard Analysis (JHA), Safety Task Analysis Review (STAR), or Site-Specific Health and Safety Plan (HASP) will take precedence over the procedures described in this document.

2.0 Responsibilities

The field sampling coordinator will have the responsibility to oversee and ensure that all procedures are performed in accordance with the project-specific sampling program and this SOP.

3.0 Health and Safety

This section presents the generic hazards associated with the collection of water-level measurements. The site-specific HASP, JHAs, and STARs will address additional requirements and will take precedence over this document. Appropriate personal protective equipment (PPE) must be worn as determined in the Site-Specific HASP, which typically consists of Level D protection. Under circumstances where potential airborne exposure is possible respiratory protective equipment may be required based on personal air monitoring results. Upgrades to Level C will be coordinated with your Site Safety and Health Officer (SSHO) or Environment, Health, and Safety (EHS) Coordinator.

Health and safety hazards during groundwater level measurements may involve:

- Slip, trips, and falls in tall grasses over obstacles and berms near well locations. Review terrain hazards prior to conducting these operations. Ensure that you have safe means of access/egress to the wellhead.

- Exposure to site contaminants. If there is product in the well (especially gasoline) take all precautions necessary to prevent fire/explosion and/or exposure to airborne vapors.

- Ergonomics. Use appropriate ergonomic techniques when inserting or retrieving equipment for the wells to preclude injury to the arms, shoulders or back.

If the well is suspected of being contaminated, or has a history of contamination, the static water-level measurements should be made while wearing appropriate personal protective equipment (PPE). The air in the wellhead should be sampled for organic vapors using a Photo Ionization Detector (PID). The results shall be recorded in the Fluid-Level Monitoring Log (Figure 1) or the project field book. This is the first indication of the presence of a non-aqueous phase liquid (NAPL). If the potential for fire or explosion exists, use of the probe ground wire is required.

4.0 Supporting Materials

This section identifies the types of equipment that may be used for measurement of groundwater levels. Based on project objectives, observed or probable well contamination, and well construction, a project-specific equipment list will be determined from the following equipment:

- Water-level and/or product-level measuring device
- Distilled water dispenser bottle
- Methanol or isopropyl in properly labeled dispenser bottles
- Plastic sheeting
- PPE as specified in the Site-Specific HASP
- Fluid-level monitoring logs and field book
- Paper towels or chemical-free cloths
- Material Safety Data Sheets (MSDSs) for any chemicals or site-specific contaminants
- A copy of the Site-Specific HASP

5.0 Methods And Procedures

When taking a series of fluid-level measurements at a number of monitoring wells, it is generally good practice to go in order from the least- to the most contaminated well. Additionally, the measurement of all site wells should be done consecutively and before any sampling activities begin. This will ensure the data are representative of aquifer conditions. All pertinent data should be entered in the Fluid-Level Monitoring Log (Figure 1) or the project field book.

5.1 Well Evaluation

Upon arrival at a monitoring well, the surface seal and well protective casing should be examined for any evidence of frost heaving, cracking, or vandalism. All observations should be recorded in the fluid-level monitoring log or the project field book.

The area around the well should be cleared of weeds and other materials prior to measuring the static-water level (avoid contact with poison ivy or other allergenic plants). A drop cloth or other material (e.g., plastic garbage bag) should be placed on the ground around the well, especially if the ground is disturbed or potentially contaminated. This will save time and work for cleaning equipment or tubing if it falls on the ground during preparation or operation. The well protective casing should then be unlocked and the cap removed.

5.2 Measuring Point Location

The measuring point location for the well should be clearly marked on the outermost casing or identified in previous sample collection records. This point is usually established on the well casing itself, but may be marked on the protective steel casing in some cases. In either case, it is important that the marked point coincide with the same point of measurement used by the surveyor. If not marked from previous investigations, the water-level measuring point should be marked on the north side of the well casing and noted in the Fluid-Level Monitoring Log (Figure 1) or the project field book. Monitoring well measurements for total depth and water level should be consistently measured from one reference point so that these data can be used for assessing trends in the groundwater.

5.3 Water-Level Measurement

Water-level measurements shall be made using an electronic or mechanical device. Several methods for water-level measurement are described below. The specific method to be used will be defined in the project-specific sampling plan.

5.3.1 Graduated Steel Tape

The graduated steel-tape method is considered an accurate method for measuring the water level in nonflowing wells. Steel surveying tapes in lengths of 100, 200, 300, 500, and 1,000 feet are commonly used; a black tape is better than a chromium-plated tape. The tapes are mounted on hand-cranked reels up to 500-foot lengths; for greater depth, a motor-driven tape drive is usually required. A slender weight is attached to the ring at the end of the tape to ensure plumbness and to permit some feel for obstructions.

The lower few feet of tape is chalked by pulling the tape across a piece of blue carpenter's chalk. The wet chalk mark identifies the portion of the tape that was submerged. Lower the graduated steel-tape from the measuring point at the top of the well until a short length of the tape is submerged. The weight and tape should be lowered into the water slowly to prevent splashing. Submergence of the weight and tape may temporarily cause the water level to rise in wells or piezometers having very small diameters. This effect can be significant if the well is in materials of very low hydraulic conductivity.

Under dry surface conditions, it may be desirable to pull the tape from the well by hand, being careful not to allow it to become kinked, and reading the water mark before rewinding the tape onto the reel. In this way, the watermark on the chalked part of the tape is rapidly brought to the surface before the wetted part of the tape dries. In cold regions, rapid withdrawal of the tape from the well is necessary before the wet part freezes and becomes difficult to read. Read the tape at the measuring point, and then read the watermark on the tape. The difference between these two readings is the depth to water below the measuring point. Errors resulting from the effects of thermal expansion of tapes and of stretch due to the suspended weight of the tape and plumb weight can become significant at high temperatures and for measured depths in excess of 1,000 feet.

The observer should make two measurements. If two measurements of static-water level made within a few minutes do not agree within 0.01 or 0.02 foot in observation wells having a depth to water of less than a couple hundred feet, continue to measure until the reason for the lack of agreement is determined or until the results are shown to be reliable. Where water is dripping into the well or covering the well casing wall, it may be impossible to get a good watermark on the chalked tape.

Water-level measurement should be entered in the fluid-level monitoring log or the project field book. The water-level measurement device shall be decontaminated immediately after use.

5.3.2 Electrical Methods

Many types of electrical instruments are available for water-level measurement; most operate on the principle that a circuit is completed when two electrodes are immersed in water. Electrodes are generally contained in a weighted probe that keeps the tape taut while providing some shielding of the electrodes against false indications as the probe is being lowered into the well. Before lowering the probe into the well, the circuitry can be checked by dipping the probe in water and observing the indicator (a light, sound, and/or meter).

To obtain a water-level measurement, slowly lower the decontaminated probe into the monitoring well until the indicator (light, sound, and/or meter) shows water contact. At this time, the precise measurement should be determined by repeatedly raising and lowering the tape or cable to converge on the exact measurement.

In wells having a layer of NAPL floating on the water, the electric tape will not respond to the oil surface and, thus, the fluid level determined will be different than would be determined by a steel tape. The difference depends on how much NAPL is floating on the water. Dual media tapes are recommended in that instance to measure both NAPL and water levels using the same measuring device. The procedure is discussed in Section 5.4.

Water-level measurement should be entered in the fluid-level monitoring log or the project field book. The water-level measurement device shall be decontaminated immediately after use.

5.3.3 Airline

The airline method is especially useful in pumped wells where water turbulence may preclude using more precise methods. A small diameter air-type tube of known length is installed from the surface to a depth below the lowest water level expected. Compressed air is used to purge the water from the tube. The pressure, in pounds per square inch (psi), needed to purge the water from the airline multiplied by 2.31 (feet of water for one psi) equals the length in feet of submerged airline. The depth to water below the center of the pressure gage can be easily calculated by subtracting the length of airline below the water surface from the total length of airline (assuming the air line is essentially straight).

Accuracy depends on the precision to which the pressure can be read. The accuracy of an airline or pressure gage measurement depends primarily on the accuracy and condition of the gage. It is normally within 1 foot of the true level as determined by means of a steel-tape measurement. The airlines themselves, however, have been known to become clogged with mineral deposits or bacterial growth, or to develop leaks and consequently yield false information. A series of airline measurements should be checked periodically by the use of a steel tape or an electric water-level indicator.

The airline and any connections to it must be airtight throughout the entire length. A long-term increase in airline pressure may indicate gradual clogging of the airline. A relatively sudden decrease in airline pressure may indicate a leak or break in the airline. Airline pressures that never go above a constant low value may indicate that the water level has dropped below the outlet orifice of the airline. To minimize the effect of turbulence, the lower end of the airline should be at least 5 feet above or below the pump intake. Corrections should be made for fluid temperatures much different from 20° C and for vertical differences in air density in the well column for cases where the depth to water is very large.

5.4 Procedures for Immiscible Fluids

At those facilities where monitoring to determine the presence or extent of immiscible fluids is required, the sampler will need to use special procedures for the measurement of fluid levels. The procedures required will depend on whether light NAPL (LNAPL) that form lenses floating on top of the water table or dense NAPL (DNAPL) that sink through the aquifer and form lenses over lower permeability layers are present.

In the case of LNAPL, measurements of immiscible fluid and water level usually cannot be accomplished by using normal techniques. For example, a chalked steel-tape measurement will only indicate the depth to the immiscible fluid (not the depth to water) and a conventional electric water-level probe will not generally respond to nonconducting immiscible fluids.

To circumvent these problems, the use of special techniques and equipment can be specified. These techniques have been specially developed to measure fluid levels in wells containing LNAPL or DNAPL, particularly petroleum products. One method is similar to the chalked steel-tape method. The difference is the use of a special paste or gel rather than ordinary carpenters chalk. Such indicator pastes, when applied to the end of the steel tape and submerged in the well, will show the top of the oil as a wet line and the top of the water as a distinct color change. Another method, similar to the electric-tape method, uses a dual purpose probe and indicator system. The probe can detect the presence of any fluid (through the wetting effect) and can also detect fluids that conduct electricity. Thus, if a well is contaminated with low density, nonconducting LNAPL such as gasoline, the probe will first detect the surface of the gasoline, but it will not register electrical conduction. However, when the probe is lowered deeper to contact water, electrical conduction will be detected. The detection of a DNAPL would be similar.

5.5 Measurement of Total Depth

During water-level measurement, the total depth of the well may also be measured. This measurement gives an indication of possible sediment buildup within the well that may significantly reduce the screened depth. The same methods used for measuring water levels (e.g., steel tape or electrical probes) may be used to measure the total well depth. The most convenient time to measure the total well depth is immediately following measurement of the water level and prior to removing the measurement device completely from the well. The measurement device (steel tape or electrical probe) is lowered down the well until the measurement tape becomes slack indicating the weighted end of the tape or probe has reached the bottom of the well. While the probe remains touching the bottom and the tape pulled taut, the total well depth shall be recorded into the field book.

6.0 Quality Assurance/Quality Control

To ensure that accurate data are collected, repeated measurements of the fluid depths should be made. The readings should be within 0.01 to 0.02 feet of each other. A secondary check, if data are available, is to compare previous readings collected under similar conditions (e.g., summer months, wells pumping, etc.).

7.0 Documentation

Data will be recorded into the fluid-level monitoring log form, the project field book, or, if groundwater sampling, the groundwater sample collection record. Additional comments, observations, or details will also be noted. These documents will provide a summary of the water-level measurement procedures and conditions and will be kept the in project files.

Figure 1 Fluid-Level Monitoring Log

Fluid-Level Monitoring Log

Site Location:	**Project Name:**
Personnel:	**Project No.:**
Gauging Instrument:	**Date(s):**

Well Number	Date	Time	Total Depth (A)	Depth to Water (A)	Depth to Oil (a)	Oil Thickness	Remarks

Figure 1

RETEC Standard Operating Procedure (SOP) 221
Groundwater Well Development

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) Standard Operating Procedure (SOP) 221 describes the method for developing groundwater monitoring wells. Well development is the process of cleaning the face of the borehole and the formation around the outside of the well screen to permit groundwater to flow easily into the monitoring well.

Monitoring wells must be developed for the following reasons:

- To restore the natural permeability of the formation adjacent to the borehole to permit the water to flow into the screen easily
- To remove the clay, silt, and other fines from the formation so that during subsequent sampling the water will not be turbid or contain suspended matter which can easily interfere with chemical analysis
- To remove any contamination or formation damage that may have occurred as a result of well drilling

Well development is necessary for all newly completed wells and may be required for wells which have been left dormant for some time or have accumulated significant quantities of sediment in the well, gravel pack, or surrounding formation.

Well development should remove clay particles deposited on the surface of the formation along with sufficient quantity of water to ensure the removal of fluids introduced into the formation during drilling or prolonged inactivity. The development process should also effectively loosen and remove finer particles from the formation matrix.

During any drilling process the side of the borehole becomes smeared with clays or other fines. This plugging action substantially reduces the permeability and retards the movement of water into the well screen. If these fines are not removed, especially in formations having low permeability, it then becomes difficult and time consuming to remove sufficient water from the well before obtaining a fresh groundwater sample because the water cannot flow easily into the well. Existing wells may also require development due to the buildup of sediments in the well or surrounding formation, or accumulation of excessive quantities of light non-aqueous phase liquid (LNAPL) and dense non-aqueous phase liquid (DNAPL) in the well due to inactivity.

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, Job Hazard Analysis (JHA), Safety Task Analysis Review (STAR), or Site-Specific Health & Safety Plan (HASP) will take precedence over the procedures described in this document.

2.0 Responsibilities

The field sampling coordinator will have responsibility to oversee and ensure that all monitoring well development is performed in accordance with the project specific sampling program and this SOP. It shall be the responsibility of the field sampling coordinator to observe all activities pertaining to development to ensure that all the standard procedures are followed properly, and to record all pertinent data on a field log or field book. The field sampling coordinator must ensure that all field workers are fully apprised of this SOP.

3.0 Health and Safety

This section presents the generic hazards associated with monitoring well development and is intended to provide general guidance in preparing site-specific health and safety documents. The site-specific HASP, JHA, and STAR will address additional requirements and will take precedence over this document. Note that monitoring well development usually requires Level D personal protection unless there is a potential for exposure to airborne site contaminants.

Health and safety hazards include but are not limited to the following:

- Slip, trips, and falls in tall grasses over obstacles and berms near well locations. Review terrain hazards prior to conducting these operations. Ensure there is a safe means of access/egress to the wellhead.
- Dermal exposure to potentially contaminated groundwater. Ensure that proper personal protective equipment (PPE) is used to mitigate the impact of splashes of groundwater to skin and/or eyes.
- Exposure to site contaminants. If there is product in the well (especially gasoline) take all precautions necessary to prevent fire/explosion and/or exposure to airborne vapors.
- Ergonomics. Use appropriate ergonomic techniques when inserting or retrieving equipment for the wells to preclude injury to the arms, shoulders or back.

4.0 Supporting Materials

The list below identifies the types of equipment which may be used for a range of monitoring well development applications. A project specific equipment list will be selected based upon project objectives, the depth to ground water, purge volumes, and well construction. Types of sampling methods and equipment are as follows:

- Surge block
- Air lift
- Bailers and bailer cord
- Pump (centrifugal, bladder, peristaltic) and discharge line
- Conductivity/temperature/pH meter(s)
- Water-level measurement equipment
- Field data sheets and field book
- Buckets and intermediate containers
- Paper towels or chemical-free cloths
- Decontamination materials

5.0 Methods and Procedures

Well development is accomplished by causing the natural formation water inside the well to move vigorously in and out through the screen. The suspended sediment is then removed from the well by bailing or pumping. Several techniques may be employed in developing a well. To be effective, all require reversals or surges in flow to avoid bridging by particles. These surges can be created by using surge blocks, air lifts, bailers, or pumps. The use of water other than the natural formation water is not recommended during well development. If water is added, the amount should be noted on the field forms or in the project field book. Water quality analyses should be conducted so that comparisons can be made with subsequent natural groundwater data.

Before developing the well, water depth, LNAPL or DNAPL depth (if present), and well depth will be measured using an electronic or mechanical device. If a measurable amount of LNAPL or DNAPL is detected, the well shall be bailed or pumped prior to development in an attempt to remove the material. This procedure should reduce the opportunity of LNAPL or DNAPL being forced back into the filter pack and formation during development. Approximately 10 well volumes (calculated from the length of the water column and the well casing diameter) should be removed from the well during development. The discharge from the well should be continuously monitored and development should be continued until a particulate free discharge is apparent and the field parameters (pH, conductivity, and temperature) have stabilized within 10 percent of the previous reading. Field parameters should be recorded on the well development record (Figure 1) after each volume is removed. All materials and equipment used in conjunction with development must be free of any contamination prior to use and all provisions made to prevent the introduction of contaminants during development. Well depths will be measured following development to determine whether sand or silt has accumulated in the well. If material has accumulated, it will be removed with a bailer.

Regardless of the method employed, any discharges from the well must be properly disposed of depending on the nature of the liquid removed from the well. Additionally, all materials and equipment placed into the well in conjunction with development must be free of any contamination prior to use. Decontamination procedures should be consistent with those described in RETEC SOP 120.

5.1 Surge Block

A surge block is a round plunger with pliable edges that will not catch on the well screen. For two-inch diameter wells, the surge block can be constructed of two aluminum plates 1.75 inches in diameter surrounding a thin section of neoprene rubber approximately 2 inches in diameter. The surge block assembly is lowered by hand down the well by connecting sections of one-half inch threaded PVC pipe. Once within the screen interval, the block is rapidly raised and lowered to agitate the water within the well.

If the surge block method is employed, development can be continued using a nitrogen driven bladder pump to evacuate the well. The bladder pump is lowered down the well and is connected to a section of teflon tubing. The nitrogen supply is turned on to activate the pump and discharge liquid from the well.

5.2 Air Lift

Compressed air pumped down a pipe inside the well casing can be used to blow water out of the monitoring well. If air is applied to the well intermittently and for short periods then the water is only raised inside the casing rather than blown out and will fall back down the casing causing the desired backwashing action. Finally, blowing the water out will remove the fines brought into the screen by the agitating action.

Considerable care must be exercised to avoid injecting air into the well screen. Such air can become trapped in the formation outside the well screen and alter subsequent chemical analyses of water samples. For this reason, the bottom of the air pipe should never be placed down inside the screen.

Another consideration is the submergence factor. Submergence is the feet of water above the bottom of the air pipe while pumping (blowing water out) divided by the total length of the air pipe. Submergence should be on the order of at least 20 percent.

5.3 Bailer

A bailer, sufficiently heavy so that it will sink rapidly through the water, can be raised and lowered through the well screen. The resulting agitation action of the water is similar to that caused by a surge block. The bailer, however, has the added advantage of removing the fines each time it is brought to the surface and emptied. Bailers can be custom-made for small diameter wells and can be hand-operated in shallow wells.

5.4 Pumping

Starting and stopping a pump so that the water is alternately pulled into the well through the screen and backflushed through the screen is an effective development method. Periodically pumping the waste will remove the fines from the well and permit checking the progress to ensure that development is complete.

6.0 Quality Assurance/Quality Control

Quality Assurance/Quality Control Plan requirements include the stabilization of field parameters to within 10 percent of the previous reading. A particulate free discharge is desirable but may not be possible based on the composition of the lithology in which the well is completed.

7.0 Documentation

The monitoring well development will be documented to provide a summary of the procedures, site conditions, and field parameters with corresponding purge volumes. Such documentation shall include:

- Field notebook
- Monitoring well development
- Health & Safety forms (JHA, STAR, and/or Site-Specific HASP amendments)

All documentation shall be placed in the project files and retained following completion of the project.

8.0 References

Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, EPA 600/4-89/034, published by National Water Well Association, 1989.

CRA Ground Water Monitoring Technical Enforcement Guidance Document, published by National Water Well Association, 1986.

A Compendium of Superfund Field Operations, EPA 540/P-87/001, published by the Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, US EPA, 1987.

Figure 1 Monitoring Well Development Log

MONITORING WELL DEVELOPMENT LOG

RETEC

Site:

Client:

Project No.:

Sample ID:

Well No.:

Development Start Date/Time:

Development End Date/Time:

Developed By:

Depth Measurement Ref. Point* ____________

Well Casing ID: 2" 4" 6" Other _____

Well Headspace/Odor ____________________

LNAPL Check (Yes/No) DNAPL Check (Yes/No)

Equipment used to measure thickness and sample free product (Make, Model, etc.) ________________

Depth to top and bottom of screened interval ____________________

Depth to LNAPL ____________

Original DTW ____________

Final DTW ____________

Depth to DNAPL ____________

LNAPL/DNAPL Thickness ____________

LNAPL/DNAPL Sample and Volume ____________________

Measured Well TD: ____________ (-) Original DTW: ____________ (=) Ht. Wtr Col.: ____________

DEVELOPMENT METHOD:

☐ Submersible Pump
☐ Centrifugal Pump
☐ Gas Lift/Displacement Pump

☐ Dedicated Bladder Pump
☐ Peristaltic Pump
☐ Inertial Lift Pump

☐ Bladder Pump
☐ Hand Pump
☐ Other __________

☐ Bailer

☐ SS
☐ Tef
☐ PVC

Development Equip. (Make, Model, etc.) ________________________________

Development Water Containerized? (Yes / No)

Development Equip. Decontaminated? ☐ Yes ☐ No

Average Development Rate: ________________ gpm

Weather ________________________

Actual Time (min.)	Vols. Purged (gals.)	Depth to Pump Intake (ft.)	Depth to Water (ft.)	Temp (^{o}C)	pH	Cond. (mS/cm)	Turbidity (NTA)	D.O. (mg/L)	Salinity (%)	Comments

* All depths in feet below reference point on wellhead, generally Top of Casing; DTW = Depth to Water; LNAPL/DNAPL = Light/Dense Non-Aqueous Phase Liquid

Figure 1

RETEC Standard Operating Procedure (SOP) 224
Aquifer Slug Test

1.0 Purpose and Applicability

Slug tests are a variety of field tests performed on wells completed in either aquifers or aquitards in order to obtain hydraulic conductivity estimates at a number of wells on a site in a reasonable amount of time and at low cost. These tests involve the instantaneous injection or withdrawal of a small volume of water followed by monitoring the time and water-level recovery back to the static pre-test condition. Slug tests are very popular and offer the advantages of not generating excessive amounts of fluids and not requiring expensive equipment. According to Freeze and Cherry (1979) a properly performed and analyzed slug test should give the investigator an order-of-magnitude estimate of the hydraulic conductivity of earth materials in close proximity to the test well. Slug tests can be used as a basis for preliminary design; however, it is recommended that pump tests or pilot tests be conducted to supplement the slug test data.

This SOP describes the techniques used to perform a slug test. Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health & Safety Plan will take precedence over the procedures described in this document.

2.0 Responsibilities

The Project Manager will be responsible for the planning and execution of slug tests. The Project Manager may choose to delegate the work to other members of the project team, but is responsible for overseeing the work and making sure that the it is done in accordance with this SOP and project specific sampling plans.

3.0 Supporting Materials

Following is a list of conventional field equipment needed to perform a standard RETEC slug test:

- A solid pipe slug, or bailer and cord
- A pressure transducer and data logger, or manual electric water-level indicator
- Wrist watch or stop watch to note starting time and elapsed time
- Decontamination equipment and solutions
- Slug test form or field book

The following considerations should be made based upon site conditions:

- The fluid-level measuring device will be dependent on site conditions. Slug tests can be performed in wells that contain non-aqueous phase liquids (NAPL). The presence of NAPL will require the use of an electric-interface probe capable of measuring depths to the top of each fluid.

- When testing wells completed in highly transmissive aquifers, a transducer and data logger should be used in order to measure rapid changes in the water level after starting the test. Inserting the transducer probe will initiate a change in the water level, which should be allowed to re-equilibrate to static before starting the test. The transducer must have the right resolution for the anticipated maximum change in water level, 0.005 pounds per square inch (psi) and 0.001 feet are generally recommended.

- If the well is expected to respond very slowly to the initial change in water level (e.g., when the saturated formation outside the production zone is composed of poorly permeable silt/clay or shale), a manual system of measurement should be used. In this type of formation there is little cost benefit in using the transducer/data logger system. An electric sounder is recommended; a calibrated steel tape would be acceptable.

- A slug should be selected that is large enough to create the most change in static-water level and short enough to be completely submerged. If the slug is to remain in the well, position it to one side so that it does not interfere with later water-level measurements or the static height of the transducer. If a solid slug is to be removed, allow time after insertion of the slug for the pre-test water level to re-equilibrate to static before starting the test.

All equipment used during the slug test, should be decontaminated following procedures outlined in SOP 120.

4.0 Methods and Procedures

This section describes methods and procedures for conducting a slug test. The project specific sampling plan should be reviewed for any additional or special requirements.

4.1 General Information

Slug tests may be performed on wells of any diameter or depth, and on both confined and unconfined aquifers. It is important to make note of the well dimensions and the depth range of the well screen or production zone (screen and filter pack, or open rock hole). It is not necessary that the static-water level prior to testing be either above or below the top of the production zone, although the analysis of the recovery water-level data will depend on these starting conditions. Composition and thickness of the filter pack material should generally be noted because it may affect the hydraulic response observed in the well and will figure into the analysis of the field data. The age of the well may affect results also, so if the year or date the well was completed is not near the year/date of the test, a note of this should be made.

The size and composition of the slug requires some planning. It is practical to use a solid slug made of PVC or steel pipe filled with sand and capped with an I-hook attached to the top plug. The I-hook will act as an attachment for the cord which introduces and retrieves the slug from the well. It is recommended that several sizes and slugs be available in order to accommodate different well and water-level conditions. Three- or five-foot lengths of one-inch diameter pipe are well suited for two-inch diameter wells. To prevent cross contamination, the slug should be decontaminated and the slug cord replaced between wells.

Pouring clean water into a well from the top of casing is not considered standard practice, but can be used in the absence of a solid slug or bailer. If water is used as a slug, it can be removed with a clean bailer. Use of a pump to instantaneously remove the water is not considered standard practice, but could be considered if the well and static-water levels are so deep that use of a slug is impractical. The use of equipment to instantaneously pressurize a sealed well, or to release water from a shut-in artesian well are acceptable, but are also not considered part of the standard practice described here.

4.2 Types of Slug Tests

A "rising head" slug test is one in which the initial change serves to lower the water level or hydraulic head in the well. A "falling head" slug test is one in which the initial change serves to raise the water level or hydraulic head. When the initial change in water level occurs entirely within the blank well casing above the well screen or open hole, either test should provide the same analytical results. When the initial change is entirely within the well screen or open hole zone, the two different test methods will produce results that are less likely to coincide due to the fact that rates of water imbibition from the well are different from drainage (flow to the well). The authors of the papers generally used for analysis of slug tests in wells having screens that straddle the water table discourage the use of their analytical method for falling head tests (Bouwer and Rice, 1976) (Bouwer, 1989).

4.3 Pre-Test Information

The following steps are to be followed when performing a slug test on a non-flowing well. These steps pertain to both transducer/data logger tests and manual tests.

1. Observe and enter the following data on the slug test form (Figure 1) or in the project field book (a copy of the well construction log can also be attached, if available):

    a. Well total depth and depth interval of the well screen or open rock hole (sound bottom of well if it has not been sounded recently for other purposes)
    b. The diameter of the well casing, screen, and original borehole size

   c. Information about the filter pack, including the depth interval and the size of material used
   d. General aquifer conditions such as confined or unconfined, total thickness, and percent of penetration by the test well are optional for the slug test form but will be needed for data analysis

2. Observe and make note of the static pre-test water levels, date of the test, and clock time of the static-water level. Make a note of the weather conditions at the start of the test. Also note any major changes in the weather that occur in longer term tests since these are an indirect measure of barometric pressure changes, which may affect water levels.

3. Provide information on the slug test form regarding type, dimensions, and volume of the slug to be used in the test. Using a specific volume-per-foot ratio for the given inside diameter of the test well, estimate about how much water-level change will occur when the slug is introduced or removed.

4. Note on the slug test form the type of test (i.e., transducer/data logger or manual).

4.4 Slug Testing - Transducer/Data Logger

The following steps are for the use of a transducer and data logger system. Manual slug testing is described in Section 4.5.

1. Insert the transducer probe in the well approximately 0.5 feet off the bottom of the well. Secure the probe cable to the protective well casing and turn on the data logger. Calibrate the data logger reading to an equivalent static-water level depth equal to that measured manually. The data logger can also be set to read zero, in which case negative numbers will relate to a lowering of the static head and positive numbers will relate to a raising of the static head. Program the frequency of measurements and the density of the fluid in the data logger.

2. Start the logging program and take a final depth-to-water measurement just prior to starting the test. Note the measurement and clock time on the slug test form. Start the test by smoothly removing or inserting the slug, so as not to disturb the transducer elevation. Make note of the start time on the slug test form.

3. Check periodically to see if the initial water level or data logger reading is being approached. Stop the test when the pre-test water level has been reached for wells that recover within one day, or after about 80 percent of the initial change has recovered if several days or weeks have elapsed since starting the test.

4.5 Slug Testing - Manual

The following steps are for a manual test using an electronic water-level probe. Transducer and data logger slug testing is described in Section 4.4.

1. Take a final depth-to-water measurement just prior to starting the test. Note the measurement and clock time on the slug test form. Start the test by removing or inserting the slug making note of the start time on the slug test form.

2. Observe manual water levels at increasing time intervals and make note of these along with the clock time of each measurement on the slug test form. Make manual observations at least as frequently as follows:

    a. Time zero to 5 minutes -- every 30 seconds
    b. 5 to 15 minutes -- every minute
    c. 15 to 60 minutes -- every 5 minutes
    d. 60 to 120 minutes -- every 15 minutes
    e. 120 minutes to 10 hours -- every hour
    f. 10 to 48 hours -- every 12 hours
    g. 48 hours to completion -- every 2 days
    h. Make note of dates of measurements if the recovery time exceeds more than a day.

3. Make elapsed time calculations in the field and observe the general rate of recovery back to the pre-test static water level. Stop the test when the pre-test water level has been reached for wells that recover within one day, or after about 80 percent of the initial change has recovered if several days or weeks have elapsed since starting the test.

5.0 Quality Assurance/Quality Control

When using a transducer/data logger system, take periodic manual measurements of the water level as a check on the transducer readings. On wells that have screens or open holes below the static- water level, perform both a rising and falling head test, and compare the analytical results of each method. Compare the calculated change in water level from slug volume and the volume/foot well casing ratio as a check on the initial readings made with the transducer system or the manual sounder measurement. These should be within about 5 to 10 percent of each other. During analysis, use the calculated value to represent the initial change in head instead of the first manual measurement taken soon after the initial change in head. Compare the analytical results to published values for hydraulic conductivities for similar earth materials. Note, the Fort Collins office has developed a spreadsheet to assist with calculating the initial displacement of the slug.

At wells that have free NAPL, the changes in NAPL thickness will need to be adjusted to the equivalent change in water level using the specific gravity of the NAPL prior to analysis. The user should refer to SOP 223 for the free NAPL Baildown test.

6.0 Documentation

The slug test form and or the project field book will be maintained as a part of the slug test results. These documents will provide a summary of the slug test method, site and weather conditions, and the slug test data. These documents will be kept in the project files for reference.

7.0 References

Freeze, R.A. and J.A. Cherry, 1979, Groundwater, published by Prentice-Hall, Inc., Englewood Cliffs, NJ, 604pp.

Bouwer, H. and R.C. Rice, 1976, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, US Water Conservation Laboratory, Phoenix, AZ.

Bouwer, Herman, 1989, The Bouwer and Rice Slug Test - An Update, US Water Conservation Laboratory, Phoenix, AZ.

Figure 1 Slug Test Form

The RETEC Group

SLUG TEST FIELD DATA SHEET

Page____of____

CLIENT____________________ SITE__________________________ Observer(s)________________

WELL NO:______________________________ Test No.________________________________

TOC Elevation___________________________ Well Depth______________________________

Water Level Data

Static Water Level ________ Type/Description of Slug______________________________________

Measuring Point ________ Slug Dimensions____________________ Slug Volume is__________ Gal__________

Elevation of meas. pt. ________ Well Inside Diameter______________________________________

Measuring Equip. ________ Date________________________ Weather______________________________

Clock Time	Elapsed Time (min)	Depth to Water (ft)	Change in Depth to Water Relative to Static Level (ft)	Comments

Figure 1

RETEC Standard Operating Procedure (SOP) 230
Groundwater Sampling

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 230 describes methods used to obtain the collection of valid and representative groundwater samples from monitoring wells. Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, Job Hazard Analysis (JHA), Safety Task Analysis Review (STAR), or Site-Specific Health & Safety Plan (HASP) will take precedence over the procedures described in this document.

2.0 Responsibilities

The field sampling coordinator will have the responsibility to ensure that all groundwater sampling is performed in accordance with the project specific sampling program and this SOP. In addition, the field sampling coordinator must ensure that all field workers, responsible for conducting groundwater sampling activities, are fully apprised of this SOP and other pertinent project documents.

3.0 Health and Safety

This section presents the generic hazards associated with low flow groundwater sampling and is intended to provide general guidance in preparing site-specific health and safety documents. The site-specific HASP, JHA, and STAR will address additional requirements and will take precedence over this document. Note that low flow groundwater sampling usually requires Level D personal protection unless there is a potential for exposure to airborne site contaminants.

Health and safety hazards include but are not limited to the following:

- Slip, trips, and falls in tall grasses over obstacles and berms near well locations. Review terrain hazards prior to conducting these operations. Ensure there is a safe means of access/egress to the wellhead.

- Dermal exposure to potentially contaminated groundwater. Ensure that proper personal protective equipment (PPE) is used to mitigate the impact of splashes of groundwater to skin and/or eyes.

- Exposure to site contaminants. If there is product in the well (especially gasoline) take all precautions necessary to prevent fire/explosion and/or exposure to airborne vapors.

- Ergonomics. Use appropriate ergonomic techniques when inserting or retrieving equipment for the wells to preclude injury to the arms, shoulders or back.

4.0 Supporting Materials

Section 4.1 identifies the types of material and equipment that may be used for a range of groundwater sampling applications. Project specific equipment will be selected from section 4.1 based upon project objectives and site conditions (e.g., the depth to groundwater, purge volumes, analytical parameters, well construction, and physical/chemical properties of the analytes). The following section includes basic types of materials and equipment necessary to complete groundwater sampling activities are listed below:

4.1 Project Documentation and Set-Up

- Work Plan
- Sampling Plan
- Quality Assurance Project Plan
- RETEC SOP 230
- HASP
- Project Contact List
- Purge-Water Disposal Plan
- Laboratory, and other subcontractor, work orders (signed)

4.2 Purging/Sample Collection

In general equipment that will contact the water must be made of inert materials, preferably stainless steel or fluorocarbon resin. Other materials may also be allowed by the project sampling plan. The properties of purging/sampling equipment should be carefully considered as well as the constituents of interest. Purging/sampling equipment may include

- Bailers and bailer cord
- Centrifugal pump, tubing, power source
- Peristaltic pump, Bladder pump, tubing and power source
- Submersible pump, tubing, power source

Dissolved oxygen and pH equipment will be calibrated daily, following the manufacturer's specifications. To ensure successful calibration equipment should be calibrated at a temperature similar to that of the groundwater to be sampled. Sample preparation/field measurement equipment may include:

- pH meter
- Specific conductance meter
- Thermometer
- Oxidation/reduction potential meter

- Dissolved oxygen meter, with flow-through or down-hole capabilities
- Filtration apparatus
- Water-level measurement equipment

In addition to purging/sampling materials and field measurement equipment the following general support equipment may be used:

- Distilled water dispenser bottle
- Methanol or isopropyl dispenser bottle
- Decontamination equipment
- Personal protection equipment as specified in the Site Specific Health and Safety Plan
- Field data sheets and field book
- Sample containers, labels, and preservation solutions
- Buckets and drums
- Coolers and ice
- Paper towels or chemical-free cloths
- Well keys
- Bolt cutter
- Utility knife
- Winter equipment (as necessary – e.g. tent, heater, ice choppers and sled)
- Ratchet wrench

5.0 Methods And Procedures

The following sections describe the methods and procedures required to collect representative groundwater samples.

5.1 Water-Level Measurement

After unlocking and/or opening a monitoring well, the first task will be to obtain a water-level measurement. A static-water level will be measured in the well prior to purging and sample collection. The water level is needed for estimating the purge volume and may also be used for mapping the potentiometric surface of the groundwater. Whenever possible, water level measurements will be collected at all of the wells on-site within 24 hours of each other, or a period reasonable to site conditions. Water-level measurements will be collected using an electronic or mechanical device following the methods described in SOP 231.

The location of the measurement point for water level measurements for each well should be clearly marked on the outermost casing or identified in previous sample collection records. This point is usually established on the well casing itself, but may be marked on the protective steel casing in some cases. In either case, it is important that the marked point coincide with the same point of measurement used by the surveyor. If the mearuing point from previous investigations is not marked, the water level measuring point should be marked on the north side of the well casing and noted in the groundwater sampling form (Figure 1). The location should be described on the groundwater sampling form.

After opening the well, the field sampler will check for indications of an airtight seal resulting in a pressure difference within the well compared to ambient conditions. If this is the case, the field sampler will allow a minimum of five minutes for the water level to stabilize before collecting a down-hole measurement. To obtain a water level measurement, the field sampler should lower a decontaminated mechanical or an electronic sounding unit into the monitoring well until the audible sound of the unit is detected or indicates water contact. At this time the precise measurement should be determined by repeatedly raising and lowering the tape or cable to converge on the exact measurement. The water-level measurement should be entered on the groundwater sampling form. The water-level measurement device shall be decontaminated immediately after use following the procedures outlined in SOP 120.

5.2 Purging and Sample Collection Procedures

5.2.1 Conventional Purging and Sampling method

Well purging is the activity of removing a volume of water from a monitoring well in order to induce "fresh" groundwater to flow into the well prior to sampling. Under most well construction and hydrogeologic conditions, this provides water that is more representative of the groundwater in saturated materials adjacent to the well.

The volume of water to be removed, referred to as the purge volume, is a function of the water-yielding capacity of the well, the well diameter and depth, and the depth to water prior to purging. The well depth should be sounded with the water-level cable or tape just before or after measuring the static depth to water. A well volume is defined as the product of the length of water column and the volume per unit length of well casing, a function of casing inside diameter. For certain States this definition will be expanded to include the diameter of the borehole (less the volume of sand pack materials) prior to well installation. The following data can be used in this field calculation:

Inside Diameter of casing (inches)	**Gallons/foot**
1 1/4	0.077
1 1/2	0.10
2	0.16
3	0.37
4	0.65
6	1.64

According to the TEGD (USEPA, 1986), the purge volume should equal at least three well volumes when the earth materials will yield relatively large quantities of water, and between one and two well volumes when the earth materials will only yield small quantities to the well. From a field operations viewpoint, large quantities (high yield) means that the well can not be pumped or bailed "dry" by removing three well volumes. Small quantities (low yield) are identified when the well can be pumped or bailed "dry".

Based on experience and recent scientific literature, it will be The RETEC Group, Inc. (RETEC) policy to minimize the generation of water turbidity when purging. Turbidity is especially of concern when testing the samples for metals or for selected organics that may be sorbed to the sediment. Turbidity will be minimized by :

- Using a low-pumping rate submersible pump such as a compressed-gas driven bladder pump
- Slowly moving the bailer in and out of the water column; avoid dropping the bailer and removing it quickly

Purging will be performed for all groundwater monitoring wells prior to sample collection. If the well being sampled is newly installed and developed or has been redeveloped, sampling can be initiated as soon as the groundwater has re-equilibrated, is free of visible sediment, and the water quality parameters have stabilized. Since site conditions vary, even between wells, a general rule-of-thumb is to wait 24-hours after development to sample a new monitoring well. Wells developed with stressful measures (e.g., backwashing, jetting, compressed air, etc.) may require as long as a 7-day interval before sampling.

Three general methods are used for well purging, bailers, surface pumps, or down-well submersible pumps. In all cases pH, temperature and specific conductance will be monitored during purging. In addition the oxidation/reduction potential and dissolved oxygen concentration of the groundwater should be collected if proper equipment is available. Field parameter values will be entered on the groundwater sampling form along with the corresponding purge volume.

The following sections explain the procedures to be used to purge and collect samples from monitoring wells.

5.2.1.1 Bailing

Obtain a clean decontaminated bailer and a spool of polypropylene rope or equivalent bailer cord. Using the rope at the end of the spool, tie a bowline knot, or equivalent, through the bailer loop. Test the knot for adequacy by creating tension between the line and the bailer. Tie again if needed.

Lower the bailer to the bottom of the monitoring well and remove an additional five feet of cord from the spool. Cut the cord at the spool and secure the rope to the well head or the wrist of the person who shall perform the bailing.

Raise the bailer by grasping a section of cord using each hand alternately. This bailer lift method is used so that the bailer cord will not come into contact with the ground or other potentially contaminated surfaces. Chord wheels can also be used to manage the bailer chord as it is retrieved. Cable wheels must be decontaminated appropriately prior to each use.

Samples collected by bailing will be poured directly into sample containers from bailers, which are full of fresh groundwater. Samples will be collected in the following order:

- Volatile organic compounds
- Semivolatile organic compounds
- Pesticides/Herbicides/PCBs/Dioxins
- Organic Indicator compounds (e.g., nitrate, nitrite, sulfide)
- Metals (total and/or dissolved)
- Miscellaneous inorganic compounds
- Radiometric compounds
- Microbial analyses

During sample collection, bailers should not be allowed to contact the sample containers.

5.2.1.2 Pumping

Groundwater withdrawal using pumps is commonly performed with centrifugal, peristaltic, submersible, or bladder pumps. Peristaltic and centrifugal pumps are limited to conditions where groundwater need only be raised through approximately 20 to 25 feet of vertical distance. Submersible or bladder pumps can be used when groundwater is greater than 25 feet below grade. Specific methods for pumps will be discussed in the project specific sampling plan. All pumps and tubing must be decontaminated according to SOP 120 prior to coming in contact with the groundwater.

Samples collected by pumping will be transferred directly from the pump discharge tubing into the sample containers. Samples will be collected in the following order:

- Volatile organic compounds (VOC) - If using any pump except a bladder pump then any VOC samples should be collected with a bailer prior to sampling for other parameters
- Semivolatile organic compounds
- Pesticides/Herbicides/PCBs/Dioxins
- Organic indicator compounds (e.g., nitrate, nitrite, sulfide)
- Metals (total and/or dissolved)
- Miscellaneous inorganic compounds
- Radiometric compounds
- Microbial analyses

During sample collection, the discharge tubing will not be allowed to contact the sample containers.

5.3 Field Parameter Monitoring

Field personnel should familiarize themselves with the field parameters to be monitored. Certain field parameters such as D.O. and oxidation/reduction should correlate to each other. If available, historical sampling forms should be reviewed prior to sampling for an initial understanding of the range of values previously obtained at each sample location. Often it is useful to photocopy the past sampling forms and have them available in the field for comparison purposes. Understanding the past results and current conditions can indicate well damaged or if meters are working properly.

5.4 Sample Preparation and Filtration

Prior to transport or shipment, groundwater samples may require preparation and/or preservation. Field preparation may entail filtration, preservation in the form of chemical additives, or temperature control. Specific handling and preservation requirements will be in accordance with SOP 110 and the project specific sampling plans. A clean pair of gloves and decontaminated sampling tools will be used when handling the samples during collection to prevent cross contamination.

Groundwater samples collected for dissolved metals analyses will be filtered prior to being placed in sample containers. Groundwater filtration is performed using a peristaltic pump and a 0.45 micron water filter unless otherwise specified in the project specific sampling plan. For most dissolved metal analyses, pH adjustment of the sample is also required and shall be performed after filtration. The filter shall be conditioned with a minimum of 500 ml of groundwater for each sampling location prior to placement of the sample into laboratory jars.

In general, groundwater samples will need to be placed on ice and inside coolers to protect the samples from the sun and to decrease their temperature to or below 4 degrees Celcius.

Field personnel should contact the laboratory prior to going out into the field to ensure necessary lab containers are available and sample preservation procedures are followed. Items such as preservative safety and clear versus opaque jars are examples of items that should be discussed with the laboratory. Sample receiving dates should also be discussed with the laboratory.

6.0 Field Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) requirements dictated by the project specific sampling plans include, but are not limited to, blind field duplicates, equipment rinse blanks (ERB), and field blanks. These samples will be collected at the following frequencies:

- Duplicate – 1 per ten samples
- ERB – 1 per day of sample collection activities or per type of field equipment used to collect samples
- Field Blank – as determined for the project
- Trip Blanks – shall be included with all VOCs, methane and other samples that consist of dissolved gas phase compounds.

7.0 Documentation

Various documents will be completed and maintained as a part of groundwater sample collection. These documents will provide a summary of the sample collection procedures and conditions, shipment method, analyses requested, and the custody history. These documents may include:

- Field book
- Groundwater sampling forms
- Sample labels
- Chain-of-custody
- Shipping receipts
- Sample nomenclature protocol

All documentation will be stored in the project files. Sample nomenclature protocol should be discussed with the project data management personnel to ensure consistency between sampling events.

8.0 References

Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, EPA 600/4-89/034, published by National Water Well Association, 1989.

RCRA Ground Water Monitoring Technical Enforcement Guidance Document, published by National Water Well Association, 1986.

A Compendium of Superfund Field Operations, EPA 540/P-87/001, published by the Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, US EPA, 1987.

Figure 1 Groundwater Sampling Form

The RETEC Group, Inc.
Groundwater Sampling Form

PROJECT __________ WELL NO. __________

PROJECT NO. __________ SAMPLERS __________

1. WELL CONDITION CHECKLIST:

a. Bump posts ______ Prot. casing/lock ______ Surface pad ______

b. Well visibility (paint) ______

c. Well label ______

2. WATER LEVEL MEASUREMENT:

DATE __________ TIME __________

WEATHER CONDITIONS __________

a. Location of measuring point __________

b. Depth of water table from measuring point __________

c. Height of measuring point above ground surface __________

d. Total depth of well below measuring point __________

e. Length of water column (line 2d-2b) __________

3. WELL PURGING:

DATE __________ TIME __________

WEATHER CONDITIONS __________

a. Purge method __________

b. Required purge volume at 3 well volumes __________

Pumping Duration	Volume Rmvd.	pH	Redox	Cond.	T(C)	Color	Turbidity

4. SAMPLE COLLECTION:

DATE __________ TIME __________

WEATHER CONDITIONS __________

a. Collection method __________

b. Meter calibration

	Date	Model
pH meter		
D.O. meter		

c. Sample information pH ______ Cond. ______ T(C) ______ Turbidity ______

Analysis	Containers	Sample Prep./Preservation

d. Chain of custody form __________ COC tape __________

e. Shipping container __________

5. COMMENTS: __________

Redox measured in mV;
Conductivity measured in ms/cm
D.O measured in mg/L

RETEC Standard Operating Procedure (SOP) 235
Low Flow Groundwater Sampling

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 235 describes methods used to obtain the collection of valid and representative groundwater samples from monitoring wells utilizing a low flow sampling technique. This technique is designed to reduce the influx of particulate matter into the well and groundwater sample to ensure a more representative analysis of groundwater quality, and to reduce aeration that can affect geochemical parameters.

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, Job Hazard Analysis (JHA), Safety Task Analysis Review (STAR), or Site-Specific Health & Safety Plan (HASP) will take precedence over the procedures described in this document.

2.0 Responsibilities

The field sampling coordinator will have responsibility to oversee and ensure that all groundwater sampling is performed in accordance with the project specific sampling program and this SOP. It shall be the responsibility of the field sampling coordinator to observe all activities pertaining to sampling to ensure that all the standard procedures are followed properly, and to record all pertinent data on a field log or field book. The collection, handling, and storage of all samples will be the responsibility of the field sampling coordinator. In addition, the field sampling coordinator must ensure that all field workers are fully apprised of this SOP.

3.0 Health and Safety

This section presents the generic hazards associated with low flow groundwater sampling and is intended to provide general guidance in preparing site-specific health and safety documents. The site-specific HASP, JHA, and STAR will address additional requirements and will take precedence over this document. Note that low flow groundwater sampling usually requires Level D personal protection unless there is a potential for exposure to airborne site contaminants.

Health and safety hazards include but are not limited to the following:

- Slip, trips, and falls in tall grasses over obstacles and berms near well locations. Review terrain hazards prior to conducting these operations. Ensure there is a safe means of access/egress to the wellhead.

- Dermal exposure to potentially contaminated groundwater. Ensure that proper personal protective equipment (PPE) is used to mitigate the impact of splashes of groundwater to skin and/or eyes.

- Exposure to site contaminants. If there is product in the well (especially gasoline) take all precautions necessary to prevent fire/explosion and/or exposure to airborne vapors.

- Ergonomics. Use appropriate ergonomic techniques when inserting or retrieving equipment for the wells to preclude injury to the arms, shoulders or back.

4.0 Supporting Materials

The following list of equipment will be used to determine the depth to water, purged volume, and analytical parameters.

Sampling/Purging Equipment

- Low flow submersible bladder pump or peristaltic sampling pump
- Teflon and polyethylene tubing
- Water level measurement equipment

Field Analytical Parameter Measurement

- In-line water quality meter (e.g., flow-through cell)

- Water quality meter with individual temperature, pH, specific conductance, dissolved oxygen (DO), turbidity, salinity, and oxidation reduction potential (ORP) probes

- Turbidity meter

Supporting Documents

- Project specific Work Plan

- Material Safety Data Sheets (MSDSs) for any chemicals or site-specific contaminants

- A copy of the Site-Specific HASP

- Field data sheets and log book

Decontamination Equipment

- Distilled water
- Isopropanol (laboratory grade)
- Spray bottles for decontamination solutions
- Chemical free paper towels

Sample Collection

- Preservation solutions (if necessary)
- Sample containers
- Coolers

Peristaltic Pump Sample Collection

- Generator and extension cord
- Battery packs

Bladder Pump Sample Collection

- Dedicated bladders
- Pump controller box
- Nitrogen (air supply)
- Detergent/Alconox
- Nitric or hydrochloric acid (laboratory grade)
- Cleaning brushes

Miscellaneous

- Disposable gloves
- Tubing cutters
- Plastic sheeting
- PPE
- Buckets and intermediate containers

5.0 Methods and Procedures

The following sections describe the methods and procedures required to collect representative groundwater samples.

5.1 Water Level Measurement

After unlocking and/or opening a monitoring well, the first task will be to obtain a water-level measurement. A static-water level will be measured in the well prior to the purging and collection of any samples. The water level is needed for estimating the purge volume and may also be used for mapping the potentiometric surface of the groundwater. Water-level measurements will be made using an electronic or mechanical device following the methods described in SOP 231.

Measurement of point location for the well should be clearly marked on the outermost casing or identified in previous sample collection records. This point is usually established on the well casing itself, but may be marked on the protective steel casing in some cases. In either case, it is important that the marked point coincide with the same point of measurement used by the surveyor. If not marked from previous investigations, the water level measuring point should be marked on the north side of the well casing and noted in the groundwater sampling form (Figure 1). Whatever measuring point is used, the location should be described on the groundwater sampling form.

To obtain a water level measurement lower a decontaminated mechanical or an electronic sounding unit into the monitoring well until the audible sound of the unit is detected or indicates water contact. At this time the precise measurement should be determined by repeatedly raising and lowering the tape or cable to converge on the exact measurement. The water-level measurement should be entered on the groundwater sampling form. The water-level measurement device shall be decontaminated immediately after use following the procedures outlined in RETEC SOP 120 (Decontamination).

5.2 Purging and Sample Collection

5.2.1 Pumping

Purging must be performed for all groundwater monitoring wells prior to sample collection. The volume of water present in each well must be computed using two measurable lengths, length of water the water column and monitoring well inside diameter. A low flow, electric driven pump (e.g., bladder pump or peristaltic pump) will be used to purge and sample well water.

The inlet of the bladder pump or peristaltic pump tubing will be lowered into the well slowly and carefully to a depth corresponding with the approximate midpoint of the screened interval of the aquifer, or 1-2 feet below the water level in the well, whichever is greater. A depth-to-water measurement device will be lowered into the well to monitor drawdown. The pump will be turned on at a flow rate of about 0.1 liters per minute (L/min). The flow rate will be adjusted up or down to maximize flow, yet ensure minimum drawdown. In no instance should a drawdown of more than 0.5 foot be allowed. The water level in the well should be carefully monitored to ensure that draw down does not increase during purging.

If the well being sampled is newly installed and developed or has been redeveloped, sampling can be initiated as soon as the groundwater has re-equilibrated, is free of visible sediment, and the water quality parameters have stabilized. Since site conditions vary, even between wells, a general rule-of-thumb is to wait 24-hours after development to sample a new monitoring well. Wells developed with stressful measures (e.g., backwashing, jetting, compressed air, etc.) may require as long as a 7-day interval before sampling.

5.2.2 Field Parameters

Groundwater will be pumped from the well into a sealed, flow-through chamber containing probes to measure the water temperature, pH, turbidity, conductivity, ORP, and DO using a Water Quality Meter. Field measurements of turbidity will also be obtained using a turbidity meter for comparison purposes. It is essential to properly calibrate the Water Quality Meter for the specific parameters being monitored, according to the procedures identified in the instrument manual. Calibration procedures and results must be documented in the site field notebook.

Field parameters values will be recorded on the Groundwater Sample Collection Record (Figure 1) or in the site field notebook along with the corresponding purge volume. After passing through the flow-through chamber, the water will be discharged into a container of known volume where the pumping rate will be measured with a watch. When the container is full, the water will be properly disposed following Site protocols.

Groundwater samples will be collected for laboratory analysis when the groundwater has stabilized; the change between successive readings of temperature, pH and conductivity are less than 10%, and turbidity is reduced to 10 NTUs or less. This may occur prior to removal of three well volumes. Stabilization of groundwater measurements are considered indicative of sampling fresh formation water and is a more reliable indicator of purging than removal of a standard volume of water.

5.2.3 Decontamination

Decontamination of non-dedicated equipment will follow the procedures outlined in RETEC SOP 120 (Decontamination), or following the procedures listed below for full field decontamination, conducted in the order presented:

- Remove gross contamination from the equipment by brushing or steam cleaning
- Wash with non-phosphate soap/detergent solution
- Rinse with laboratory-grade nitric acid (for potential inorganic contamination)
- Rinse with tap water
- Rinse with laboratory grade isopropanol
- Rinse with tap water
- Rinse with distilled water
- Allow to air dry
- Repeat as necessary

Teflon tubing will be dedicated to each well and will, therefore, not require decontamination.

5.3 Sample Preparation

Proper packaging and shipment of samples will minimize the potential for sample breakage, leakage, or cross contamination and will provide a clear record of sample custody from collection to analysis. Information on sample custody and shipping is also detailed in RETEC SOP 110 (Packaging and Shipment of Samples). Samples will be packaged on ice and shipped in a container able to maintain a temperature at or below 4°C.

6.0 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) requirements include, but are not limited to, blind field duplicates, blind rinsate blanks, and blind field blanks. These samples will be collected on a frequency of one QA/QC sample per 20 field samples or a minimum of one QA/QC sample per day unless otherwise specified in the project specific sampling plan.

7.0 Documentation

The groundwater sampling program will be documented to provide a summary of the sample collection procedures and conditions, shipment method, the analyses requested and the custody history. Such documentation shall include:

- Field notebook
- Groundwater sample collection record
- Sample labels
- Chain-of-custody forms
- Shipping receipts
- Health & Safety forms (JHA, STAR, and/or Site-Specific HASP amendments)

All documentation shall be placed in the project files and retained following completion of the project.

The RETEC Group, Inc.
Groundwater Sampling Form

PROJECT ______________________ WELL NO.______________________
PROJECT NO. ______________________ SAMPLERS______________________

1. WELL CONDITION CHECKLIST:

a. Bump posts____________ Prot. casing/lock__________ Surface pad__________
b. Well visibility (paint)____________
c. Well label____________

2. WATER LEVEL MEASUREMENT:

DATE______________________ TIME______________________
WEATHER CONDITIONS______________________
a. Location of measuring point______________________
b. Depth of water table from measuring point______________________
c. Height of measuring point above ground surface______________________
d. Total depth of well below measuring point______________________
e. Length of water column (line 2d-2b)______________________

3. WELL PURGING:

DATE______________________ TIME______________________
WEATHER CONDITIONS______________________
a. Purge method______________________
b. Required purge volume at 3 well volumes______________________

Pumping Duration	Volume Rmvd.	pH	Redox	Cond.	T(C)	Color	Turbidity

4. SAMPLE COLLECTION:

DATE______________________ TIME______________________
WEATHER CONDITIONS______________________
a. Collection method______________________
b. Meter calibration Date Model
pH meter______________________
D.O. meter______________________
c. Sample information pH__________ Cond.__________ T(C)__________ Turbidity__________

Analysis	Containers	Sample Prep./Preservation

d. Chain of custody form______________________ COC tape______________________
e. Shipping container______________________

5. COMMENTS:______________________
____
____

RETEC Standard Operating Procedure (SOP) 260
Lake and Stream Sediment Sampling

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 260 describes sampling of sediments from stream and lake bottoms. Lake and stream sediment sampling is performed to define the chemical, physical, and/or biological composition of the sediments. Sediment samples may be obtained directly from shallow, slow moving waters using trowels or shovels or from deep water bodies using dredge/clam shell type samplers.

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, Job Hazard Analysis (JHA), Safety Task Analysis Review (STAR), or Site-Specific Health & Safety Plan (HASP) will take precedence over the procedures described in this document.

2.0 Responsibilities

The project manager is responsible for ensuring that a properly designed sampling program is prepared prior to any sample collection. The field sampling coordinator will have the responsibility to oversee and ensure that all sediment sampling is performed in accordance with the project-specific sampling program and SOP 260. In addition, the field sampling coordinator must ensure that all field workers are fully apprised of SOP 260.

3.0 Health and Safety

This section presents the generic hazards associated with lake and stream sediment sampling and is intended to provide general guidance in preparing site-specific health and safety documents. The site-specific HASP, JHA, and STAR will address additional requirements and will take precedence over this document. Note that lake and stream sampling usually requires Level D personal protection unless there is a potential for exposure to airborne site contaminants.

Health and safety hazards include but are not limited to the following:

- Slip, trips, and falls in tall grasses over obstacles, and muddy conditions or side slopes near stream banks. Review terrain hazards prior to conducting these operations. Ensure there is a safe means of access/egress to the sampling location.

- Dermal exposure to potentially contaminated sediment. Ensure that proper personal protective equipment (PPE) is used to mitigate the impact of splashes of water or sediment to skin and/or eyes.
- Ergonomics. Use appropriate ergonomic techniques when inserting or retrieving equipment from the lake or stream to preclude injury to the arms, shoulders or back.

4.0 Supporting Materials

The following materials must be on hand in sufficient quantity to ensure that proper sampling procedures may be followed.

- Project-specific sampling program
- Personal protection equipment as specified in the Project Health and Safety Plan
- Paper towels or chemical-free cloths
- Coolers and ice
- Dredges (e.g., Ponar) and rope
- Sample bottles, containers, and labels
- Sampling implements (e.g., spoons, scoops, etc.)
- Decontamination equipment and solutions
- Field data sheets and field book
- Waders or boat
- Measuring tape
- Boating safety gear (e.g., life jackets)
- Material Safety Data Sheets (MSDSs) for any chemicals or site-specific contaminants
- A copy of the site-specific HASP

5.0 Methods and Procedures

Select sample locations and method(s) in accordance with the project-specific sampling plan. Determine and record the depth of water at each sample location. Collect samples using appropriate sampling equipment and proper health and safety gear.

Refer to SOP 210 for guidance when using a trowel or shovel. Retrieve the sample slowly and carefully through the water column to minimize sample loss. If using a dredge, first secure the rope to the dredge. Open the dredge and lock it into position. Slowly lower the dredge through the water column to the bottom sediments. Close the jaws of the dredge by jerking the dredge rope once or twice. Pull the dredge back up through the water column at a steady, even pace. Repeat if sediment recovery is inadequate. Several attempts may be necessary to obtain sufficient sample volume. If, after several attempts, sample volume is still inadequate, adjust the sampling location. All equipment will be decontaminated after each use following procedures outlined in SOP 120.

Specific procedures pertaining to the handling and shipment of samples shall be in accordance with SOP 110. A clean pair of gloves and decontaminated sampling tools will be used when handling the samples during collection to prevent cross contamination. A representative sample will be placed in the sampling container using a clean implement such as a scoop, spoon or tongue depressor. Sample containers shall be labeled with the following information:

- Client or project name, or unique identifier, if confidential
- Unique sample description (i.e., sampling point number and horizontal/vertical location)
- Sample collection date and time
- Sample collector's name or initials
- Analysis to be performed

These data shall be recorded on the sediment sampling form (Figure 1) and/or field book.

If sampling from a boat, all appropriate boating safety regulations must be understood and followed by the sampling crew.

6.0 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) requirements include, but are not limited to, blind field duplicates, blind rinsate blanks, and blind field blanks. These samples will be collected on a frequency of one QA/QC sample per 20 field samples or a minimum of one QA/QC sample per day unless otherwise specified in the project-specific sampling plan.

7.0 Documentation

Documentation may consist of all or part of the following:

- Sediment sampling forms
- Field log book
- Chain-of-custody forms
- Shipping receipts
- Health and Safety forms (JHA, STAR, and/or site-specific HASP amendments)

Field records should contain sufficient detail which provide a clear understanding how and where samples were taken. A description of sediments using the Unified Soil Classification system should be included. All documentation shall be placed in the project files and retained following completion of the project.

Figure 1 Sediment Sampling Form

The RETEC Group, Inc.
SEDIMENT SAMPLING FORM

PROJECT________________________________ SAMPLE NO.______________________
DATE________________ TIME___________ SAMPLED BY______________________
WEATHER CONDITIONS____

SAMPLE LOCATION____
SAMPLE TYPE GRAB________________ COMPOSITE______________________
SAMPLE DEPTH____
SURFACE WATER FLOW RATE____
SURFACE WATER TYPE____
SAMPLE CONDITION (i.e. odor, oily)____________________________________
____

SAMPLE COLLECTION
COLLECTION METHOD____
COLLECTION TIME____

ANALYSIS	CONTAINERS	SAMPLE PREP/PRESERVATION

CHAIN OF CUSTODY FORM____________________ COC TAPE____________________
SHIPPING CONTAINER____

COMMENTS____
____
____

RETEC Standard Operating Procedure (SOP) 250
Surface Water Sampling

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 250 describes the basic techniques and general considerations to be followed for the collection of Surface Water samples from rivers, lakes, and ponds. Specific details of actual sample collection are highly dependent upon local conditions as well as upon the purpose of the water quality study. Nevertheless, certain aspects of sample collection procedures are independent of project-specific variations.

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, Job Hazard Analysis (JHA), Safety Task Analysis Review (STAR), or Site-Specific Health & Safety Plan (HASP) will take precedence over the procedures described in this document.

2.0 Responsibilities

The project manager is responsible for ensuring that a properly designed sampling program is prepared prior to any sample collection. The field sampling coordinator will have the responsibility to oversee and ensure that all surface water sampling is performed in accordance with the project specific sampling program and this SOP. In addition, the field sampling coordinator must ensure that all field workers are fully apprised of this SOP.

3.0 Health and Safety

This section presents the generic hazards associated with surface water sampling and is intended to provide general guidance in preparing site-specific health and safety documents. The site-specific HASP, JHA, and STAR will address additional requirements and will take precedence over this document. Note that surface water sampling usually requires Level D personal protection unless there is a potential for exposure to airborne site contaminants.

Health and safety hazards include but are not limited to the following:

- Slip, trips, and falls in tall grasses over obstacles, and muddy conditions or side slopes near stream banks. Review terrain hazards prior to conducting these operations. Ensure there is a safe means of access/egress to the sampling location.

- Dermal exposure to potentially contaminated water. Ensure that proper personal protective equipment (PPE) is used to mitigate the impact of splashes of water to skin and/or eyes.

- Ergonomics. Use appropriate ergonomic techniques when inserting or retrieving equipment from the lake or stream to preclude injury to the arms, shoulders or back.

4.0 Supporting Materials

The following materials must be on hand in sufficient quantity to ensure that proper sampling procedures may be followed:

- Project specific sampling program
- Personal protection equipment as specified in the Project Health and Safety Plan
- Sample containers, labels, and preservatives
- Decontamination equipment and solutions
- Paper towels or chemical-free cloths
- Coolers and ice
- Field equipment as specified in the sampling program, the corresponding manufacturer's manuals, and the appropriate calibration standard
- Vertical or horizontal type samplers;
- Boat or raft
- Weighted tape measurer or rigid gage
- Field data sheets and field
- Material Safety Data Sheets (MSDSs) for any chemicals or site-specific contaminants
- A copy of the site-specific HASP

5.0 Methods and Procedures

The following describes methods and procedures required to collect representative Surface Water samples.

5.1 Sample Location Selection

Selecting a precise sampling location requires professional judgment and an understanding of the purpose of the study. Sampling locations where mixing is incomplete should be avoided if an average composition is required. Often areas of poor lateral or vertical mixing can be visually identified. For example, color or turbidity differences may be apparent immediately below the confluence of a tributary and the main river or at a wastewater discharge point. Use of a field conductivity meter is recommended for determining the uniformity of the water composition across the width and depth of the water body. Once the sampling point has been selected, it must be fixed by detailed description, maps, or with the aid of stakes, buoys, or other landmarks so that others can identify the sampling location.

5.2 Stream Sampling

In shallow streams (those which can be safely traversed on foot) the sample container can be filled directly with the flowing water. In deep rivers, a boat or raft will usually be required to obtain a representative sample. Unless otherwise specified in the project specific sampling plan, samples should be collected at the mid-depth section or deepest flow channel of the stream.

Stream depth and discharge need to be recorded. Stream depth can be determined using a depth sounder or by physical measurement with a heavily weighted flexible measuring tape or a rigid gage. Stream velocity measurements can be collected using a Marsh-McBirney Model 2000 portable flowmeter or similar instruments, and top setting wading rod at the gaging stations. The discharge at the gaging stations can be calculated by determining the mean flow velocity across a stream cross- section and multiplying this by the cross-sectional area as measured with a tape and the wading rod at that point. The top setting wading rod should be used to place the velocity sensor at 60 percent of total water depth as measured from the water surface. This is the same stream gaging method employed by the U.S. Geological Survey (1977). A vertical or horizontal type sampler should be used for collecting samples at a specific depth in the water column.

5.3 Lake and Pond Sampling

Water in lakes and ponds is generally poorly mixed and thermal stratification is frequently observed, Single samples can only represent the specific spot from which they were obtained. For many studies, samples collected at the inlet(s) and/or outlet(s) of the lake or pond are of the most interest. In other studies, a grid is established over the lake or pond and samples are collected at grid line intersections. As with deep rivers, a horizontal type sampler should be used for sample collection.

5.4 Sample Handling and Preservation

In general, the shorter the time lapse between sample collection and analysis, the more reliable the results will be. Certain water quality parameters, especially pH, temperature, and dissolved oxygen, are so closely related to the environment of the water that meaningful results can only be obtained by in-situ field measurements.

Specific procedures pertaining to the handling and shipment of samples shall be in accordance with SOP 110. A clean pair of gloves and decontaminated sampling tools will be used when handling the samples during collection to prevent cross contamination. A representative sample will be placed in the sampling container. Sample containers shall be labeled with the following information:

- Client or project name, or unique identifier, if confidential
- Unique sample description (i.e., sampling point number and depth)
- Sample collection date and time
- Sampler's name or initials
- Analyses to be performed

These data shall be recorded on the Surface Water Sampling form (Figure 1) and/or field book.

Prior to transport or shipment, Surface Water samples may require preparation and or preservation. Field preparation may entail filtration, or preservation in the form of chemical additives or temperature control. Specific preservation requirements will be described in the project specific sampling plan.

Surface Water samples collected for dissolved metals analyses will be filtered prior to being placed in sample containers. Groundwater filtration will be performed using a peristaltic pump and a 0.45 micron water filter unless specified otherwise in the project specific sampling plan. For most dissolved metal analyses, pH adjustment of the sample is also required and shall be performed after filtration.

6.0 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) requirements include, but are not limited to, blind field duplicates, blind rinsate blanks, and blind field blanks. These samples will be collected on a frequency of one QA/QC sample per 20 field samples or a minimum of one QA/QC sample per day unless otherwise specified in the project specific sampling plan.

7.0 Documentation

There are several documents that must be completed and maintained as part of the Surface Water Sampling procedure. The documents will provide a summary of the sample collection procedures and conditions, shipment method, the analyses requested, and the custody history. The documents may include:

- Field log book

- Surface Water Sampling forms
- Sample labels
- Chain of custody
- Shipping receipts
- Health and Safety forms (JHA, STAR, and/or site-specific HASP amendments)

The field record should be of sufficient detail to allow others to understand how and where samples were taken. All documentation will be retained in the appropriate project files.

8.0 References

U.S. Geological Survey, 1977, National Handbook of Recommended Methods for Water-Data Aquistion, U.S. Dept. of Interior, Virginia.

Figure 1 Surface Water Sampling Form – Page 1

Figure 1 sampling form – page 2

The RETEC Group, Inc.
SURFACE WATER MONITORING FIELD LOG

PROJECT____________________ SAMPLE ID__________

DATE________ TIME from:______ to:______ SAMPLED BY__________

WEATHER (LAST PRECIP, TEMP, ETC.)____________________

1. SURFACE WATER SAMPLE COLLECTION

a. Collection Method (circle): grab, composite, other____________________

b. Description of surface water body (stream, pond, lagoon, culvert, etc.) and general condition (turbidity, odors, sheen, plants, animals, etc.):____________________

c. Stream (etc.) Width at Collection transect____________________

d. Distance of Collection Point. from which stream bank:____________________

e. Total Depth @ Collection Point.:__________ Collected fr. Depth__________

f. Water Chemistry: pH________ Cond.(umhos/cm)________ Temp.(°C)________ Other________

g. Collection Time:____________________

h. Analysis and Container Information:

ANALYSIS & METHOD NO.	CONTAINERS: QTY, VOLUME,	PRESERVATION

2. SAMPLE CUSTODY AND SHIPPING

a. Entered on Chain-of-Custody Form?__________ C.O.C. Seal/Tape?__________

b.Shipping Date & Method____________________

COMMENTS____________________

The RETEC Group, Inc.
SURFACE WATER MONITORING FIELD LOG, Page 2 of 2

3. SURFACE WATER FLOW MEASUREMENT

a. Measurement Location/Station______________________________

b. Measurement Method/Equipment Used______________________________

c. Upstream section: sand, weeds, cobbles, boulders, other______________________________

d. **Flow (circle)**: even, uneven (turbulent).

e. Description of Gage Measuring Points:______________________________

____

f. **Surface Water Stage (circle)**: low, average, high;

steady, falling, rising, peak.

BEFORE SAMPLING:

TIME	WATER DEPTH / HEIGHT RELATIVE TO GAGE	CALCULATED HEAD	CALCULATED FLOW
AVG.DEPTH:			

AFTER SAMPLING:

AVG.DEPTH:			

COMMENTS______________________________

Appendix B

Additional Field Forms

ThermoRetec
Smart Solutions. Positive Outcomes.

Pg.______ of______

DRUM INVENTORY FORM

Date ______________ Project No. ______________ Field Eng. ____________________

Client ______________ Project Name. _____________ Project Location:_________________

Drum No.	Date Sealed	Drum Contents	Storage Location

The RETEC Group, Inc.

Fluorescence Log

Project Name:
Project Number:
Client:
Instrument Type:
Serial Number:

Borehole ID	Date	Time	Depth Interval (ft bgs)	Fluorescence Yes/No	Description

ThermoRetec
Smart Solutions. Positive Outcomes.

Field Photogragh Log

Date ____________________ Client ____________________

Project No. ____________________ Photographer ____________________

Roll of Film No. ____________

Photo No.	Bore Hole ID	Time	Depth Interval	Notes

Field Equipment Calibration/Maintenance Log

Client: Alaska Railroad Corporation

Location:

Project Mgr

Project No.:

Site Eng.:

Site EHS Officer:

Date	Type of Equipment[1]	Equipment ID Number	Procedure[2]	Reference Standards[3]	Initials of Individual	Company	Calibration OK Yes/No

Maintenance Required/Procedures:

1Certifications or statements of manufacturer calibration can be obtained from RETEC office files.

2 Use space below if necessary.

3 Type of calibration gas used and concentration; buffer solutions, etc.

Appendix C

Modified ASTM 2488: Soil Logging Procedure

Modified ASTM 2488: Soil Logging Procedure

Each description should contain the following elements as applicable:

	Element	Example
1	Group Name and Symbol*	Sandy silt
2	Color	Dark greenish gray (5GY,4/1)
3	Content	30% sand, 70% silt
4	Particle size range (coarse grains only)	Very fine to medium
5	Particle angularity (coarse grains only)	Subrounded to subangular
6	Particle shape (coarse grains only)	Elongated
7	Plasticity of fines (fines only)	Medium plasticity
8	Odor	Moderate odor
9	Moisture	Very moist
10	Sheen	Slight
11	Reaction to HCl - optional	Weak
12	Consistency	Firm
13	Structure (if present)	Laminated
14	Additional comments (as applicable)	Trace black staining throughout core

* Put symbol in the appropriate column on the log form.

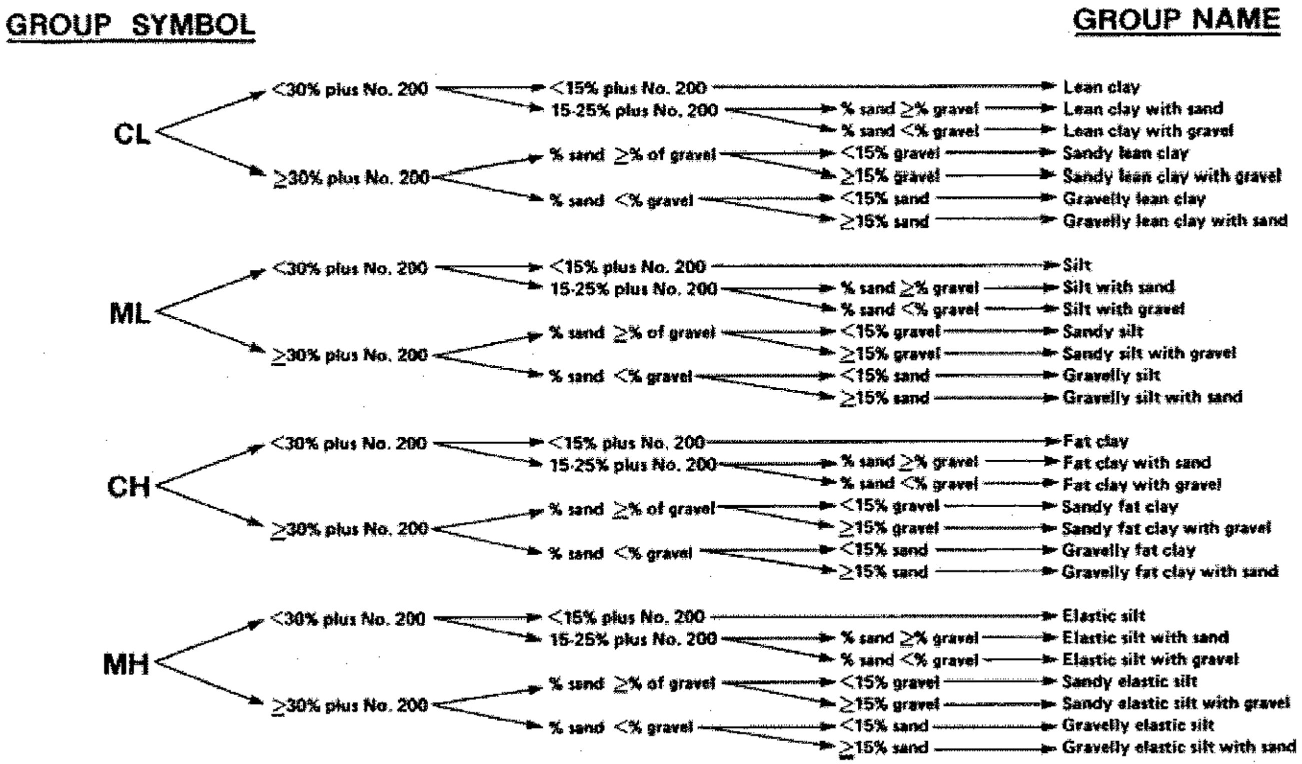
Examples

ML **Sandy Silt**: Dark greenish gray (5GY, 4/1); 30% very fine to medium, elongated subrounded to subangular sand; medium plasticity; moderate odor; very moist; slight sheen; weak reaction to HCl; firm; laminated; trace black staining throughout core.

SP **Sand**: Brown (7.5YR, 4/3); very fine to fine, flat, rounded grains with trace clay; no odor; wet; no sheen; strong reaction to HCL; dense; caliche layering.

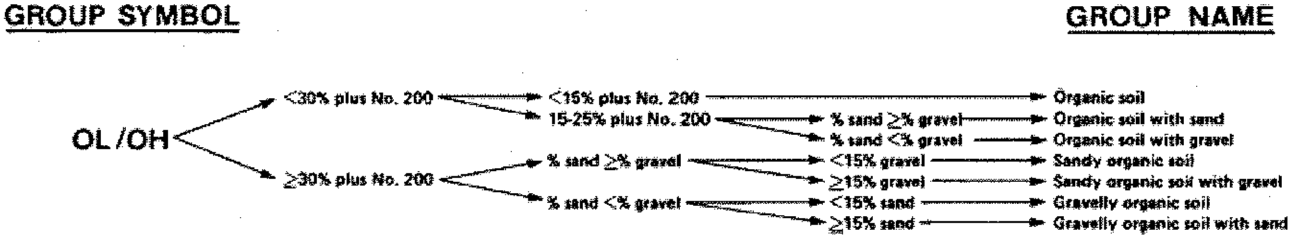
CL/ML **Silty Clay:** Dark bluish gray (5B/4/1); 55% clay, trace very fine elongated, angular sand in <1/8" interbeds; high plasticity; no odor; moist; no sheen; no reaction to HCl; hard.

1. **Group name** – Examples: silty sand, lean clay
For identifying fine-grained soils use the following flowchart (>50% fines):



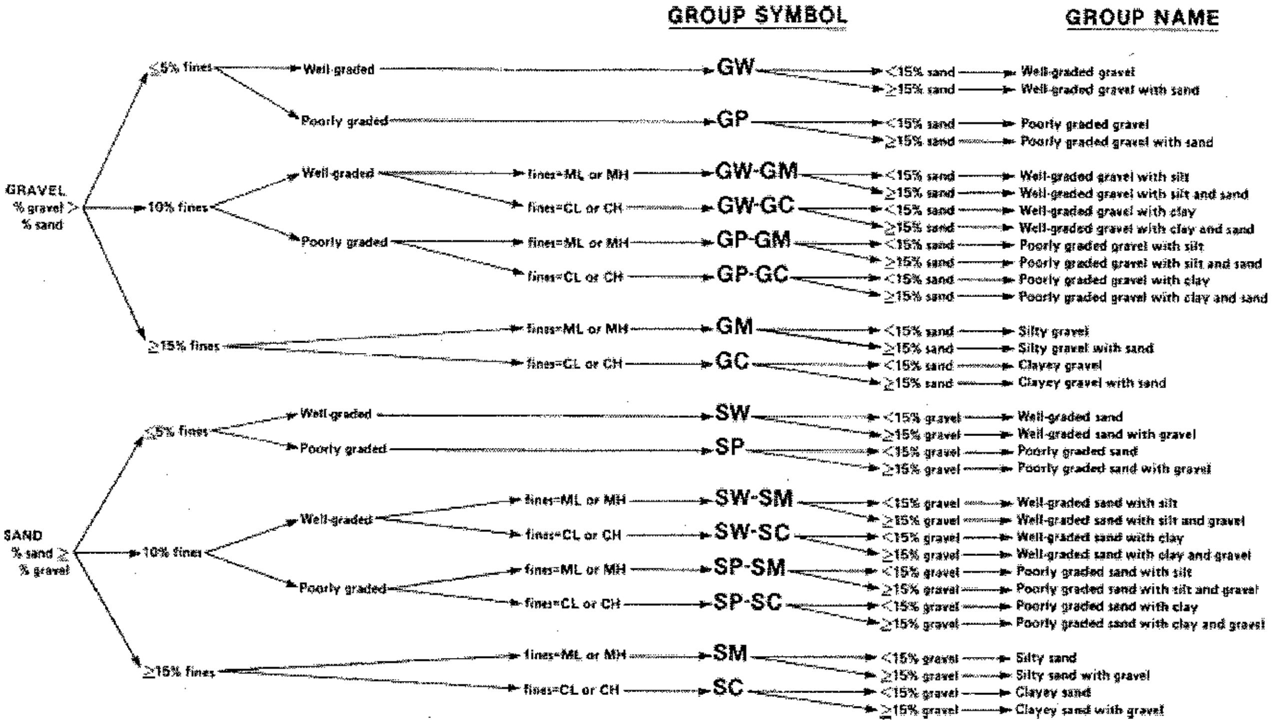
NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

For identifying coarse-grained soils use the following flowchart (<50% fines):



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

The following is the procedure to use for identifying a borderline soil with two possible classifications. Use a borderline symbol (ML/CL, SP/SM) when:

- The percentages of the constituents are estimated to be about the same (e.g. between 45 and 55%).
- The soil could be either poorly graded or well graded.
- The soil could be a silt or a clay.
- A fine-grained soil has properties that indicate it is at the boundary between a soil of low compressibility and a soil of high compressibility.

The group name for a soil with a borderline symbol should be the group name for the first symbol that is the dominant constituent.

<u>Example:</u> Silty clay = CL/ML or Clayey silt = ML/CL

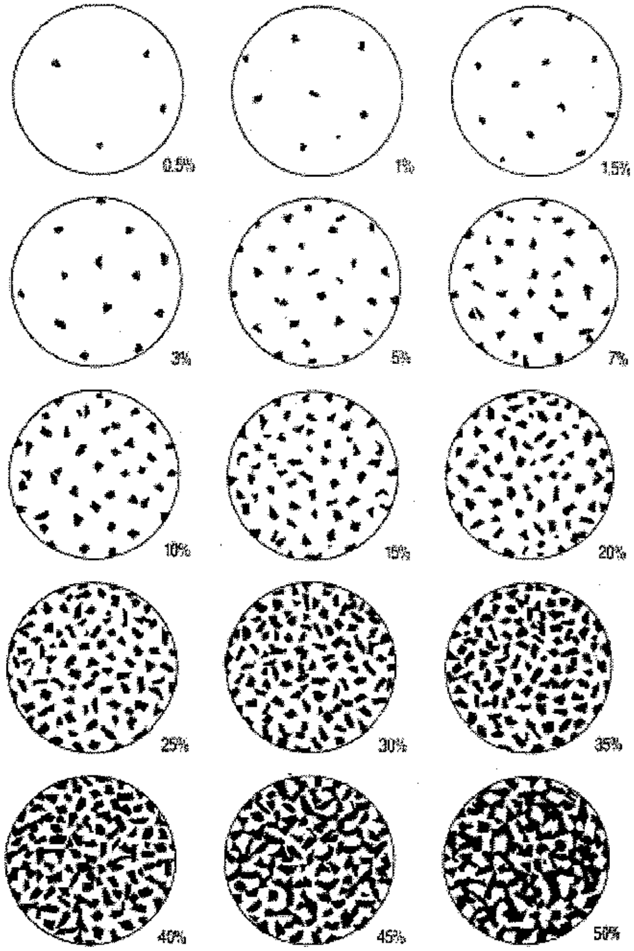
2. **Color** – Color from the Munsell soil color chart

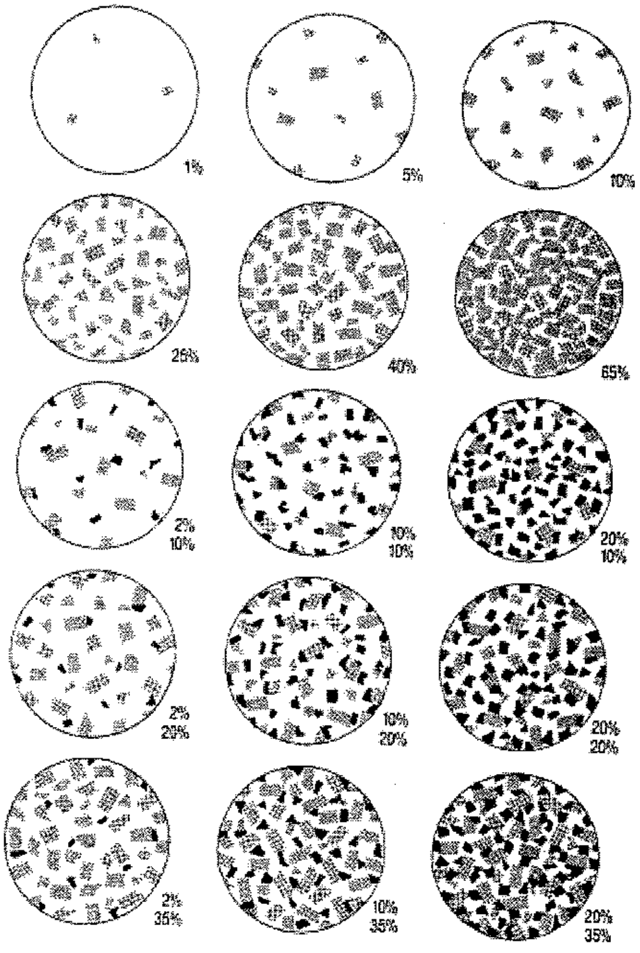
Non-gley soils:
- Take the code from the tab (7.5YR)
- Locate the color on the chart
- Take the number from the left side of chart (4)
- Take the number from the bottom of the chart (/2)
- The final color will then be: brown (7.5YR, 4/2)

Gley soils:
- Locate the color on the gley chart
- Take the code from the bottom of the chart (5GY)
- Take the number from the left key page (3/1)
- The final color will then be: very dark greenish gray (5GY, 3/1)

Special Soil Color Characteristics	
Mottled	Marked with spots or blotches of different color or shades of color
Caliche	A crust of calcium carbonate that forms on the stony soil of arid regions. Can be mottled or in layers.

3. **Content** – Percentages of each constituent
Use the following chart to estimate the percentage of each constituent in the sample.



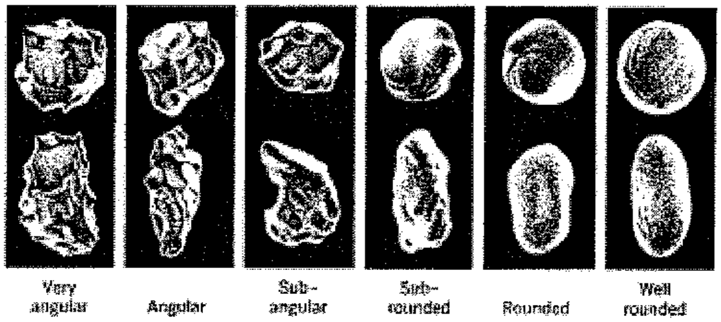


4. **Particle size range** – (Coarse grains only)

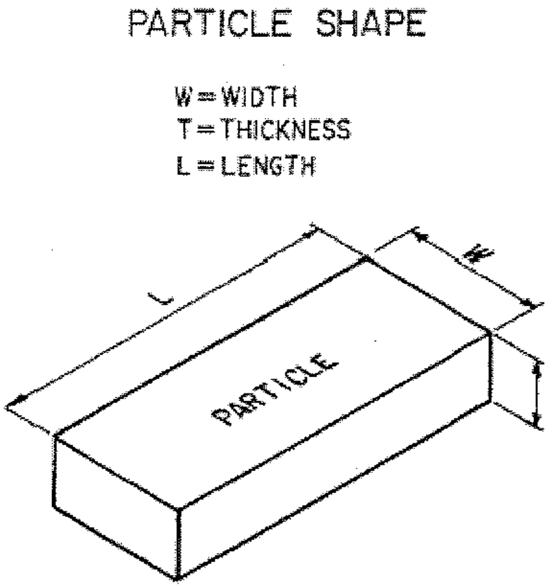
Using the following table determine the size range of the coarse-grained sediments in the sample.
See the grain size card provided for visual representation of grain size.

Component	Fraction	Upper limit	Lower Limit
Gravel	Coarse	3 in	1 in
	Medium	1 in	3/4 in
	Fine	3/4 in	0.08 in
Sand	Coarse	0.08 in	0.02 in
	Medium	0.02 in	0.01 in
	Fine	0.01 in	0.003 in
Silt	-	0.003 in	

5. **Particle angularity** – (Coarse grains only)
Using the following figure determine the angularity of the coarse-grained sediments in the sample.



6. **Particle shape** – (Coarse grains only)
Using the following picture and chart, determine the shape of the particle.



The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle respectively.

Flat	Particle with width/thickness >3.
Elongated	Particles with length/width >3.
Flat & elongated	Particles meet criteria for both flat and elongated.

7. **Plasticity** – (Fine-grained only)
Shape the sample into an elongated pat and roll by hand on a smooth surface or between the palms into a thread about 1/8" in diameter. (If sample is too wet to roll, flatten and let some of the moisture evaporate.) Reroll repeatedly until the thread crumbles at 1/8" diameter. Then lump the pieces together and knead until the lump crumbles. The plastic limit is when the lump crumbles.

Using the following table, describe the plasticity of the sample:

Description	**Criteria**
Nonplastic	A 1/8" thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

8. **Odor** - Note odd odors and rate the strength of the odor: slight, moderate, strong.

9. **Moisture** - Describes the moisture within the soil sample.

Description	**Criteria**
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below the water table

10. **Sheen** – Describes the availability of free product in a sample.

Take 2-3 tablespoons of sample, place in a 4 or 8 oz glass sample jar filled with water. Stir or shake the sample; use the following table to describe the sheen on the top of the water.

Description	**Criteria**
No sheen	Surface of water is free of any sheen.
Light sheen	Surface of the water has a slight evidence of sheen. Appears as one to numerous light spots or as a thin film partially covering the water surface.
Moderate sheen	Surface of the water has obvious sheen. Appears as a thin film covering the water surface.
Heavy sheen	Surface of the water has droplets of product floating on the surface. Usually indicative of a LNAPL bearing layer.

11. **Reaction to HCl** – Describes how a sample reacts to hydrochloric acid.

Description	**Criteria**
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

12. **Consistency** – Describes the density and/or compressive strength of the sample. For coarse-grained samples using the following:

- Very loose
- Loose
- Medium dense
- Dense
- Very dense

For fine-grained samples use the following table:

Description	Criteria
Very soft	Thumb will penetrate soil more than 1".
Soft	Thumb will penetrate soil about 1".
Firm	Thumb will indent soil about 1/4".
Hard	Thumb will not indent soil but readily indented with thumbnail.
Very Hard	Thumbnail will not indent soil.

13. **Structure** – Describes structural features when present.

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6mm thick, note thickness.
Laminated	Alternating layers of varying material or color with layers less than 6mm thick, note thickness.
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Homogenous	Same color and appearance throughout sample.

14. **Additional Comments** - Hydrocarbon staining, iron staining, caliche layers, trace shells, plant material, fossils

References:

ASTM International, D 2488-00, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure),* February 2000.

Compton, Robert R., *Geology in the Field, 1985.*

Boring ID:
Sheet 1 of

The RETEC Group, Inc.
Soil Boring Log

Project:	**Contractor:**	**Boring Location:**
Project #:	**Operator:**	
Location:	**Rig Type:**	
Client:	**Method:**	
Start Date:	**Sampling Method:**	
End Date:	**Boring Diameter:**	
Geologist:	**Total Depth:**	
Reviewed by:	**Water Level:**	

					Coarse Grained Soils Only				**Fine Grained Soils Only**													
Depth	**Group Symbol**	**Group Name**	**Color**	**Content**	**Grain Size**	**Grain Angularity**	**Particle Shape**	**Compactness**	**Dilatency**	**Toughness**	**Plasticity**	**Dry Strength**	**Consistency**	**Odor**	**Moisture**	**Sheen**	**Structure**	**Additional Comments (Reaction with HCl, cementation of intact coarse-grained soils etc)**	**PID (ppm)**	**Sample Interval**	**%Recovery**	**Sample ID Number**

Form Version: 1
Reviewed By: Stan Flagel
Last Revision: 3/28/05

Appendix D

Historical Data Summary

List of Tables (Located on Enclosed CD)

Sediment (Freshwater and Marine)

Surface Water (Freshwater and Marine)

Groundwater

List of Tables (Located on Enclosed CD) - *continued*

Soil

Existing Site Data Summary

This section provides a summary of historical (or existing) Site data by media. The discussion is organized to reflect the site-wide approach to the investigation, and thus does not include a property-by-property discussion of existing conditions. A detailed discussion of data by property was included in the SBR (RETEC, 2004f).

The distribution of compound concentrations exceeding preliminary screening levels is discussed by media in the following subsections and focuses on a series of figures and tables. Work Plan Figures 2-8 through 2-11 show the distribution of exceedences by media and the tables in this appendix provide supporting data. The tables (included on the CD in this Appendix) are organized by media and for each media include: 1) summary of data for each compound (including the total number of samples analyzed, the number of detections and exceedences, and the range of detected concentrations); 2) a listing of the specific compounds that exceeded preliminary screening levels at each sampling location shown on Work Plan Figures 2-8 through 2-11; and 3) all historical results from the database. The tables showing the historical results are further organized by analyte class (VOCs, SVOCs, metals, etc.).

For ease of locating samples on the maps and tables, groundwater and soil results are grouped according to the six soil study areas used in the SBR (RETEC, 2004f), or according to location (e.g., Bluffs) if they fall outside one of the six areas. Sediment and surface water results are grouped according to whether the samples are located above or below the Knik Arm Power Plant (LP-120) (KAPP) dam (freshwater or marine conditions, respectively).

The figures and tables of existing data that are presented in this Work Plan and appendix represent the most recent data available at each sample collection location (with the exception of the tables that show the complete historical results). For each medium, the database was queried to find the most recently collected sample for each analyte class (e.g., VOCs, SVOCs, metals, etc.) at each location. Groundwater and surface water sample locations are more likely to have multiple samples collected on different dates than are soil or surface water samples. While this ensures that the figures, summary tables, and exceedence tables present the most current data available at each location, it does not represent a data set collected from a single period of time (i.e., data shown represents data collected from various years). For each sample collection location, the most recent date for each analyte class was used (rather than just the most recent date) because all compounds were not necessarily analyzed each time a sample was collected at a sampling location.

All historical data were compared to preliminary screening levels as a means of identifying potential source areas to help focus the scope of the investigation. As described in Section 4.1.1, the screening levels applied here are preliminary and may or may not be the screening levels that are applied in the human health and ecological risk assessments (RA) upon completion of the RI (RA screening levels will be developed in the RA Work Plan). All investigation compounds are summarized in Work Plan Tables 2-1 and 2-2 along with the respective preliminary screening level used for comparison to historical (or existing) data for the Site. All compound detections for which no applicable screening level was available are presented in this section as exceedences, with the exception of metals. Because many metals are naturally occurring at the Site at low levels, only detections that exceeded an actual screening level were identified as exceedences. In addition, background levels for metals were evaluated for each media. If applied, the derivation of background levels is described further in the section for that media. All background sample locations are identified on Work Plan Figure 3-5.

Work Plan Figures 2-8 through 2-11 are maps showing the spatial distribution of exceedences at the Site for each media. These figures show the locations at which *any* compound exceeded a screening level. Included at the bottom of each figure is a summary table showing the exceedences for each location by analyte class, as well as the date the sample was collected. These tables provide a high-level look at what kinds of compounds exceeded at each location.

Tables D-1, D-17, D-32, and D-40 provide further detail on the exceedences shown on Work Plan Figures 2-8 through 2-11. Each table lists the actual compounds that exceeded screening levels at each location, and their respective screening levels and concentrations. Note that several of the compounds shown on these tables do not actually have screening levels and are included because there was a detection of that compound.

Tables D-2, D-3, D-18, D-19, D-33, and D-41 present a summary of data by media. The tables are organized by analyte class and give an overview of which kinds of compounds most frequently exceed at the site. Again, note that detections of non-metal compounds that do not have a screening level are treated as exceedences.

Finally, all historical data for each media (not just the most current results) are presented in Tables D-4 through D-16 (sediment), D-20 through D-31 (surface water), D-34 through D-39 (groundwater), and D-42 through D-48 (soil). The tables are organized by analyte class. Each table is organized by study area for soil and groundwater, and by freshwater or Freshwater conditions for sediment and surface water.

Sediment and Surface Water

Ecological screening levels were used to evaluate concentrations in sediment and surface water. The KAPP (LP-120) dam divides the Ship Creek riparian zone into a marine-influenced zone (downstream of the dam) and a freshwater zone (upstream of the dam). Marine screening levels (Work Plan Tables 2-1 and 2-2) for sediment and surface water were applied to samples collected downstream of the dam and the freshwater screening levels (Work Plan Tables 2-1 and 2-2) were applied to samples collected upstream of the dam. Surface water samples collected from ditches or streams were compared to the freshwater screening levels.

Previous investigations have focused on known source areas of the Site. Consequently, the distribution of existing sediment and surface water data across the Site is not always uniform. As shown on Work Plan Figures 2-8 and 2-9, sediment and surface water samples tend to be clustered near the KAPP (LP-120) dam. Although sparse, distribution of other sediment and surface water samples along Ship Creek is fairly uniform.

Sediment

The majority of exceedences in sediment samples occur in the pond upstream of the KAPP (LP-120) dam and immediately downstream of the dam, as shown on Work Plan Figure 2-8. The table included at the bottom of Work Plan Figure 2-8 shows that samples collected in the KAPP (LP-120) pond exceeded screening levels for most of the analyte classes, including PCBs and pesticides. Exceedences in the dioxin/furan analyte class occurred only in the riparian area south of Arctic Cooperage (LP-991). Details about which compounds had exceedences at each sampling location may be found on Table D-1. Tables D-2 and D-3 provide summaries of freshwater and marine sediment data, respectively, and an overview of which compounds were most commonly detected and their exceedence frequencies.

Background metals for sediment were evaluated using results from upstream sample HC-05 (Work Plan Figure 3-5). Metals concentrations measured at this location were below the freshwater ecological screening levels for all metals, so background values were not applied to sediment. Unlike the other compounds discussed in this section, metals naturally occur in the environment at low levels. Therefore, detected metals were not treated as exceedences in the absence of a screening level. All sediment samples had an exceedence of at least one metal and metals exceedences account for many of the exceedences shown on Work Plan Figure 2-8. Individual metal detections that exceeded screening levels are identified in Table D-1.

Complete sediment analytical results are provided in Tables D-4 through D-16.

Surface Water

As with sediment, most surface water exceedences occurred in the pond above the KAPP (LP-120) dam and in the area immediately downstream of the dam (Work Plan Figure 2-9). As shown on the table at the bottom of Figure 2-9, the majority of surface water exceedences are VOCs and metals. There are no exceedences of PCB or Pesticides in surface water. No surface water samples were analyzed for dioxins. Table D-17 lists actual compounds and concentrations of exceedences. Tables D-18 and 19 provide further details on which compounds had the highest detection and exceedence frequencies for freshwater and marine surface water samples, respectively.

Background metals for surface water were evaluated using time series results from upstream sample location EL-SC-6 (Work Plan Figure 3-5). Background concentrations for aluminum, barium, cadmium, and silver were determined to be higher than the freshwater ecological screening levels. For the marine screening levels, only aluminum background concentrations were higher than the screening level. The background concentration was determined by taking two times the average concentration or the maximum whichever is lower (U.S. EPA, 2000b). Unlike the other compounds discussed in this section, metals naturally occur in the environment at low levels. Therefore, detected metals were not treated as exceedences in the absence of a screening level. Many surface water samples had an exceedence of at least one metal. Individual metals detections that exceeded screening levels are identified in Table D-17.

Complete surface water analytical results are provided in Tables D-20 through D-31.

Groundwater

U.S. EPA Region IX Tap Water Preliminary Remediation Goals (PRGs) (U.S. EPA, 2004c) were used as the preliminary screening levels for the majority of compounds in groundwater. The ADEC Groundwater Clean-Up Level was used for GRO, DRO, and RRO. Background metals concentrations were evaluated using samples collected from springs along the upgradient north bluff. However, because the background concentrations in the spring samples were not higher than the PRG values used for screening levels, background values were not applied.

The distribution of exceedences in groundwater is shown on Work Plan Figure 2-10. Note that the distribution of exceedences is strongly influenced by the fact that previous sampling lacked temporal and analytical continuity. Previous investigations focused on known source areas of the Site, so the distribution of samples across the Site tends to be clustered. Similarly, the compound lists for previous investigations were frequently focused on compounds known or suspected to exist for a particular area of the Site or property.

The majority of sampling locations with exceedences in groundwater occur in the Terminals in Area 3 (LP-019, LP-007, LP-005, LP-025, LP-027, and LP-004), the Princess Cruises area (LP-065/RY-065), and the Arctic Cooperage Site (LP-991). In addition, some of the north bluff springs on the eastern end of the Site have exceedences. Table D-32 lists the actual compounds that exceeded and the detected concentration. Table D-33 provides an overview of the compounds that were most frequently detected or exceeded.

There were no groundwater exceedences for PCBs or pesticides. These compounds do not naturally occur and are only used in a limited number of industrial processes. Consequently, samples were only analyzed for these compounds at specific locations at the Site based on operational history. The table at the bottom of Work Plan Figure 2-10 shows which samples were sampled for these compounds.

Complete groundwater analytical results are provided in Tables D-34 through D-39.

Soil

The U.S. EPA *Region IX Industrial Soil PRGs* (U.S. EPA, 2004c) were used as the screening levels for the majority of compounds in soil. The ADEC *"Under 40 inch Zone" Method 2 Cleanup Level for Ingestion* (ADEC, 2004a) was used for GRO, DRO, and RRO. Note, soil sampling in areas with ecological habitat has not been conducted; future sampling will include comparison to ecological screening levels, where appropriate.

Background metals values for surface, root zone, and deep soils were derived in the EAFB Operable Unit 5 RI/FS (USAF, 1994) (Work Plan Figure 3-5). For this Work Plan, the upper tolerance limit values for each of those zones reported in the Operable Unit 5 RI/FS were averaged to define a general background level for each metal.

Background metals values were derived in the EAFB, Alaska Environmental Restoration Program: Basewide Background Sampling Report (USAF, 1993), as discussed in Section 3.5.1 of this Work Plan. These values, summarized in Work Plan Table 3-6, were applied as soil background concentrations for metals. The average of the values for the surface, root, and deep zones were compared to the screening level value. Using this method, only arsenic was determined to have a background value higher than the PRG screening level.

As part of the data evaluation for this Work Plan, the historic document library was reviewed to identify samples that had been removed by excavations in all areas except Area 3 (Area 3 excavation will be considered for the RI Report). The data corresponding to these samples were qualified in the database and are not included in this analysis, as they are results for soil that has been removed and are not representative of existing conditions at the Site.

Many of the excavation sites were designated no further action because limits of excavation samples indicated that concentrations in the remaining soils were below the applicable action levels. The preliminary screening levels used for the historic data evaluation presented in this Work Plan are frequently much lower than the action levels that were applied to the excavations. Therefore, confirmation samples from closed sites that were designated no further action are symbolized differently on the figures and are noted on the tables.

As with groundwater, historic soil samples were collected as part of investigations focusing on specific areas of the Site with known or suspected impacts. Consequently, the distribution of samples across the Site is not always uniform and the distribution of exceedences on Work Plan Figure 2-11 reflects this. Compound lists for previous investigations were frequently focused on compounds known or suspected to exist for that particular area of the Site or property.

Soil samples at a given location are typically collected on the same date but from different depths. This evaluation did not distinguish between soil samples collected from the surface and subsurface because information regarding the soil sample collection depth was unavailable for many historical soil samples. If there is an exceedence shown at a soil sample location, it represents the highest concentration for all depths sampled at that location. The exceedence summary provided in Table D-40 and the complete historical tables (Tables D-42 through 48) show the depth range of each sample, if known.

As shown on Work Plan Figure 2-11, the majority of sampling locations with exceedences in soil occur in the Terminals in Area 3 (LP-019, LP-007, LP-005, LP-025, LP-027, and LP-004), the Princess Cruises area (LP-065/RY-065), and the Arctic Cooperage Site (LP-991). This distribution is similar to that seen in groundwater. Most exceedences in soil are due to exceedences of VOCs, hydrocarbon fuels, or metals, as can be seen on the table included at the bottom of Work Plan Figure 2-11. A list of the actual compounds that exceeded screening levels is provided on Table D-40. An overview of the frequency at which specific compounds were detected and exceeded screening levels is provided in Table D-41.

Sampling for PCBs was concentrated in areas of known or suspected use areas. Because PCBs do not naturally occur in the environment and are used only in a limited number of industrial processes, the distribution of PCB samples is probably appropriate. The distribution of PCB samples and exceedences is represented on the table at the bottom of Work Plan Figure 2-11.

There were no soil exceedences for pesticides or dioxins/furans.

Complete soil analytical results are provided in Tables D-42 through D-48.