FINAL DATA GAPS WORK PLAN

8801 East Marginal Way South

Tukwila, Washington

AGREED ORDER Number 6069

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ABBREVIATIONS

8801 site	8801 East Marginal Way South property and adjoining sediments in the LDW
AMEC	AMEC Earth and Environmental Inc.
AS	air sparge
BEHP	bis(2-ethylhexyl)phthalate
bgs	Below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
cPAH	carcinogenic polycyclic aromatic hydrocarbons
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
FFS	Focused Feasibility Study
IAAI	Insurance Auto Auctions, Inc.
LDW	Lower Duwamish Waterway
MCH	Merrill Creek Holdings, LLC
NFA	North Fire Aisle
ORC©	oxygen-releasing compound
PACCAR	PACCAR Inc
PCBs	Polychlorinated biphenyls
COPC	Chemical of potential concern
PQL	practical quantitation limits
PSC	preliminary screening criteria
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SFA	South Fire Aisle
SVE	soil vapor extraction
SVOCs	Semivolatile organic compounds
SWS area	Southwest storage area
SWS	Southwest Storage
TBT	tributyl tins
UST	Underground storage tank
VOCs	Volatile organic compounds

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1.0 INTRODUCTION

AMEC Earth and Environmental, Inc., (AMEC) has prepared this Data Gaps Work Plan (work plan) on behalf of PACCAR Inc (PACCAR). This work plan recommends areas for further delineation of contaminants at the 8801 East Marginal Way South Site (8801 site) in Tukwila, Washington. The areas that require further delineation are discussed in the Draft Remedial Investigation (RI) Report that was submitted to Washington State Department of Ecology (Ecology) in 2010 (AMEC 2010) and in later correspondence with Ecology (Ecology 2011a). This work plan also incorporates Ecology's comments dated July 14, 2011on the draft data gaps work plan (Ecology 2011b).

The 8801 site consists of an upland portion (8801 property) and the adjoining sediments in the Lower Duwamish Waterway (LDW). The 8801 site is subject to two separate Agreed Orders: Agreed Order No. 6069, which applies to the 8801 property, and Agreed Order No. 3599, which applies to the sediments. This work plan fulfills the data gaps conditions in Agreed Order No. 6069. The LDW is designated as a Superfund site for sediments by the United States Environmental Protection Agency (EPA). Ecology is working with EPA to identify sources of contamination to the LDW.

1.1 BACKGROUND

The upland portion of the 8801 site occupies 24.30 acres on the east bank of the LDW at 8801 East Marginal Way South (Parcel 5422600060), Tukwila, Washington (Figure 1). The upland portion of the 8801 site is owned by Merrill Creek Holdings, LLC, (MCH) and is leased to Insurance Auto Auctions, Inc., (IAAI), which uses the 8801 site to store and auction damaged and wrecked vehicles.

Various consultants have performed field activities at the 8801 site since 1986. The field work undertaken since 1986 have included extensive, area wide, and focused investigations. As a result of the investigations 42 groundwater monitoring wells were installed and a large number of samples analyzed. Major remedial activities included removal of underground storage tanks (USTs), installation of a groundwater pumping and treatment system, contaminated soil excavation and disposal, application of oxygen-releasing compounds to the subsurface soil, storm-drain inspection and cleaning, and installation of an air sparge (AS) and soil vapor extraction (SVE) system.

An Interim Action Work Plan submitted to Ecology in 2008 (AMEC 2008) identified data gaps on the 8801 site. Since 2008, work on the LDW Superfund site has required cleanup levels on properties adjacent to the LDW to be revised to more stringent levels. AMEC revised preliminary screening criteria (PSCs) for the 8801 site to levels protective of the LDW sediment and surface water cleanup. The revised PSCs were applied to the entire list of chemicals analyzed at the 8801 site; the results were submitted to Ecology in the draft RI report in November, 2010 (AMEC 2010). After revisions, the final chemicals of potential concern (COPCs) for the 8801 site were agreed on in March, 2011 (Table 1).

1.2 OBJECTIVES AND SCOPE OF WORK

The objective of the work described in this work plan is to address the identified data gaps in order to commence the Focused Feasibility Study (FFS) for the 8801 site. COPC locations have primarily been identified at the 8801 site and therefore analysis detailed in this work plan focused specifically on the suite of chemicals relevant to the area identified (Table 1). Further sampling and analysis of soil, groundwater, and surface materials will more precisely identify the locations and extents of COPCs through the use of lower detection limits, will document the lateral and/or vertical extent of contamination, will evaluate impacts to groundwater through leaching, and will identify surface sources that may be contributing to chemicals detected in the storm water solids.

AMEC proposes the following scope of work to achieve these objectives:

- Analyze new samples for selected chemicals using lower reporting limits (where possible) to achieve significantly lower detection limits (see Table 1 for COPC location and chemical analysis detection and reporting level).
- Collect soil samples from 23 locations to evaluate lateral and/or vertical extent of known COPCs.
- Install 11 monitoring wells and collect groundwater samples to determine if chemicals are leaching into groundwater.
- Collect groundwater samples at 47 locations to evaluate the distribution of volatile organic compounds (VOCs) in groundwater across the 8801 site.
- Collect 8 bulk samples of paint, joint compounds, and mastic to determine if these surface materials are the source of tributyl tins (TBTs) and polychlorinated biphenyls (PCBs) in storm water solids collected from the site storm water control system.

The revised PSCs are significantly lower than detection limits for some of the chemicals previously detected at the 8801 site. The objective of using analytical methods with lower detections limits on

some samples is to determine whether trace levels of those chemicals are present. These lower detection limits are primarily related to vinyl chloride.

2.0 PAST INVESTIGATIONS, DATA GAPS, AND PROPOSED WORK

Before the FFS can begin, the contamination at the site must be completely characterized. This section summarizes the current knowledge of contamination on the site and proposes further work to close data gaps. The attached Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (Appendices A, B, and C, respectively) describe specifics of the proposed methodology, including quality control measures. This section is divided primarily by physical areas of the site (Figure 2), with the final two sections describing specific tasks spanning multiple areas.

2.1 SOUTH FIRE AISLE

The South Fire Aisle (SFA) contained six USTs, which were removed by 2004. Multiple investigations within the SFA have included an investigation at the eastern and western ends, beyond the area of the UST excavations. In 2004, excavation to the east of the former USTs, between the Manufacturing Building and the Administration Building, removed additional hydrocarbon-contaminated soil along the route of former railroad tracks. Oxygen-releasing compound (ORC©) was injected in 2004 along the western end of the area where the USTs had been located to remediate some residual petroleum hydrocarbons.

After the excavations, diesel- and lube-oil-range hydrocarbons were detected in the SFA at one location and lube-oil-range hydrocarbons were detected just north of the SFA at one location within the Manufacturing Building. Gasoline-range hydrocarbons were detected in two more locations in the vicinity of the lube-oil-range hydrocarbons (M4 and FWW-1). Contamination was delineated vertically in all four locations and laterally for all but the gasoline-range hydrocarbons. Groundwater samples, collected from cross- and down-gradient monitoring wells after the UST remediation activities in the SFA were completed, confirm that gasoline-, diesel-, and lube-oil-range hydrocarbons are not present in groundwater in elevated concentrations.

PCBs above the PSCs were identified in one soil sample on the eastern end of the SFA excavation. Slightly elevated levels of arsenic were also detected in the same area.

A storm drain lies north of the M4 and FWW-1 locations where gasoline-range hydrocarbons were detected. To delineate the northern extent of the gasoline-range hydrocarbons in soil, one soil boring will be advanced to the north of M4 to a depth of 10 feet below ground surface (bgs) (boring DG11-8, Figure 3). Two soil samples will be collected from the boring and analyzed for petroleum-range

hydrocarbons in the gasoline and diesel ranges and for benzene, toluene, ethylbenzene, and xylenes (BTEX). Samples will be collected from boring intervals where odor or visual indications of contamination are present. If no indications of contamination are present, one soil sample will be collected from near the surface and the other from just above the water table.

Two soil borings (DG11-9 and DG11-10) will also be advanced on the eastern end of the SFA excavation area. The borings will be advanced to a depth of 5 feet bgs. One soil sample will be collected from each boring for arsenic and PCBs analysis.

2.2 FORMER SOUTHWEST STORAGE AREA

The former Southwest Storage (SWS) area and the area to the south were within the LDW until they were filled in approximately 1967. The source of the fill material is unknown. The limits of the SWS area fill are as follows: to the north, the northern boundary of the former Monsanto property, acquired by Kenworth in 1966; to the south, the southern boundary of the 8801 site; to the west, the western boundary of the 8801 property; and to the east, a line approximately 36 feet east from the western boundary of the 8801 property. In 2007, IAAI undertook an excavation in the central part of the SWS area to install the new storm water treatment system. The excavated soil was disposed of offsite. Soil samples that were analyzed from the sidewall and base of the excavation did contain some chemicals above the PSCs.

Multiple chemicals have been detected in excess of their PSCs primarily in the northern portion of the SWS area, including diesel- and lube-oil-range hydrocarbons in soil, VOCs primarily in soil with limited groundwater occurrence, PCBs in soil and in one monitoring well, metals (arsenic, copper, lead, nickel, silver, and zinc) primarily in soil with some groundwater occurrences, bis(2-ethylhexyl)phthalate (BEHP) in soil and groundwater, and carcinogenic polycyclic aromatic hydrocarbons (cPAHs) in soil. Samples were collected north of the SWS area during the excavation for installation of the AS/SVE system. Some VOCs and metals were detected in the AS/SVE trench samples; however, the concentrations are generally lower than concentrations in the SWS area. Samples collected from the eastern portion of the SWS area generally did not exceed PSCs, except at a localized hot spot at boring location E7. Many of the contaminants have been vertically delineated, though the extent of some chemicals is not fully defined below the water table. In addition, dioxins/furans have been identified in a storm water solid sample collected in 2004 from the former southern storm water treatment system located on the western side of the SWS area.

Groundwater data is needed in the SWS area to determine if COPCs that have not been vertically delineated occur in concentrations sufficient to partition into groundwater. It is also needed to determine if COPCs in concentrations exceeding the PSCs in seep samples from along the LDW are related to entrained particulates or are dissolved in the groundwater. On the eastern and northern

edges of the SWS area, additional soil data is also needed to ensure that lead and PCBs are adequately delineated.

To close these data gaps, one groundwater monitoring well (MW-43A) and three soil borings (DG11-1, DG11-2, and DG11-3) are proposed in or in the vicinity of the SWS area (Figure 3). The proposed soil boring for the monitoring well will be located in the northern part of the SWS area, close to borings where higher concentrations of the COPCs have been previously identified. This soil boring will be advanced to 25 feet bgs prior to the installation of the monitoring well, and up to two discrete soil samples will be collected for analysis of petroleum-range hydrocarbons in the gasoline and diesel ranges, BTEX, low-level PAHs, PCBs, vinyl chloride, BEHP, dibenzofuran, arsenic, copper, lead, nickel, silver, and zinc.

The boring and related monitoring well will be set back from the western boundary of the 8801 property because drilling is inhibited by an embankment that was constructed to form the shoreline during infilling. Due to high tidal fluctuation at this location, the well screen will be installed from approximately 6 to 16 feet bgs. The screen position will be evaluated in the field based on encountered lithology.

After well development, groundwater samples will be collected and analyzed for petroleum-range hydrocarbons in the gasoline and diesel ranges, semi-volatile organic compounds (SVOCs), low-level PAHs, PCBs, low-level vinyl chloride, VOCs, and total and dissolved arsenic, copper, lead, nickel, silver, and zinc.

On the eastern and northern boundaries of the SWS area, three soil borings will be advanced to a depth of 15 feet bgs. Two soil samples will be collected from each boring and analyzed for PCBs, lead, and BEHP. Boring DG11-1 is positioned close to a previous boring, C6, where dioxins/furans were detected. Therefore, one soil sample from DG11-1 will be selected for dioxin/furan and pentachlorophenol analysis. Samples will be collected from areas where odor or visual indications of contamination are present. If no indications of contamination are present, one soil sample will collected from near the surface and the other just above the water table. The water table position will be determined based on the mean position of groundwater in high and low tide at the adjacent monitoring well.

2.3 E7 AREA

One sample at E7, located near the southern boundary of the 8801 site had soil concentrations of gasoline-range hydrocarbons, benzene, and total xylenes exceeding PSCs. No known source on the 8801 site has been identified; however, hydrocarbons, PCBs and copper were identified in soil was that was excavated from the adjacent Rhone Poulenc property to the south in approximately the same

vicinity as E7. At the 8801 site, no gasoline was detected in soil samples collected to the north, west, and east of E7. To identify whether copper, PCBs and petroleum-range hydrocarbons are present to the north of the excavation on the former Rhone Poulenc site, two borings (DG11-11 and DG11-12) will be advanced to a total of 3 feet bgs (Figure 3). Soil samples will be continuously collected from the surface to three feet in both borings. One near surface soil sample from each of the borings will be analyzed for petroleum-range hydrocarbons in the gasoline and diesel ranges, low-level PAHs, PCBs and copper. The remaining samples will be held pending analysis results from the surface sample.

2.4 FORMER MIDDLE OUTFALL AREA

Samples of solids from within the drainage pipe and catch basin N near the now-closed middle outfall contained PCBs in elevated concentrations. After collection of the samples, the catch basin and piping were completely cleaned and the catch basin and outfall sealed with concrete grout. The piping associated with the former middle outfall is to be removed; however, in advance of the removal Ecology has asked that samples be collected. The investigation proposed in this area will be to determine if solids in the storm water drain leaked to the surrounding soil. Four shallow borings will be advanced to a depth of 5 feet bgs to the north (DG11-6 and DG11-7) and south (DG11-4 and DG11-5) of the middle outfall piping and catch basin N (Figure 3). One sample from each boring will collected in native soil and analyzed for PCBs. In addition, one sample collected from each of DG11-5 and DG11-6 will be analyzed for dioxins/furans and pentachlorophenol.

2.5 NORTHWEST CORNER

The northwest corner consists of the area between the former Fiberglass Shop, the northern boundary of the 8801 site, the western boundary of the 8801 property, and the eastern edge of the former USTs in this vicinity. An acetone UST, various hydrocarbon-containing USTs, a distillation unit used to recycle acetone, and a methyl ethyl ketone peroxide storage shed were formerly located in this area. IAAI undertook a large excavation in the central part of this area in 2007 to install the new storm water treatment system. The soil excavated during the work was disposed of offsite. One or more samples contained PCBs, BEHP and some metals above the PSC remaining in the excavation wall and base samples.

Within the northwest corner, high concentrations of the VOCs acetone, vinyl chloride, and toluene have been detected at boring A1 (northwest of the former Fiberglass Shop) in both soil and groundwater, and total petroleum hydrocarbons have been identified adjacent to the northeast corner of the former Fiberglass Shop. Both the VOCs and petroleum hydrocarbons have been vertically delineated in this location.

One new groundwater monitoring well (MW-44A) is proposed on the western perimeter of the northwest corner (Figure 3) to determine if the COPCs identified at boring A1 and in scattered locations throughout the area have partitioned to groundwater.

A soil boring will be advanced to a depth of 25 feet bgs for installation of the monitoring well. Two discrete soil samples will be collected and analyzed for petroleum-range hydrocarbons in the gasoline and diesel ranges; SVOCs; low-level PAHs; PCBs; VOCs; and total arsenic, copper, lead, nickel, silver, and zinc. Samples will be collected from areas where odor or visual indications of contamination are present. If no indications of contamination are present, one soil sample will collected from near the surface and the other just above the water table.

The well screen for monitoring well (MW-44A) will be installed between 5 and 15 feet bgs. The screen position will be evaluated in the field based on encountered lithology. after well development, groundwater samples will be collected and analyzed for petroleum-range hydrocarbons in the gasoline and diesel ranges; SVOCs; low-level PAHs; PCBs; low-level vinyl chloride; VOCs; and total and dissolved arsenic, copper, lead, nickel, silver, and zinc .

2.6 NORTH FIRE AISLE

In 1986, four USTs were removed from area of the North Fire Aisle (NFA) north of the old power house and near existing monitoring wells MW-8A and MW-8B. These USTs were part of a storage and recycling system for thinners used in the painting area of the Manufacturing Building. The thinners were recycled in a methyl ethyl ketone still located in a small building adjacent to and west of the Manufacturing Building.

Soil and groundwater samples collected in 1986 and 1987, shortly after the USTs were removed, had high concentrations of 1,1,1-trichloroethane, 4-methyl-2-pentanone (also known as methyl isobutyl ketone, and used on the site north of the 8801 site), toluene, and 1,1-dichloroethane (a breakdown product of 1,1,1-trichloroethane). Trichloroethene and tetrachloroethene concentrations were not significantly elevated in soil during the 1986 investigation. 8801 site data and recent data from an investigation on the Boeing Thompson property to the north show elevated concentrations of trichloroethene and tetrachloroethene in soil west of the NFA near sample points G0 and D0. Therefore, the former USTs in the NFA may not be the only sources of the contamination detected in soil and groundwater in the northern area of the 8801 site.

To determine whether previously detected VOCs extend vertically into the groundwater in the vicinity of G0 and D0, two groundwater monitoring wells (MW-45A and MW-46A) will be installed (Figure 3). Soil borings will be advanced to 25 feet bgs for installation of monitoring wells, and up to two discrete soil samples will be collected from each boring for analysis of VOCs. One sample from each well will

also be submitted for cation exchange analysis. Samples will be collected from areas where odor or visual indications of contamination are present. If no indications of contamination are present, one soil sample will collected from near the surface and the other just above the water table.

The well screens for the monitoring wells close to D0 (MW-45A) and G0 (MW-46A) will be installed between 6 and 16 and between 8 and 18 feet bgs, respectively. All screen positions will be evaluated in the field based on encountered lithology. After well development, groundwater samples will be collected and analyzed for low-level vinyl chloride and VOCs.

2.7 OFF-HIGHWAY BUILDING AREA

The Off-Highway Building was used primarily for assembly of off-highway trucks, although it had previously been used as a repair shop. Paint storage and a paint booth were located at the south end of the building, and a fueling area was located west of the building. Both grid and focused investigation borings in the area identified elevated levels of petroleum hydrocarbons, VOCs, and occasionally PAHs in the soil, and VOCs in the groundwater. The primary VOCs identified in this area were ethylbenzene, toluene, total xylenes, trichloroethene, and tetrachloroethene, although only the last two have been detected down-gradient. The COPCs in soil under the building have been vertically delineated in most locations. The direct source of the contamination under the Off-Highway Building is unknown, but the petroleum hydrocarbons may derive from leaks in the former fueling area.

Petroleum hydrocarbons have been detected in soil beneath the Off-Highway Building, but there are no monitoring wells near these soil sample locations. To close the data gap, a set of groundwater monitoring wells (MW-47A and MW-47B) will be installed close to the highest detected concentration of hydrocarbons in soil to determine if non-aqueous-phase hydrocarbons are present in this area and if VOCs are present in the deeper levels of the upper aquifer (Figure 3). Soil borings will be advanced to 20 feet bgs and 45 feet bgs for installation of the monitoring wells. Two discrete soil samples (with one being in the screen interval) will be collected and analyzed for petroleum-range hydrocarbons in the gasoline and diesel ranges, low-level PAHs, VOCs, hexane, and speciated hydrocarbons (EPH/VPH) from the A boring. The soil sample from the well screen interval from both monitoring wells will be analyzed for metals, low-level PAHs, PCBs, VOCs, SVOCs and TPH. Samples will be collected from areas where odor or visual indications of contamination are present. If no indications of contamination are present, one soil sample will collected from near the surface and the other just above the water table.

The well screen for the A monitoring well will be placed between 5 and 15 feet bgs to intersect the groundwater table and determine if non-aqueous product is present. The well screen for the B monitoring well will be placed between 30 and 40 feet bgs to terminate on a silt layer. The screen

positions will be evaluated in the field based on encountered lithology. After well development, groundwater samples from both monitoring wells will be collected and analyzed for total and dissolved metals, low-level PAHs, PCBs, VOCs, SVOCs and petroleum-range hydrocarbons in the gasoline and diesel ranges.

2.8 GROUNDWATER SAMPLING

VOCs (primarily 1,1-dichloroethene, chloroethane, tetrachloroethene, trichloroethene, and vinyl chloride) have been detected in groundwater at the 8801 site in concentrations exceeding PSCs, though tetrachloroethene concentrations have not exceeded PSCs since 2006. Excluding grab groundwater samples collected in 2004 for which there is no additional data, these VOCs occur in the NFA at MW-8A and in wells on the western part of the 8801 site through to the SWS area, although not all VOCs are detected in all locations. 1,1-dichloroethene, chloroethane, trichloroethene, and vinyl chloride concentrations have exceeded PSCs in samples from monitoring wells on the western boundary of the 8801 property as recently as 2009.

To delineate the southern edge of the VOC plume and determine the concentrations of VOCs up gradient of the existing remediation system, five new groundwater monitoring wells are proposed (MW-48A, MW-48B, MW-49A, MW-49B and MW-40B). In advance of installation of the monitoring wells, soil borings will be advanced and one soil sample collected from the well screen interval of each boring (an extra sample will be collected from MW-40B at a depth that corresponds with the screen interval at MW-40A). The soil sample from the well screen interval from the monitoring wells will be analyzed for metals, low-level PAHs, PCBs, VOCs, SVOCs and petroleum-range hydrocarbons in the gasoline and diesel ranges.

The well screen for the monitoring well will be placed between 5 and 15 feet bgs to intersect the groundwater table in the A wells and between 40 and 50 feet bgs to terminate on the silt layer in the B wells. . The screen position will be evaluated in the field based on encountered lithology. After well development, groundwater samples will be collected.

Comprehensive sampling of groundwater in all permanent monitoring wells west of MW-16A (including newly proposed wells) is proposed. The groundwater samples would be analyzed for VOCs and low-level vinyl chloride to meet the revised PSCs.

Samples from three monitoring wells (MW-26A, MW-30A and MW-37A) will be analyzed for dissolved and total metals, SVOCs and PCBs and samples from two monitoring wells (MW-16A and MW-42A) will be analyzed for PCBs analysis. In monitoring wells MW-47A, MW-47B, MW-48A, MW-48B, MW-49A, MW-49B and MW-40B the groundwater will be analyzed for total and dissolved metals, low-level PAHs, PCBs, VOCs, SVOCs and petroleum-range hydrocarbons in the gasoline and diesel ranges.

Natural attenuation parameters will be measured in selected wells in the area of MW-8A, mid plume and down gradient of the remediation system and in the newly installed wells MW-47A, MW-47B, MW-48A, MW-48B, MW-49A, MW-49B and MW-40A.

2.9 SURFACE MATERIALS

Samples of storm water solids on the 8801 site since 2004 have contained chemicals not identified in soil samples from the 8801 site, or not identified in locations near the storm water system. Ecology requires identification of the source(s) of the chemicals. Chemicals such as TBT have not been found in soil. Although PCBs have been found in soil, their source has not been identified. Therefore, a limited investigation for potential paint and mastic material sources will be undertaken on the surface of the 8801 site.

Five samples of paint from buildings and from paint markings on the ground surface will be collected and analyzed for cadmium, chromium, lead, zinc, nickel, TBT, and PCBs. Three samples of mastic from the buildings and jointing compounds from between concrete slabs will be collected and analyzed for PCBs.

3.0 SCHEDULE AND REPORTING

After completion of the field work, the data will be tabulated and screened against the PSCs. Further details on the use of the data from the data gaps investigation and the timing of the work are provided below.

3.1 SCREENING OF ANALYTICAL RESULTS

Analytical data from the data gaps investigation will be screened against the PSCs to determine whether the identified COPCs continue to be of concern. After the initial screening of the new data, the full suite of identified COPCs will then be rescreened against screening criteria adjusted for natural background concentrations and to determine if concentrations are below the practical quantitation limits (PQLs). Chemicals in concentrations not exceeding their respective background concentrations and chemicals for which 95 percent of the results do not exceed the PQLs will be removed from the list of COPCs for the site. The final chemicals of concern will be listed and incorporated into the evaluation in the FFS report.

3.2 REPORT AND SCHEDULE

The FFS report will follow the requirements laid out in the Model Toxics Control Act section on remedial investigation and focused feasibility study (WAC 173-340-350). The data gaps sampling activities described in this work plan will commence within 30 days following approval of the work plan. Results of these sampling activities will be included in and will inform the FFS.

4.0 REFERENCES

AMEC Earth & Environmental (2008). Draft Interim Action Work Plan with Remedial Investigation and Feasibility Study, 8801 East Marginal Way South, Tukwila, Washington, May, 16, 2008. Submitted to PACCAR Inc by AMEC, Kirkland, Washington.

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Washington State Department of Ecology (2011a). Personal email communication, confirming acceptance of final list of chemicals of potential concern. March 18, 2011.

Washington State Department of Ecology (2011b). Letter entitled, "Ecology Review of Draft Data Gaps Work Plan – Agreed Order #6069". July 14, 2011.

5.0 LIMITATIONS

This report was prepared exclusively for PACCAR by AMEC Earth & Environmental, Inc. The quality of information, conclusions, and estimates contained herein is consistent with the level of effort involved in AMEC services and based on (i) information available at the time of preparation, (ii) data supplied by outside sources, and (iii) the assumptions, conditions, and qualifications set forth in this report. This Data Gaps Work Plan is intended to be used by PACCAR for the 8801 site only, subject to the terms and conditions of its contract with AMEC. Any other use of, or reliance on, this report by any third party is at that party's sole risk.

TABLE

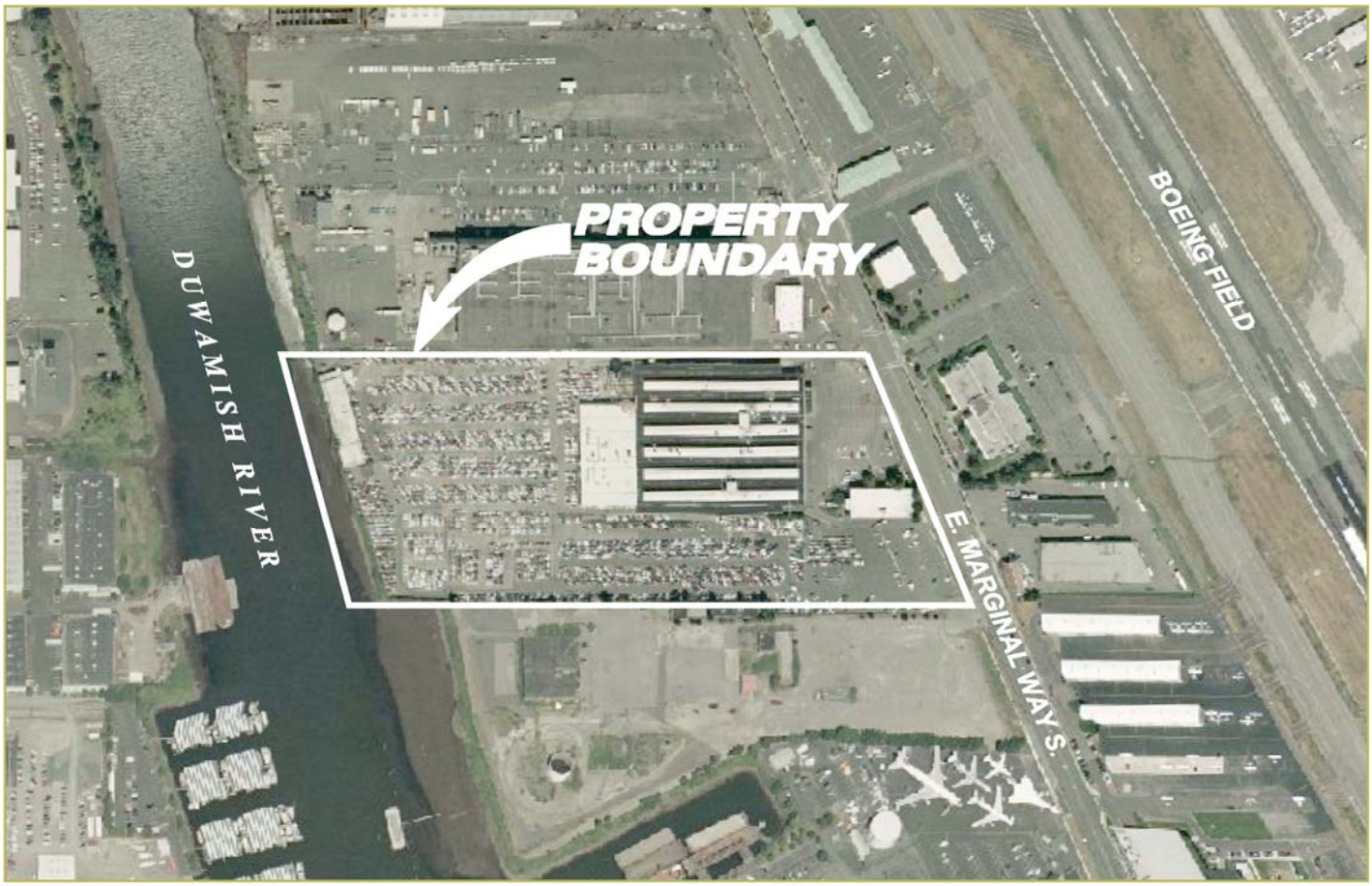
TABLE 1
Chemicals of Potential Concern and Laboratory Detection Levels
8801 East Marginal Way South, Tukwila, Washington

Chemical	Comments	SOIL		WATER	
		MDL/LOD	RL/LOQ	MDL/LOD	RL/LOQ
acetone	A1 only	0.482 ug/kg	5.0 ug/kg	0.72 ug/L	5.0 ug/L
acenaphthene	Limited areas only	16.4 ug/kg	67 ug/kg	0.546 ug/L	1.0 ug/L
anthracene	Limited areas only	20.2 ug/kg	67 ug/kg	0.531 ug/L	1.0 ug/L
benzene	Limited areas only - Off Highway Building, NW corner, E7 and BY 1/3 of SWS area.	0.296 ug/kg	1.0 ug/kg	0.056 ug/L	1.0 ug/L
benzo(g,h,i)perylene	Limited areas only	25.9 ug/kg	67 ug/kg	0.546 ug/L	1.0 ug/L
benzo[a]anthracene	Limited areas only	19.4 ug/kg	67 ug/kg	0.520 ug/L	1.0 ug/L
benzo[a]pyrene	Limited areas only	20.9 ug/kg	67 ug/kg	0.484 ug/L	1.0 ug/L
benzo[b]fluoranthene	Limited areas only	32.5 ug/kg	67 ug/kg	0.577 ug/L	1.0 ug/L
benzo[k]fluoranthene	Limited areas only	(w/benzo(b))	(w/benzo(b))	(w/benzo(b))	(w/benzo(b))
bis(2-ethylhexyl) phthalate	Limited areas only	23.9 ug/kg	67 ug/kg	1.877 ug/L	1.0 ug/L
butyl benzyl phthalate	Limited areas only	24.6 ug/kg	67 ug/kg	0.557 ug/L	1.0 ug/L
chloroethane	Limited areas only	0.462 ug/kg	1.0 ug/kg	0.152 ug/L	1.0 ug/L
chloromethane (methyl chloride)	Limited areas only	0.263 ug/kg	1.0 ug/kg	0.098 ug/L	2.0 ug/L
chrysene	Limited areas only	21.0 ug/kg	67 ug/kg	0.549 ug/L	1.0 ug/L
dibenz[a,h]anthracene	Limited areas only	24.6 ug/kg	67 ug/kg	0.482 ug/L	1.0 ug/L
dichloroethane, 1,1-	Limited areas only	0.203 ug/kg	1.0 ug/kg	0.053 ug/L	1.0 ug/L
dichloroethane, 1,2-	Limited areas only	0.191 ug/kg	1.0 ug/kg	0.075 ug/L	1.0 ug/L
dichloroethylene, 1,1-	Limited areas only	0.336 ug/kg	1.0 ug/kg	0.091 ug/L	1.0 ug/L
dichloroethylene, 1,2-	Limited areas only	0.266 ug/kg	1.0 ug/kg	0.100 ug/L	1.0 ug/L
dibenzofuran	South west storage area only	18.2 ug/kg	67 ug/kg	0.479 ug/L	1.0 ug/L
dimethyl phthalate	Sediment only	26.5 ug/kg	67 ug/kg	0.528 ug/L	1.0 ug/L
di-n-octylphthlate	Sediment only	19.1 ug/kg	67 ug/kg	0.508 ug/L	1.0 ug/L
ethylbenzene	VOC will analyze where known TPH- see benzene	0.202 ug/kg	1.0 ug/kg	0.094 ug/L	1.0 ug/L
fluoranthene	Limited areas only	41.6 ug/kg	67 ug/kg	0.515 ug/L	1.0 ug/L
fluorene	Limited areas only	15.6 ug/kg	67 ug/kg	0.558 ug/L	1.0 ug/L
indeno[1,2,3-cd]pyrene	Limited areas only	27.0 ug/kg	67 ug/kg	0.485 ug/L	1.0 ug/L
methyle chloride (dichloromethane)	Limited areas only	0.635 ug/kg	2.0 ug/kg	0.391 ug/L	2.0 ug/L
methylnaphthalene, 2-	Sediment only	24.4 ug/kg	67 ug/kg	0.475 ug/L	1.0 ug/L
naphthalene	Limited areas only	14.9 ug/kg	67 ug/kg	0.553 ug/L	1.0 ug/L
pcb mixtures	Limited areas only				
pcb - Aroclor 1016	Limited areas only	9.83 ug/kg	33 ug/kg	0.13 ug/L	1.0 ug/L
pcb - Aroclor 1221	Limited areas only				
pcb - Aroclor 1232	Limited areas only				
pcb - Aroclor 1242	Limited areas only				
pcb - Aroclor 1248	Limited areas only				
pcb - Aroclor 1254	Limited areas only				
pcb - Aroclor 1260	Limited areas only	7.06 ug/kg	33 ug/kg	0.147 ug/L	1.0 ug/L
phenanthrene	Limited areas only	20.0 ug/kg	67 ug/kg	0.557 ug/L	1.0 ug/L
tetrachloroethylene (perchloroethylene)	Limited areas only	0.257 ug/kg	1.0 ug/kg	0.088 ug/L	1.0 ug/L
trichlorethane, 1,1,1-	Limited areas only	0.226 ug/kg	1.0 ug/kg	0.089 ug/L	1.0 ug/L
trichlorethane, 1,1,2-	Limited areas only	0.286 ug/kg	1.0 ug/kg	0.035 ug/L	1.0 ug/L
trichloroethylene	Limited areas only	0.212 ug/kg	1.0 ug/kg	0.076 ug/L	1.0 ug/L
trimethylbenzene, 1,3,5-	VOC will analyze where known TPH- see benzene	0.254 ug/kg	1.0 ug/kg	0.063 ug/L	1.0 ug/L
toluene	VOC will analyze where known TPH- see benzene - and A1	0.151 ug/kg	1.0 ug/kg	0.056 ug/L	1.0 ug/L
vinyl chloride (chloroethylene)	Limited areas only	0.235 ug/kg	1.0 ug/kg	0.075 ug/L	1.0 ug/L
xylene (dimethylbenzene)	VOC will analyze where known TPH- see benzene	0.392 ug/kg	1.0 ug/kg	0.144 ug/L	2.0 ug/L
benzoic acid	Storm water solids only	251 ug/kg	670 ug/kg	5.111 ug/L	10.0 ug/L
benzyl alcohol	Storm water solids only	86.6 ug/kg	330 ug/kg	2.008 ug/L	5.0 ug/L
pentachlorophenol	Limited areas only	96.4 ug/kg	330 ug/kg	2.411 ug/L	5.0 ug/L
phenol (total)	Limited areas only	0.035 ppm	0.4 ppm	0.035 ppm	0.04 ppm
Tributyltin	Limited areas only	1.02 ug/kg	4.5 ug/kg	0.003 ug/L	0.018 ug/L
Arsenic (III)	Limited areas only				

TABLE 1
Chemicals of Potential Concern and Laboratory Detection Levels
8801 East Marginal Way South, Tukwila, Washington

		SOIL		WATER	
Chemical	**Comments**	**MDL/LOD**	**RL/LOQ**	**MDL/LOD**	**RL/LOQ**
Arsenic (V)	Limited areas only				
Arsenic (total)	Limited areas only	0.46 mg/kg	5.0 mg/kg	3.33 ug/L	50 ug/L
Cadmium	Limited areas only	0.11 mg/kg	0.2 mg/kg	0.18 ug/L	2.0 ug/L
Chromium (VI)	Limited areas only	0.003 ppm	0.1 ppm	0.003 ppm	0.01 ppm
Chromium, total (or III)	Limited areas only	0.27 mg/kg	0.5 mg/kg	1.24 ug/L	5.0 ug/L
Copper	Limited areas only	0.05 mg/kg	0.2 mg/kg	0.92 ug/L	2.0 ug/L
Lead	Limited areas only	0.13 mg/kg	2.0 mg/kg	1.55 ug/L	20.0 ug/L
Mercury	Limited areas only	0.0013 mg/kg	0.025 mg/kg	0.0069 ug/L	0.10 ug/L
Nickel	Limited areas only	0.30 mg/kg	1.0 mg/kg	3.86 ug/L	10.0 ug/L
Selenium	Limited areas only	0.65 mg/kg	5.0 mg/kg	4.99 ug/L	50.0 ug/L
Silver	Limited areas only	0.03 mg/kg	0.3 mg/kg	0.43 ug/L	3.0 ug/L
Zinc	Limited areas only	0.12 mg/kg	1.0 mg/kg	1.45 ug/L	10.0 ug/L
Gasoline	Limited areas only	2.39 mg/kg	5.0 mg/kg	0.06 mg/L	0.25 mg/L
Diesel	Limited areas only	0.742 mg/kg	5.0 mg/kg	0.016 mg/L	0.10 mg/L
Lube oil	Limited areas only	1.31 mg/kg	10.0 mg/kg	0.049 mg/L	0.20 mg/L
2,3,7,8-TCDD (Dioxin)	Limited areas only	0.34 pg/g	1.0 pg/g	3.67 pg/L	10.0 pg/L

FIGURES



NOT TO SCALE

IMAGE PROVIDED BY KING COUNTY IMAP.
IMAGE DATE 2005

AMEC Earth & Environmental 11810 North Creek Parkway North Bothell, WA, U.S.A. 98011-8201	amec	CLIENT LOGO	CLIENT PACCAR INC	
PROJECT 8801 EAST MARGINAL WAY SOUTH, Tukwila, Washington		DWN BY: JRS	DATUM:	DATE: MARCH 2011
TITLE SITE LOCATION MAP		CHK'D BY: MS	REV. NO.:	PROJECT NO: 9-915-14995-L
		PROJECTION:	SCALE: NOT TO SCALE	FIGURE No. 1

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BOEING THOMPSON PROPERTY

NORTH OUTFALL (NO. 1)

FORMER FIBERGLASS SHOP

OFF-HWY BUILDING DEMOLISHED

DEMOLISHED

NORTH FIRE AISLE

FORMER MANUFACTURING BUILDING

EAST MARGINAL WAY

FORMER STORM - MIDDLE OUTFALL (CLOSED 2004)

DUWAMISH WATERWAY

SEEP 4

SEEP 3

SEEP 2

SEEP 1

SEEP 6

CENTRAL OUTFALL (NO.2) (FORMER 8801 SOUTH OUTFALL)

SEEP 5

FORMER SOUTHWEST STORAGE AREA

SOUTH FIRE AISLE

FORMER ADMINISTRATION BUILDING

FORMER MONSANTO PARCEL

KING COUNTY STORM DRAIN LINE

0 60 120 240

SCALE IN FEET

LEGEND

EXISTING BUILDINGS

FORMER BUILDINGS

CONTAINER PROPERTY LLC

(INSURANCE AUTO AUCTIONS INCOPRATED VEHICLE STORAGE ON BOTH 8801 AND CONTAINER PROPERTY)

MUSEUM OF FLIGHT

	CLIENT LOGO	CLIENT: PACCAR INC	DWN BY: JRS	PROJECT: 8801 EAST MARGINAL WAY SOUTH, Tukwila, Washington	DATE: MARCH 2011
			CHK'D BY: MS		PROJECT NO: 9-915-14995-L
		AMEC Earth & Environmental, 11810 North Creek Parkway North, Bothell, WA, U.S.A. 98011-8201	DATUM:	TITLE: 8801 SITE KEY SITE FEATURES	REV. NO.:
			PROJECTION:		FIGURE No. 2
			SCALE: AS SHOWN		

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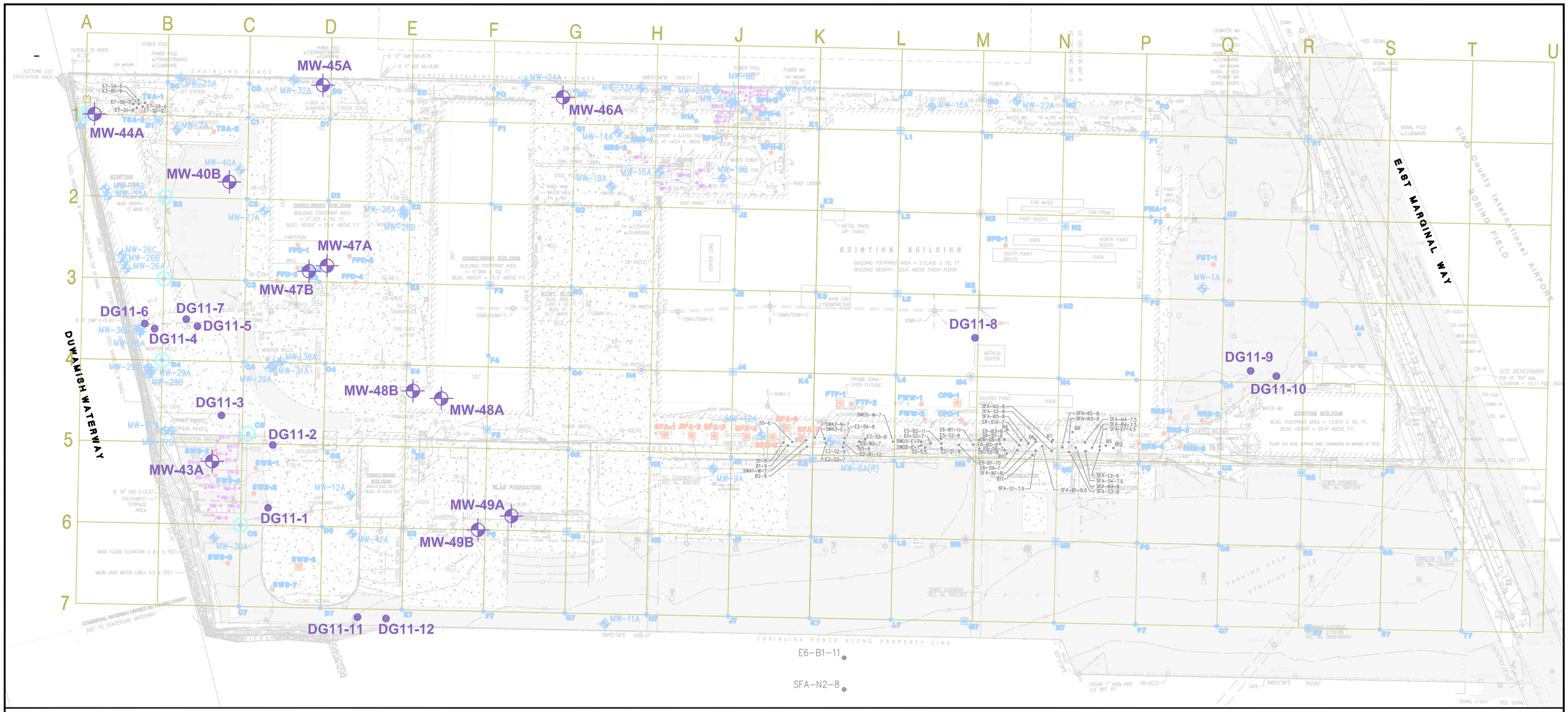

LEGEND:

PHASE II SAMPLE LOCATIONS

MW-47A — DATA GAP MONITORING WELL

DG11-8 — DATA GAP BORING

GRID SOIL SAMPLING LOCATION

MW-36B — SHALLOW ZONE GROUNDWATER MONITORING WELL (INSTALLED DURING PHASE II)

PREVIOUS SOIL BORING LOCATION

NOTE: 1. ALL LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND EXPLORATION POINTS ARE FROM KENNEDY-JENKS FIGURES 2 AND 3, 046001.00/REPORT/P04SK003.

0 60 120 240
SCALE IN FEET

CLIENT LOGO

CLIENT: PACCAR INC

AMEC Earth & Environmental
11810 North Creek Parkway North
Bothell, WA, U.S.A. 98011-8201

DWN BY:	JRS
CHK'D BY:	MS
DATUM:	NONE
PROJECTION:	NONE
SCALE:	AS SHOWN

PROJECT: 8801 EAST MARGINAL WAY SOUTH
Tukwila, Washington

TITLE: 8801 SITE
PROPOSED DATA GAPS BORINGS AND MONITORING WELLS

DATE: JULY 2011
PROJECT NO: 9-915-14995-L
REV. NO.:
FIGURE No. 3

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I-206 - BOEING WELL

0 100 200

SCALE IN FEET

MW-25A MW-32A MW-45A MW-24A MW-46A MW-33A MW-21 MW-23A MW-8A MW-8B MW-34A MW-13 RW3 MW-16A MW-22A

MW-44A MW-7A RW1 MW-14A DEMOLISHED MW-20

MW-40A MW-40B MW-18A MW-15A MW-19B

MW-35B MW-35A RW2

MW-28A MW-28B

FORMER FIBERGLASS SHOP

MW-27A DEMOLISHED

MW-26C MW-26B MW-26A

MW-47A MW-47B

DEMOLISHED

FORMER MANUFACTURING BUILDING

MW-1A

MW-36B MW-36A

MW-29C MW-29A MW-29B

MW-38A MW-39A MW-31A

MW-48B MW-48A

MW-37A MW-37B

MW-42A MW-6A(R) MW-4 MW-3A MW-3 MW-2

MW-43A MW-5

MW-12A DEMOLISHED MW-9A

MW-10

MW-30A MW-41A MW-49B MW-49A

MW-11A

DUWAMISH WATERWAY

LEGEND

MW-35A — MONITORING WELLS TO BE SAMPLED

MW-9A — MONITORING WELLS
A - SCREEN INSTALLED IN ZONE A AQUIFER
B - SCREEN INSTALLED IN ZONE B AQUIFER
C - SCREEN INSTALLED IN ZONE C AQUIFER

RW3 — RECOVERY WELLS

MW-21 — WELLS REMOVED OR COVERED

NOTE: LOCATION OF MW-17 WAS NOT IDENTIFIED IN PREVIOUS INVESTIGATION REPORTS.

CLIENT: PACCAR INC

AMEC Earth & Environmental
11810 North Creek Parkway North
Bothell, WA, U.S.A. 98011-8201

DWN BY: JRS
CHK'D BY: MS
DATUM: NONE
PROJECTION: NONE
SCALE: 1" = 100'

PROJECT: 8801 EAST MARGINAL WAY SOUTH
Tukwila, Washington

TITLE: 8801 SITE
PROPOSED SITE-WIDE
MONITORING WELL LOCATIONS

DATE: JULY 2011
PROJECT NO: 9-915-14995-L
REV. NO.:
FIGURE No. 4

G:\91\14000\14995-L - PACCAR\14995-L-27.dwg - PLAN - Jul. 18, 2011 11:05am - jeffrey.sanders

APPENDIX A

Sampling and Analysis Plan

FINAL SAMPLING AND ANALYSIS PLAN

Data Gaps Investigation

8801 East Marginal Way South

Tukwila, Washington

Prepared by:

AMEC Earth & Environmental, Inc.
11810 North Creek Parkway North
Bothell, Washington 98011

July 29, 2011

Project No. 9-915-14995-L

TABLE OF CONTENTS

TABLES

APPENDICES

ABBREVIATIONS

8801 site	8801 East Marginal Way South property and adjoining sediments in the LDW
AMEC	AMEC Earth and Environmental Inc.
bgs	Below ground surface
Boeing	The Boeing Company
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
HASP	Health and Safety Plan
IDW	Investigation-derived waste
LDW	Lower Duwamish Waterway
MDL	Method detection limit
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
Monsanto	Monsanto Industrial Chemical Company
MTCA	Model Toxics Control Act
MS/MSD	Matrix spike/matrix spike duplicate
PACCAR	PACCAR Inc
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
COPC	Chemical of potential concern
PID	Photoionization detector
QA/QC	Quality assurance/quality control
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SVOCs	Semivolatile organic compounds
SWS area	Southwest storage area
TPH	Total petroleum hydrocarbons
UST	Underground storage tank
VCP	Voluntary Cleanup Program
VOCs	Volatile organic compounds
WAC	Washington State Administrative Code

FINAL SAMPLING AND ANAYLSIS PLAN
8801 East Marginal Way South Site
Tukwila, Washington

1.0 INTRODUCTION

AMEC Earth and Environmental, Inc., (AMEC) has prepared this SAP on behalf of PACCAR Inc (PACCAR) for investigation of soil, groundwater, and surface materials at the 8801 site. The site location is shown on Figure 1 of the work plan. This SAP has been prepared in accordance with Washington Administrative Code (WAC) Ecology Model Toxics Control Act (MTCA) Cleanup Regulations (WAC 173-340-820) and also incorporates as companion documents a site-specific Health and Safety Plan (HASP), prepared in accordance with WAC 173-340-810, and a Quality Assurance Project Plan (QAPP).

This SAP describes in detail the proposed data gaps investigation activities and specifies procedures for collection of soil, groundwater, and surface materials at the 8801 site. The data gaps investigation includes collection of soil samples from 23 locations to evaluate lateral or vertical extent of known chemicals of potential concern (COPCs), groundwater samples from existing on-site monitoring wells and from 11 newly installed wells, and surface material samples from the on-site building and painted surfaces.

1.1 OBJECTIVES AND SCOPE OF WORK

The objectives of the data gaps investigation are to further sample and analyze soil, groundwater, and surface materials to more precisely identify the COPCs, to document the lateral and/or vertical extent of contamination, to evaluate impacts to groundwater through leaching, and to identify surface sources that may be contributing to chemicals detected in the storm water solids.

AMEC proposes the following scope of work to achieve these objectives:

- Advance four soil borings (DG11-1 through DG11-3 and DG11-8) to 15 feet below ground surface (bgs).
- Advance six soil borings (DG11-4 through DG11-7, DG11-9 and DG11-10) to 5 feet bgs.
- Advance two soil borings (DG11-11 through DG11-12) to 3 feet bgs.
- Advance seven soil borings to depths ranging from 20 to 25 feet bgs and complete these soil borings as monitoring wells MW-43A through MW-49A.

- Advance four soil borings to depths ranging from 40 to 50 feet bgs and complete these soil borings as monitoring wells MW-40B, MW-47B, MW-48B and MW-49B.
- Collect and analyze soil samples from the borings for the area-specific chemicals, including those for new analysis with lower detection limits.
- Collect and analyze soil samples from the eleven newly installed monitoring wells for either area-specific chemicals and in seven locations 8801 site chemicals of potential concern (COPCs) to determine if leaching to groundwater is occurring.
- Collect and analyze groundwater samples from the newly installed monitoring wells and existing on-site monitoring wells to evaluate the distribution of volatile organic compounds (VOCs) and low-level vinyl chloride in groundwater across the 8801 site.
- Collect and analyze groundwater samples from selected monitoring wells to determine if poly-chlorinated biphenyl's (PCBs), metals and semi-volatile organic compounds (SVOCs) are present in those wells.
- Collect bulk samples of paint, mastic, and joint compounds to determine if surface materials are the source of tributyl tins (TBTs) and PCBs in storm water solids detected in storm water solids from the 8801 site.

The revised preliminary screening criteria (PSCs) are significantly lower than detection limits for some of the chemicals previously analyzed at the 8801 site. The objective of using lower detections limits for the analysis on some samples is to determine whether trace levels of those chemicals are present. These lower detection limits are primarily related to vinyl chloride.

2.0 SITE BACKGROUND

This section provides basic information about site history, site geology and hydrogeology, and previous investigations.

2.1 SITE DESCRIPTION AND HISTORY

The site occupies approximately 25 acres on the east bank of the Lower Duwamish Waterway (LDW) at the street address 8801 East Marginal Way South, Tukwila, Washington (Work Plan Figure 1). During the early 20th Century, the site was developed and occupied by various companies, including a subsidiary of General Motors Corporation, Boeing, and Monsanto, before being purchased by PACCAR in 1946. From 1946 to 2002, Kenworth Motor Truck Company, a subsidiary of PACCAR, occupied the 8801 site and manufactured heavy trucks there. The factory was decommissioned in 2002 (Kennedy/Jenks June 2003).

In October, 2000, before the decommissioning, PACCAR entered into the Voluntary Cleanup Program (VCP) with Ecology. The program involved removing underground storage tanks and associated contaminated soil impacted by petroleum hydrocarbons and conducting two major site investigations to characterize soil, groundwater, seeps, and stormwater at the site. In October, 2004, PACCAR sold the property to Merrill Creek Holdings, LLC who then leased the property to Insurance Auto Auctions Incorporated (IAAI).

The 8801 site is surrounded primarily by industrial properties, including Boeing to the north, the former Monsanto property to the south, East Marginal Way and Boeing Field to the east, and the LDW (classified as a Superfund site for sediments) to the west.

2.2 GEOLOGY AND HYDROGEOLOGY

The soil in the lower Duwamish valley is alluvial in nature, derived largely from sedimentation. The soil is typically comprised of stratified silt, clay, and sand with layers of peat. Soil permeability ranges from moderately low to moderate. In the industrial area around the 8801 site, many areas have been raised with imported fill and the LDW channel has been modified. On the southwest corner of the 8801 site, a bend in the river was straightened by filling with sand, silt, and gravel.

Previous investigations documented interbedded silt and sand layers and lenses consistent with the regional geology. Fill material, as thick as 10 feet in some areas, was identified immediately beneath the asphalt or concrete surface in most locations across the site. The fill is primarily underlain by silt with sand and gravel, underlain by poorly-graded silty fine to medium sand. This poorly-graded silty sand thickens westward across the site to a maximum thickness of about 33.5 feet on the western property boundary. Underlying the poorly-graded sand is a sandy-silt. The deeper sandy silt forms a confining layer that is predominantly continuous on the western portion of the site and discontinuous on the eastern portion of the site.

The upper groundwater surface is typically observed between about 8 and 10 feet bgs at the site. This upper groundwater zone lies within silty sand, sandy silt, and a poorly graded silty sand on top of a silt confining layer. A deeper groundwater zone is present beneath the confining layer in poorly graded silty sand.

Previously installed monitoring wells have been screened across different soil and hydrogeologic units to evaluate vertical contaminant migration. Wells labeled ‘A’ are screened in the upper portion of the poorly graded silty sand, wells labeled ‘B’ are screened at the base of the poorly graded silty sand and into the top of the confining layer, and wells labeled ‘C’ are screened below the confining layer in a deeper, poorly graded silty sand.

Existing on-site monitoring well construction details are summarized on Table 1. The shallow wells ("A" wells) screened in the poorly-graded sand have total depths ranging from about 10 to 25 feet bgs. Wells screened at the interface between the poorly-graded sand and the confining layer ("B" wells) have total depths ranging from 23.5 to 44 feet bgs. The deeper wells screened in the poorly-graded silty sand below the confining layer ("C" wells) have total depths ranging from 56 to 59 feet bgs.

2.3 ON-SITE MONITORING WELLS

Figure 4 of the work plan shows the existing monitoring well locations at the 8801 site, as well as proposed new monitoring wells. Each monitoring well is identified with an "A," "B," or "C" depending on the depth at which the well is screened (see previous section).

A total of 32 wells (MW-1A, MW-6A(R), MW-7A, MW-8A, MW-9A, MW-11A, MW-12A, MW-14A, MW-15A, MW-16A, MW-18A, MW-22A, MW-23A, MW-24A, MW-25A, MW-26A, MW-27A, MW-28A, MW-29A, MW-30A, MW-31A, MW-32A, MW-33A, MW-34A, MW-35A, MW-36A, MW-37A, MW-38A, MW-39A, MW-40A, MW-41A, and MW-42A) are screened in the shallow aquifer and are still in use as monitoring wells throughout the site.

A total of eight monitoring wells (MW-8B, MW-19B, MW-26B, MW-28B, MW-29B, MW-35B, MW-36B, and MW-37B) are screened in the intermediate aquifer and are still in use as monitoring wells throughout the site.

Two monitoring wells (MW-26C and MW-29C) are screened in the deep aquifer and are still in use as monitoring wells along the western boundary of the site.

3.0 FIELD PROCEDURES

This section presents the field investigation procedures to be employed in sampling soil, groundwater, and surface materials. The field investigation will consist of drilling soil borings; installing monitoring wells; collecting and analyzing soil and groundwater samples; and collecting and analyzing samples of paint, mastic, and joint compound from the surface materials (for example, buildings and painted surfaces). The proposed soil boring/monitoring well locations are illustrated on Figure 3 of the work plan.

3.1 UTILITY SURVEY

AMEC will oversee a geophysical survey conducted by a private utility locator to identify subsurface utilities within 20 feet of the proposed soil boring locations. Below-grade utilities will be identified and their inferred locations will be marked on the ground surface at the 8801 site. In addition, subsurface

activity locations may be reviewed with the site owner or owner's representative, if they are available at the time.

3.2 CALIBRATION OF FIELD EQUIPMENT

Field instruments will be calibrated at the beginning of field activities each day. Calibration results and times will be recorded in the field notes. Field equipment requiring calibration includes the PID and the Horiba U-22 water quality meter.

The PID and water quality meter calibration instructions are included with the equipment manuals enclosed in the equipment cases. In general, the PID will be used to screen soil for the presence of lighter-end petroleum hydrocarbons such as gasoline and benzene. The Horiba U-22 water quality meter will be used to measure water quality parameters such as dissolved oxygen, temperature, oxidation-reduction potential, and turbidity.

3.3 SOIL SAMPLE COLLECTION

Three soil borings (DG11-1 through DG11-3) will be advanced adjacent to the south west storage (SWS) area, four soil borings (DG11-4 through DG11-7) will be advanced along the former Middle Outfall pipe, one boring (DG11-8) will be advanced within the former Manufacturing Building, two soil borings (DG11-9 and DG11-10) will be advanced at the eastern end of the south fire aisle (SFA) and two borings will be advanced on the southern boundary close to the western perimeter (DG-11-11 and DG-11-12) (Figure 3 of the work plan). The borings will be advanced at each location using a push-probe drill rig. Soil borings DG11-1, DG11-2, DG11-3, and DG11-8 will be terminated at 15 feet bgs. Soil borings DG11-4 through DG11-7, DG11-9 and DG11-10 will be terminated at 5 feet bgs and soil borings DG-11-11 and DG-11-12 will be terminated at 3 feet bgs.

Soil boring MW-43A-SB will be advanced in the SWS area and will be completed as groundwater monitoring well MW-43A. Soil boring MW-44A-SB will be advanced in the Northwest Corner area and will be completed as groundwater monitoring well MW-44A. Soil boring MW-45A-SB will be advanced between the Northwest Corner and the North Fire Aisle and will be completed as groundwater monitoring well MW-45A. Soil boring MW-46A-SB will be advanced near the former sampling point G0 near the west end of the North Fire Aisle and will be completed as groundwater monitoring well MW-46A. Soil borings MW-47A-SB and MW-47B-SB will be advanced within the former Off Highway Building and will be completed as groundwater monitoring wells MW-47A and MW-47B, respectively. Soil borings MW-48A-SB, MW-48B-SB, MW-49A-SB and MW-49B-SB will be advanced to the east of the existing remediation system and south of MW-47A. The wells will be completed as MW-48A, MW-48B, MW-49A and MW-49B, respectively. Soil boring MW-40B-SB will be advance to the west of the existing monitoring well MW-40A and will be completed as monitoring well MW-40B. The proposed monitoring well locations are shown on Figure 3 of the work plan. The borings will be advanced at

each location using a hollow stem auger (HSA) drill rig. Soil borings MW-43A-SB through MW-49A-SB will be terminated at 25 feet bgs except soil boring MW-47A-SB which will be terminated at 20 feet bgs. Soil borings MW-40B-SB, and MW-47B-SB through MW-49B-SB will be terminated at 50 feet bgs or less.

All soil boring and monitoring well locations are subject to change based on observed conditions in the field (utilities, equipment, etc.).

Soil samples from the borings will be collected continuously using a stainless steel split-spoon sampler (push-probe and HSA borings) from the surface to 15 feet bgs. AMEC will inspect all soil samples and will screen the soil samples for VOCs using a photo-ionization detector (PID). Each soil sample will be examined and relevant sample information (for example, depth of sample collection, date and time of sample acquisition, and PID measurement) will be recorded.

To prevent cross-contamination, any equipment that is repeatedly in contact with the soil will be decontaminated before and after each individual sampling attempt.

The procedure for collecting the soil samples is as follows:

In borings DG11-1 through DG11-3, DG11-8, and MW-43A-SB through MW-49B-SB, two discrete soil samples will be collected with the soil sample collected in the screen interval in MW-40B-SB, MW-47A-SB through MW-49B-SB. In shallow borings DG11-4 through DG11-7, DG11-9 and DG11-10, one discrete soil sample will be collected from one interval in native soil. In shallow borings DG11-11 and DG11-12, three soil samples will be collected at one foot intervals. The upper sample will be analyzed and the remaining two samples from both borings held.

Samples will be collected from areas where odor or visual indications of contamination are present. If no indications of contamination are present, one soil sample will collected from near the surface and the other just above the soil/groundwater contact. Gravel and vegetation will be removed from the discrete sample. If a layer of asphaltic pavement is encountered, it will be excluded from the sample and its presence noted on the boring log.

3.4 SOIL SAMPLE ANALYSES

Soil samples from the borings will be submitted to the analytical laboratory for the following analyses (summarized in Table 2):

- One sample from each of borings DG11-1, DG11-5, and DG11-6 will be analyzed for dioxins/furans by EPA Method 1613B and for pentachlorophenol by EPA Method 8041A.

- Two samples from each of borings DG11-1 through DG11-3 will be analyzed for lead by EPA Method 6010C/6020A, for PCBs by EPA Method 8082A, and for bis(2-ethylhexly)phthalate (BEHP) by EPA Method 8270D.
- One sample from each of borings DG11-4 through DG11-7 will be analyzed for PCBs by EPA Method 8082A (low-level).
- Two samples from boring DG11-8 will be analyzed for TPH as gasoline, diesel, and oil by Ecology Method Northwest Total Petroleum Hydrocarbon-Gasoline (NWTPH-Gx) and NWTPH-Diesel (Dx) and for benzene, toluene, ethylbenzene, and total xylenes (BTEX) by EPA Method 8260B.
- One sample from each of borings DG11-9 and DG11-10 will be analyzed for PCBs by EPA Method 8082A (low-level) and arsenic by EPA Method 6010C.
- Three samples will be collected and one sample analyzed from each of borings DG11-11 and DG11-12 for TPH as gasoline, diesel, and oil by Ecology Method Northwest Total Petroleum Hydrocarbon-Gasoline (NWTPH-Gx) and NWTPH-Diesel (Dx), PCBs by EPA Method 8082A (low-level), low-level poly aromatic hydrocarbons (PAHs) by EPA Method 8270 SIM, and copper by EPA Method 6010C.
- One sample from boring MW-40B-SB will be analyzed for TPH as gasoline, diesel, and oil by Ecology Method Northwest Total Petroleum Hydrocarbon-Gasoline (NWTPH-Gx) and NWTPH-Diesel (Dx), mercury by EPA Method 7470A/7471B and other metals (arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc) by EPA Method 6010C/6020A, low-level PAHs by EPA Method 8270-SIM, SVOCs by EPA Method 8270D, PCBs by EPA Method 8082A, and VOCs by EPA Method 8260B.
- Two samples from boring MW-43A-SB will be analyzed for TPH as diesel and oil by Method NWTPH-Dx, vinyl chloride by EPA Method 8260B, low-level PAHs by EPA Method 8270-SIM, dibenzofuran and BEHP by EPA Method 8270D, PCBs by EPA Method 8082A, mercury by EPA Method 7470A/7471B, and other metals (arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc) by EPA Method 6010C/6020A.
- Two samples from boring MW-44A-SB will be analyzed for TPH as gasoline, diesel, and oil by Ecology Methods NWTPH-Gx and NWTPH-Dx, VOCs by EPA Method 8260B, SVOCs by EPA Method 8270D, PCBs by EPA Method 8082 (low-level), mercury by EPA Method 7470A/7471B, and other metals (arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc) by EPA Method 6010C/6020A.

- Two samples from each boring MW-45A-SB and MW-46A-SB will be analyzed for TPH as gasoline, diesel, and oil by Ecology Methods NWTPH-Gx and NWTPH-Dx, VOCs by EPA Method 8260B, and BEHP by EPA Method 8270D.
- Two samples from boring MW-47A-SB will be analyzed for TPH as gasoline, diesel, and oil by Ecology Methods NWTPH-Gx and NWTPH-Dx, VOCs (including *n*-hexane) by EPA Method 8260B, low-level PAHs by EPA Method 8270-SIM, extractable petroleum hydrocarbons (EPH) by Method NW-EPH, and volatile petroleum hydrocarbons (VPH) by Method NW-VPH. In addition one soil sample from the screen location of MW-47A-SB and MW-47B-SB will be analyzed for TPH as gasoline, diesel, and oil by Ecology Method Northwest Total Petroleum Hydrocarbon-Gasoline (NWTPH-Gx) and NWTPH-Diesel (Dx), mercury by EPA Method 7470A/7471B and other metals (arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc) by EPA Method 6010C/6020A, low-level PAHs by EPA Method 8270-SIM, SVOCs by EPA Method 8270D, PCBs by EPA Method 8082A, and VOCs by EPA Method 8260B.
- Two samples from each boring MW-48A-SB and MW-49A-SB will be analyzed for VOCs by EPA Method 8260B. In addition one soil sample from the screen location of MW-40B-SB, MW-48A-SB, MW-48B-SB, MW-49A-SB and MW-49B-SB will be analyzed for TPH as gasoline, diesel, and oil by Ecology Method Northwest Total Petroleum Hydrocarbon-Gasoline (NWTPH-Gx) and NWTPH-Diesel (Dx), mercury by EPA Method 7470A/7471B and other metals (arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc) by EPA Method 6010C/6020A, low-level PAHs by EPA Method 8270-SIM, SVOCs by EPA Method 8270D, PCBs by EPA Method 8082A, and VOCs by EPA Method 8260B.

All samples will be collected in properly labeled, laboratory-prepared sample containers. Sample labels will include sample identification, site, date, time, preservatives added, requested analyses, and the sample collector's initials. Handling and chain of custody procedures are described later in this document and in the QAPP.

If soil samples contain metals in concentrations (in mg/kg) greater than or equal to 20 times the maximum concentration for the hazardous waste toxicity characteristics listed in 40 CFR 261.24 (in mg/l]), then the sample will be analyzed using Toxicity Characteristic Leaching Procedure (TCLP) using EPA Methods 1311 and 6010 series. Part of each sample will be held for TCLP analysis at the laboratory. We will direct the laboratory to notify us of such high concentrations in advance of the laboratory report, to allow for additional analysis within specified holding times for the samples.

Soil samples analyzed by Ecology Method NWTPH-Dx will be prepared in the analytical laboratory using silica gel acid wash to eliminate non-petroleum hydrocarbon (organic) interference.

Soil samples for TPH as gasoline, VOCs (including vinyl chloride), and VPH analyses will be collected using a plastic syringe and placed into laboratory-supplied, pre-weighed volatile organic analyte vials in accordance with EPA soil sampling method 5035A. Soil samples for all other analyses (including EPH) will be placed in laboratory-supplied glass sample jars and securely fitted with Teflon-lined plastic lids. Particles greater than 2 centimeters in diameter will be removed from the samples and discarded with the drilling cuttings.

Soil samples for BEHP analysis will be sampled using a stainless steel split spoon sampler in the drill rig to prevent cross contamination. Samples will be put in 8-ounce glass pre-cleaned screw top jars using a metal spoon, and the sampler will wear silvered gloves, which will be stored away from any plastic material.

Soil sample methods, required sample containers, preservation requirements, and holding times are provided in Table 3.

The established nomenclature for the soil samples will be:

DDMMYY – Boring Number-Depth

For example, a sample from boring DG11-1 collected at 5 feet bgs on May 5, 2011, would be identified as:

050511 – DG11-1-5

For tracking, duplicate samples will be labeled with a discrete, hypothetical boring number, starting at 100 (the actual origin of the samples will be recorded in the field log):

050511 – DG11-100

3.5 MONITORING WELL INSTALLATION AND DEVELOPMENT

The monitoring well riser pipe and screens will be 2-inch-diameter, flush-threaded Schedule 40 PVC. The well screens will be 10-foot-long, slotted screens with 0.010-inch slots. The well screens will be installed to straddle the water table. Placement of the well screens will be determined in the field and based on drilling conditions, but it is planned that approximately 2 feet of screen will be above the water table. After placement of the well screen, a filter pack consisting of #10 Colorado silica sand will be placed in the annular space to a height of 2 feet above the top of the screen. Above this, a bentonite pellet seal will be placed and hydrated with clean water. The wells will be completed with a grout seal to the ground surface. The surface completion will conform to the State of Washington

standards, and will consist of an 8-inch-diameter, flush-mounted, traffic-weight well monument. The monitoring wells will be fitted with water-tight locking well caps and keyed-alike locks.

Within 48 hours of well installation, the monitoring wells will be developed by the driller by surging with a surge block, followed by pumping out water until the water is clear and free of suspended solids. A minimum of six well volumes will be removed from each newly installed monitoring well. AMEC will record the volume, clarity, and specific conductance of the groundwater during the well development. The development water will be contained in 55-gallon drums. Water quality parameters will be measured and recorded during well development.

3.6 SURVEYING OF MONITORING WELLS

The horizontal locations and the elevations of the tops of inner and outer casings of the existing on-site and the newly installed monitoring wells will be surveyed by a professional surveyor licensed in Washington. Elevations will be established to the nearest 0.01 foot and locations to the nearest 0.1 foot.

3.7 GROUNDWATER LEVEL MEASUREMENTS

Groundwater surface elevations will be used to make an initial assessment of the groundwater potentiometric surface, surface gradient, and direction of groundwater flow. Depth to groundwater will be measured manually during a one-day period for all on-site wells and before sampling in each well.

Groundwater elevation will be measured with a pre-cleaned electronic water level meter or oil/water interface probe with an accuracy of ±0.01 feet. The groundwater elevation measurement shall be made from the top of the well casing (location marked by land surveyors). The measuring device shall be decontaminated between each use. Wells with known or suspected contamination will be measured last.

3.8 GROUNDWATER SAMPLE COLLECTION

Groundwater samples will be collected from the newly installed monitoring wells no sooner than 24 hours after development. The existing and newly installed monitoring wells will be sampled using a low-flow groundwater sampling technique using a portable bladder pump. The groundwater sampling procedures will be as follows:

1. Open well cap and allow water in the well to equilibrate pressure for several minutes.
2. Measure depth to water from established measuring point at top of casing and record on groundwater sampling field data sheet. Determine middle depth of the water column.

3. Connect new, low density polyethylene tubing to a bladder pump and lower the pump bottom to the middle depth of the water column in the well.
4. Establish the volume cycle appropriate for the pump size (150 mL or 29 mL).
5. Record measurements every 3 to 5 pumped volumes with Horiba U-22 or equivalent water quality meter for the following parameters: temperature, pH, specific conductance, dissolved oxygen, oxidation-reduction potential, and turbidity.
6. Record measurements of cycle volume.
7. Water quality will be considered stable when two consecutive measurements of parameters are within the following ranges:
    - ± 0.1 pH (units)
    - ± 5% electrical conductivity (milli-Siemens per centimeter [mS/cm])
    - ± 10 mV oxidation-reduction potential (millivolts [mV])
    - ± 10% turbidity (nephelometric turbidity units [NTUs])
    - ± 10% dissolved oxygen (mg/L)
    - ± 0.2 degrees Centigrade (C)
8. After water quality stabilizes, begin sample collection directly from pump discharge tubing.
9. Reduce pump rate for collection of VOC fraction.

If the well is purged dry before water quality stabilizes, the well will be allowed to recharge, and a groundwater sample will be immediately collected when there is sufficient water accumulated to obtain the necessary sample quantity. Groundwater samples will be collected at approximately mid-screen from all wells. All water quality parameters will be recorded on the Groundwater Field Sampling Form.

3.9 GROUNDWATER SAMPLE ANALYSES

Groundwater samples collected from the monitoring wells will be submitted to the analytical laboratory for the following analyses (summarized in Table 2):

- Each groundwater sample collected from the existing site monitoring well network and from the eleven newly installed wells MW-40B, MW-43A, MW-44A, MW-45A, MW-46A, MW-47A, MW-47B, MW-48A, MW-48B, MW-49A and MW-49B will be analyzed for VOCs by EPA Method 8260B and low-level vinyl chloride by EPA Method 8260B-SIM.

In addition to VOCs the following specific samples will be analyzed:

- Groundwater samples collected from monitoring well MW-16A and MW-42A will be analyzed for PCBs by EPA Method 8082A.
- Groundwater samples collected from monitoring wells MW-26A, MW-30A and MW-37A will be analyzed for SVOCs by EPA Method 8270D, low-level PAHs by EPA Method 8270-SIM, and total and dissolved metals (arsenic, copper, lead, nickel, silver, and zinc) by EPA Method 6010C/6020A.
- Groundwater samples collected from the eleven newly installed monitoring wells will be analyzed for TPH as gasoline, diesel, and oil by Ecology Methods NWTPH-Gx and -Dx, SVOCs by EPA Method 8270D, low-level PAHs by EPA Method 8270-SIM, low-level PCBs by EPA Method 8082A, and total and dissolved metals by EPA Method 6010C/6020A.
- Groundwater samples collected from monitoring wells MW-8A, MW-43A, MW-44A, MW47A/B, MW-48A/B and MW49A/B will also be analyzed for natural attenuation parameters (chlorinated ethenes, total organic carbon, non-halogenated VOCs, ethene, ethane, methane, ammonia N, orthophosphate P, nitrate, sulfate, sulfide, chloride, alkalinity, and total iron). Natural attenuation parameters also include field records of ferrous iron (Fe^{2+}), dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, temperature, and conductivity.

All samples will be collected in properly labeled, laboratory-prepared sample containers. Sample labels will include sample identification, site, date, time, preservatives added, requested analyses, and the sample collector's initials. Handling and chain of custody procedures are described later in this document and in the QAPP.

Soil sample methods, required sample containers, preservation requirements, and holding times are listed in Table 3.

The established nomenclature for the groundwater samples will be:

DDMMYY - Well Number

For example, groundwater sample from well MW-42A on May 5, 2011, would be identified as:

050511 – MW-42A

Duplicate samples will be labeled with a discrete hypothetical well number, starting at 100 (the actual origin of the samples will be recorded in the field log):

050511 – MW100

3.10 SURFACE MATERIALS SAMPLE COLLECTION

Sampling of storm water solids on the 8801 site since 2004 has identified chemicals that have not been identified in analyzed soil samples, or not in soil near the storm water system. Ecology requires identification of the source(s) of these chemicals. Since chemicals such as TBT have not been identified in soil and no source for the PCBs has been identified, sources not in the soil will be investigated:

- Five samples of paint from the buildings and from paint markings on the ground will be collected using a chisel and hammer by chipping away the top surface of the paint. The samples will be collected in a sampling bag provided by the laboratory. Each sample will be analyzed for cadmium, chromium, lead, zinc, and nickel by EPA Method 6010C/6020A, TBT by PSEP/Krone, and PCBs by EPA Method 8082A.
- A total of three samples of concrete jointing compounds and mastic will be collected. Mastic will be collected using a box cutter to cut out the area where mastic is located. Jointing compound will be collected by pulling out a 2-inch sample from the joint. The samples will be collected in a sampling bag provided by the laboratory. Each sample will be analyzed for PCBs by EPA Method 8082A.

The established nomenclature for the surface material samples will be:

DDMMYY – sample number

For example, a sample from surface material collected on May 5, 2011, would be identified as:

050511 – S01

Duplicate samples will be labeled with a discrete sample number, starting at 100 (the actual origin of the samples will be recorded in the field log):

050511 – S01-100.

3.11 HEALTH AND SAFETY

All site personnel performing field activities (groundwater sampling, etc.) will adhere to applicable safety procedures, detailed in the Health and Safety Plan (HASP) in Appendix C of the Data Gaps Work Plan, and shall sign the HASP Acceptance Sheet. Additionally, site visitors will check in with the Field Manager or Site Health and Safety Coordinator and will sign the Site Visitor Log and Safety Orientation Forms. Field tasks and associated potential hazards, summarized in the HASP, will be discussed in daily tailgate meetings attended by all site personnel.

3.12 FIELD QA/QC REQUIREMENTS AND PROCEDURES

QA/QC field procedures will be followed to ensure viability and integrity of sample analytical data. Field duplicates, field blanks, MS/MSD, and trip blanks will be collected as required under the QAPP (Appendix B of the Data Gaps Work Plan). Field duplicate samples will be collected at a frequency of one per 10 soil and groundwater samples, MS/MSD duplicates at a frequency of one per twenty soil and groundwater samples, and one equipment blank for groundwater samples per day. In addition, trip blanks and temperature blanks will accompany each cooler shipped to the laboratory.

QA/QC results will be evaluated in accordance with the QAPP. Questionable or unacceptable results will be brought to the immediate attention of the QA/QC representatives for AMEC, the analytical laboratory, and PACCAR. The potential causes of any such occurrences will be evaluated on an expedited basis and any deficiencies, if found, will immediately be rectified.

3.13 SAMPLE HANDLING, CHAIN-OF-CUSTODY, AND SHIPPING PROCEDURES

After logging the samples on the Chain-of-Custody form, samples will be placed in a cooler containing either gel ice or wet ice (in zip-lock bags) to maintain a temperature as close as possible to 4 degrees Centigrade (°C). At the conclusion of each day's sampling activities, the coolers will be prepared for shipment by placing sample containers in such a manner as to avoid leaks, spills, or volatilizations of samples from the sample containers. Within the cooler, containers will be cushioned to prevent movement that could cause breakage. If possible, samples will be transported directly to the laboratory by the field technician within the appropriate sample holding time. If a courier is used, the Chain-of-Custody form will be signed and dated with the time of relinquishment to the courier, and a notation will be made to identify the courier (for example, FedEx or UPS). The field technician will keep a copy of the Chain-of-Custody form and will place the original and copies in a zip-lock bag, which will be taped inside the lid of the cooler for the laboratory.

3.14 EQUIPMENT DECONTAMINATION

Sampling equipment will be decontaminated to maintain data quality, to prevent cross contamination, and to prevent the potential introduction of contaminants into previously unimpacted areas. Reusable sampling equipment, including the drill rig, down-hole drilling equipment, and stainless-steel materials, will be decontaminated before obtaining each sample. General decontamination procedures for non-dedicated soil sampling equipment and accessories are as follows.

- Wash with potable water and nonphosphate detergent solution.
- Rinse with potable tap water.
- Rinse with deionized water.

- Rinse with isopropyl alcohol.
- Air dry.

3.15 INVESTIGATION DERIVED WASTE MANAGEMENT

Investigation Derived Waste (IDW) generated by the field investigation will be labeled and securely stored on the 8801 site in 55-gallon drums approved by the US Department of Transportation. Drums will be stored at a designated location. The various waste streams will include the following:

- Potentially contaminated liquids, including fluids derived from purging, development of monitoring wells, and equipment decontamination water
- Potentially contaminated solids, principally soil cuttings

Each drum will be labeled with standardized IDW drum labels to indicate its contents, date of collection, location from which the IDW originated, and other pertinent information. In addition, all drums will also be labeled with indelible paint sticks or pens. AMEC will maintain an inventory of the drums. On completion of the project, the IDW will be disposed of at an appropriate off-site facility, following a review of the investigation analytical data.

4.0 DOCUMENTATION

The integrity of data obtained from samples collected during the field investigation depends on proper sample management and handling. Proper sample management includes sample labeling, which assigning a specific identification number and affixing proper identification and markings to the collected samples. Proper handling includes proper packing and transport of the sample containers.

4.1 FIELD LOG BOOK

The field logbook serves as the primary record of field activities. Entries shall be made chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct the applicable events. The field logbook shall be bound, with consecutively numbered, water repellent pages.

At a minimum, the following information will be recorded in either the field logbook or a separate sample log sheet during the collection of each sample:

- Sample location and description
- Sampler's name(s)
- Date and time of sample collection

- Type of sample (soil, groundwater, or surface water)
- Type of sampling equipment used
- Field instrument readings and calibration
- Field observations and details related to analysis or integrity of samples (weather conditions, noticeable odors, colors, etc.)

4.2 LABELING

Each sample container sent to the lab will have a unique sample identification label with the following information:

- Project name and location
- Project number
- Sample identification number
- Date and time of collection
- Analyses to be performed
- Initials of the sampler

4.3 SAMPLE CHAIN OF CUSTODY

Chain-of-Custody forms will be completed at the end of each sampling day using the information from the field notebook. The forms will be reviewed and signed by the field consultant or sampling consultant. The completed Chain-of-Custody form will be placed inside a sealed plastic re-sealable bag and taped inside the lid of the cooler.

5.0 REFERENCES

Specific laboratory method references are provided in the QAPP.

Puls R.W. and Barcelona, M. J., United States Environmental Protection Agency, 1996, Low Flow Groundwater Sampling Procedures.

Ecology, 2005, Guidance on Remediation of Petroleum – Contaminated Ground Water by Natural Attenuation, Publication 05-09-091, July.

Ecology, 2007, Model Toxics Control Act (WAC 173-340).

Kennedy/Jenks, June 2003, Technical Addendum to Data Gaps Work Plan.

EPA 2003. Procedure for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures. U.S. EPA. Office of Research and Development. November 2003. EPA-600-R-02-013

TABLES

TABLE 1
Summary of Well Construction Details
8801 East Marginal Way South, Tukwila, Washington

Well Designation	Date of Installation	Status	Casing Diameter/ Construction	Borehole Diameter	Total Well Depth (ft)	Blank Interval (ft)	Screened Interval (ft)	Slot Size (in)
MW-1A	16-Feb-86	Functional	4" / PVC	excavation	10	5	5	0.020
MW-6A(R)	26-Apr-04	Functional	2" / PVC	9 inches[(b)]	20	5	15	0.010
MW-7A	19-Jun-86	Functional	2" / PVC	9 inches[(b)]	19.2	4.7	14.5	0.020
MW-8A	23-Jun-86	Functional	2" / PVC	9 inches[(b)]	18	3	15	0.020
MW-8B	14-Mar-02	Functional	2" / PVC	9 inches	28.5	23.5	5	0.010
MW-9A	20-Jun-86	Functional	2" / PVC	9 inches[(b)]	20.4	5.4	15	0.020
MW-11A	20-Jun-86	Functional	2" / PVC	9 inches[(b)]	20.8	5.3	15.5	0.020
MW-12A	23-Jun-86	Functional	2" / PVC	9 inches[(b)]	20.5	5	15.5	0.020
MW-14A	23-Sep-86	Functional	2" / PVC	9 inches[(b)]	15.4	1.4	14	0.020
MW-15A	26-Sep-86	Functional	2" / PVC	9 inches[(b)]	15.9	1.9	14	0.020
MW-16A	26-Sep-86	Functional	2" / PVC	9 inches[(b)]	16.9	1.9	15	0.020
MW-18A	14-Jul-87	Functional	2" / PVC	9 inches[(b)]	18.6	8.6	10	0.020
MW-19B	16-Jul-87	Functional	2" / PVC	9 inches[(b)]	37	32	5	0.020
MW-22A	16-Jul-87	Functional	2" / PVC	9 inches[(b)]	20.3	5.3	15	0.020
MW-23A	17-Jul-87	Functional	2" / PVC	9 inches[(b)]	20	5	15	0.020
MW-24A	15-Apr-97	Functional	2" / 316 SS	9 inches[(b)]	20	5	15	0.010
MW-25A	9-Apr-97	Functional	2" / PVC	9 inches	23	13	10	0.010
MW-26A	9-Apr-97	Functional	2" / PVC	9 inches	20	10	10	0.010
MW-26B	16-Apr-97	Functional	2" / PVC	9 inches	40	35	5	0.010
MW-26C	5-Jun-97	Functional	2" / PVC	9 inches	59	49	10	0.010
MW-27A	14-Apr-97	Functional	2" / 316 SS	9 inches	25.5	20.5	5	0.010
MW-28A	14-Apr-97	Functional	2" / 316 SS	9 inches	20.3	15.3	5	0.010
MW-28B	14-Apr-97	Functional	2" / 316 SS	9 inches	40.3	35.3	5	0.010
MW-29A	8-Apr-97	Functional	2" / PVC	9 inches	25	15	10	0.010
MW-29B	12-Mar-02	Functional	2" / PVC	9 inches	44	34	10	0.010
MW-29C	26-Mar-02	Functional	2" / PVC	9 inches	56	49	7	0.010
MW-30A	8-Apr-97	Functional	2" / PVC	9 inches	24.3	14.3	10	0.010
MW-31A	9-Apr-97	Functional	2" / PVC	9 inches	23	13	10	0.010
MW-32A	9-Apr-97	Functional	2" / PVC	9 inches	23	13	10	0.010
MW-33A	14-Mar-02	Functional	2" / PVC	9 inches	20	10	10	0.010
MW-34A	14-Mar-02	Functional	2" / PVC	9 inches	20	10	10	0.010
MW-35A	13-Mar-02	Functional	2" / PVC	9 inches	20	10	10	0.010
MW-35B	13-Mar-02	Functional	2" / PVC	9 inches	40	35	5	0.010
MW-36A	11-Mar-02	Functional	2" / PVC	9 inches	20	10	10	0.010
MW-36B	11-Mar-02	Functional	2" / PVC	9 inches	42	37	5	0.010
MW-37A	11-Mar-02	Functional	2" / PVC	9 inches	20	10	10	0.010
MW-37B	12-Mar-02	Functional	2" / PVC	9 inches	40	35	5	0.010
MW-38A	2-May-02	Functional	2" / PVC	9 inches	23	13	10	0.010
MW-39A	11-Mar-02	Functional	2" / PVC	9 inches	20	10	10	0.010
MW-41A	13-Feb-04	Functional	2" / PVC	9 inches	21.5	11.5	10	0.010
MW-42A	26-Apr-04	Functional	2" / PVC	9 inches	20	5	15	0.010

Acronyms:

PVC Schedule 40 PVC pipe
SS Stainless steel
TOC Top of well casing

TABLE 2
Sample Location, and Analytical Program for Data Gaps Investigation
8801 East Marginal Way South, Tukwila, Washington

Location or Monitoring Well	Analytical Methods																	
	Gasoline-range organics by Method NWTPH-Gx	Diesel- and heavy oil-range organics by Method NWTPH-Dx	Volatile organic compounds by EPA Method 8260B	Vinyl chloride (low level) by EPA Method 8260B-SIM	Semivolatile organic compounds by EPA Method 8270D	Polycyclic aromatic hydrocarbons by EPA Method 8270-SIM (low level) 0.1 ug/L and 5.0 ug/kg	Polychlorinated biphenyls by EPA Method 8082A (low level) 0.1 ug/L and 20 ug/kg	Dissolved metals by EPA Methods 6010C/6020A and 7470A/7471B (mercury)	Total metals by EPA Methods 6010C/6020A and 7470A/7471B (mercury)	Tributyl tin (TBT) by Method PSEP/Krone	Dioxin/Furans by EPA Method 1613B	Pentachlorophenol by EPA Method 8041A	Bis (2-ethylhexyl) phalate (BEHP) by EPA Method 8270D	Waste disposal - RCRA 8, TCLP & flash point (from drums)	Field Duplicate	MS/MSD	Equipment Blank	Comments
Surface Materials (paint, mastic, joint fillers)																		
SS							8		5	5					1			Cadmium, chromium, lead, nickel, zinc
Soil Samples																		
DG11-1							2		2		1	1	2	1	1			Lead only
DG11-2							2		2				2					Lead only
DG11-3							2		2				2					Lead only
DG11-4							1								1			DTB = 5' bgs
DG11-5							1				1	1						DTB = 5' bgs
DG11-6							1				1	1						DTB = 5' bgs
DG11-7							1								1	1		DTB = 5' bgs
DG11-8	2	2	2															BTEX only
DG11-9							1		1									Arsenic only DTB = 5' bgs
DG11-10							1		1									Arsenic only DTB = 5' bgs
DG11-11	1	1				1	1		1									Copper only DTB = 3" bgs
DG11-12	1	1				1	1		1									Copper only DTB = 3" bgs
MW-40B-SB	2	2	2		2	2	2		2									
MW-43A-SB	2	2	2		1	2	2		2				2	1				dibenzofuran by EPA Method 8270D; arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc
MW-44A-SB	2	2	2		2	2	2		2					1				arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc
MW-45A-SB	2	2	2										2					
MW-46A-SB	2	2	2										2					
MW-47A-SB	2	2	2		1	2	1		1						1			dup VOCs only, *n*-hexane, EPH/VPH by NW-EPH/NW-VPH
MW-47B-SB	1	1	1		1	1	1		1									
MW-48A-SB	1	1	2		1	1	1		1									
MW-48B-SB	1	1	1		1	1	1		1									
MW-49A-SB	1	1	2		1	1	1		1									
MW-49B-SB	1	1	1		1	1	1		1									
Soil Totals	**21**	**21**	**21**	**0**	**11**	**15**	**26**	**0**	**22**	**0**	**3**	**3**	**12**	**3**	**4**	**1**	**0**	
Groundwater Samples																		
Previously Existing Monitoring Wells																		
MW-1A			1	1														
MW-6A(R)			1	1														
MW-7A			1	1														
MW-8A			1	1														
MW-8B			1	1														
MW-9A			1	1														
MW-11A			1	1														
MW-12A			1	1														
MW-14A			1	1														
MW-15A			1	1														
MW-16A			1	1			1											
MW-18A			1	1											1		1	
MW-19B			1	1											1		1	
MW-22A			1	1														
MW-23A			1	1												1		
MW-24A			1	1												1		
MW-25A			1	1														
MW-26A			1	1	1		1	1	1							1		
MW-26B			1	1														

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W:_Projects\14000s\14995 Paccar\14995-L\Phase 30\FINAL\Data Gaps SAP\Attachments\Table 2 Sampling Matrix 072911 Final

TABLE 2
Sample Location, and Analytical Program for Data Gaps Investigation
8801 East Marginal Way South, Tukwila, Washington

Location or Monitoring Well	Analytical Methods																	
	Gasoline-range organics by Method NWTPH-Gx	Diesel- and heavy oil-range organics by Method NWTPH-Dx	Volatile organic compounds by EPA Method 8260B	Vinyl chloride (low level) by EPA Method 8260B-SIM	Semivolatile organic compounds by EPA Method 8270D	Polycyclic aromatic hydrocarbons by EPA Method 8270-SIM (low level) 0.1 ug/L and 5.0 ug/kg	Polychlorinated biphenyls by EPA Method 8082A (low level) 0.1 ug/L and 20 ug/kg	Dissolved metals by EPA Methods 6010C/6020A and 7470A/7471B (mercury)	Total metals by EPA Methods 6010C/6020A and 7470A/7471B (mercury)	Tributyl tin (TBT) by Method PSEP/Krone	Dioxin/Furans by EPA Method 1613B	Pentachlorophenol by EPA Method 8041A	Bis (2-ethylhexyl) phalate (BEHP) by EPA Method 8270D	Waste disposal - RCRA 8, TCLP & flash point (from drums)	Field Duplicate	MS/MSD	Equipment Blank	Comments
MW-26C			1	1											1			
MW-27A			1	1														
MW-28A			1	1														
MW-28B			1	1														
MW-29A			1	1														
MW-29B			1	1														
MW-29C			1	1											1		1	
MW-30A			1	1	1		1	1	1									
MW-31A			1	1														
MW-32A			1	1														
MW-33A			1	1														
MW-34A			1	1														
MW-35A			1	1														
MW-35B			1	1													1	
MW-36A			1	1														
MW-36B			1	1														
MW-37A			1	1	1		1	1	1						1			
MW-37B			1	1														
MW-38A			1	1											1			
MW-39A			1	1														
MW-40A			1	1														
MW-41A			1	1														
MW-42A			1	1			1											
Newly Installed Monitoring Wells																		
MW-40B	1	1	1	1	1	1	1	1	1						1		1	
MW-43A	1	1	1	1	1	1	1	1	1									
MW-44A	1	1	1	1	1	1	1	1	1							1		
MW-45A	1	1	1	1	1	1	1	1	1								1	
MW-46A	1	1	1	1	1	1	1	1	1									
MW-47A	1	1	1	1	1	1	1	1	1						1			
MW-47B	1	1	1	1	1	1	1	1	1									
MW-48A	1	1	1	1	1	1	1	1	1									
MW-48B	1	1	1	1	1	1	1	1	1									
MW-49A	1	1	1	1	1	1	1	1	1						1			
MW-49B	1	1	1	1	1	1		1	1									
Groundwater Totals	**11**	**11**	**53**	**53**	**14**	**11**	**15**	**14**	**14**	**0**	**0**	**0**	**0**	**0**	**9**	**4**	**6**	

Notes:
DTB = depth to base
EPA = US Environmental Protection Agency

TABLE 3
Sample Containers, Preservation and Storage
8801 East Marginal Way South, Tukwila, Washington

Analysis	Method Reference	Sample Container	Number of Containers	Preservation and Storage	Holding Time
Soil					
Gasoline-range organics	NWTPH-Gx	VOA vial w/MeOH	1	10 mL MeOH	14 days
Diesel-range organics[1]	NWTPH-Dx	8 oz. CWM jar[2] with PTFE lid	1	4° C	14 days
EPH	MTCA NW-EPH	8 oz. CWM jar with PTFE lid	1	HCl pH<2; 4° C	14 days
VPH	MTCA NW-VPH	VOA vial w/stir bar[5]	2	HCl pH<2; 4° C	14 days
Volatile organic compounds[3,4]	EPA 8260B	VOA vial w/stir bar[5]	2	Freeze within 48 hrs	14 days
Low-level vinyl chloride	EPA 8260B SIM	VOA vial w/sodium bisulfate	2	Sodium Bisulfate	14 days
Semivolatile organic compounds	EPA 8270C	4 oz. CWM jar with PTFE lid	1	4° C	14 days
Polycyclic aromatic hydrocarbons	EPA 8270D SIM	4 oz. CWM jar with PTFE lid	1	4° C	14 days
Polychlorinated biphenyls	EPA 8082	4 oz. CWM jar with PTFE lid	1	4° C	14 days
Metals	EPA 200/6000/7000	4 oz. CWM jar with PTFE lid	1	4° C	14 days
Dioxins/furans	EPA 1613B	4 oz. CWM jar with PTFE lid	1	4° C	14 days
Pentachlorophenol	EPA 8041	4 oz. CWM jar with PTFE lid	1	4° C	14 days
Water					
Gasoline-range organics	NWTPH-Gx	VOA vial w/HCl	3	HCl pH<2, 4° C	14 days
Diesel range organics	NWTPH-Dx	500-mL amber bottle w/HCl	2	HCl pH<2, 4° C	14 days
Volatile organic compounds[3,4]	EPA 8260B[6]	VOA vial	3	HCl pH<2, 4° C	14 days
Polycyclic aromatic hydrocarbons	EPA 8270D	1-Liter amber	2	4° C	7 days
Low-level vinyl chloride	EPA 8260B SIM	VOA vial w/HCl	2	HCl pH<2, 4° C	14 days
Polychlorinated biphenyls	EPA 8082	1-Liter amber	1	4° C	14 days
Semivolatile organic compounds	EPA 8270C	1-Liter amber	1	4° C	14 days
Total metals	EPA 200/6000/7000	500-mL polyethylene w/HNO3	1	HNO3, pH<2, 4o C	28 days
Dissolved metals[7]	EPA 200/6000/7000	500-mL polyethylene	1	HNO3, pH<2, 4o C	28 days[8]

Notes:
1. Silica gel cleanup will be performed on samples where the chromatograph indicates a possible biogenic influence.
2. Sample fraction would come from the same 8 oz jar that was collected for PAHs
3. Includes benzene, toluene, ethylbenzene, total xylenes, and *n*-hexane
4. Includes 1,2-dichloroethane, 1,2-dibromoethane, and *n*-hexane for selected samples that appear to be contaminated based on field screening.

TABLE 3
Sample Containers, Preservation and Storage
8801 East Marginal Way South, Tukwila, Washington

Analysis	Method Reference	Sample Container	Number of Containers	Preservation and Storage	Holding Time

5. Sample volume = 5 ounces
6. 1,2-Dibromoethane will be analyzed using EPA Method 8011.
7. Sample to be filtered in the lab.
8. Sample must be filtered within 48 hours of collection for this holding time to apply.

CWM jar = Clear, wide-mouth glass jar
EPH = Extractable petroleum hydrocarbons
HCl = Hydrochloric acid
MeOH = Methanol
PTFE = teflon
VOA = volatile organic analysis
VPH = Volatile petroleum hydrocarbons

TABLE 4
Natural Attenuation Parameter Sampling Containers, Preservation, and Storage
8801 East Marginal Way South, Tukwila, Washington

Natural Attenuation Parameter Analysis[1]	Method	Sample Container	Number of Containers	Preservation and Storage	Holding Time
Ferrous iron (soluble)	Field-measured	N/A	N/A	N/A	N/A
Dissolved oxygen (DO)	Field-measured	N/A	N/A	N/A	N/A
Oxidation-reduction potential (ORP)	Field-measured	N/A	N/A	N/A	N/A
pH	Field-measured	N/A	N/A	N/A	N/A
Conductivity	Field-measured	N/A	N/A	N/A	N/A
Temperature	Field-measured	N/A	N/A	N/A	N/A
Chlorinated Ethenes	EPA 8260B	VOA vial w/HCl	3	HCl pH<2, 4°C	14 days
Total organic carbon	EPA 300.0	25 mL unpreserved polyethylene	1	none	28 days
Non-halogenated VOCs	EPA 8260B	VOA vial w/HCl	3	HCl pH<2, 4°C	14 days
Ethene, ethane, methane	RSK175	40 mL HCl Vials	3	HCl	14 days
Ammonia N	EPA 350.1	400 mL unpreserved polyethylene	1	H2SO4, pH<2, 4°C	28 days
Orthophosphate P	EPA 300.0	50 mL, unpreserved polyethylene	1	filter on site	2 days
Nitrate	EPA 300.0	100 mL unpreserved polyethylene	1	none	2 days
Sulfate	EPA 300.0	50 mL unpreserved polyethylene	1	4°C	28 days
Sulfide	EPA 300.0	500 mL unpreserved polyethylene	1	4°C	7 days
Chloride	EPA 300.0	50 mL unpreserved polyethylene	1	none	28 days
Total Iron	EPA 6020	100 mL HNO_3 polyethylene	1	HNO_3	180 days
Alkalinity	EPA 310.1	100 mL unpreserved polyethylene	1	4°C	14 days

Notes
[1]Ecology, 2007
EPA = US Environmental Protection Agency
HCl = hydrochloric acid
HNO_3 = nitric acid
mL = milliliter
NA = not applicable
VOAs = volatile organic analysis

APPENDIX A.1

Groundwater Field Sampling Form & Well Development Log

GROUNDWATER SAMPLING LOG
Low Flow Sampling

MONITORING WELL/PIEZOMETER NUMBER _____

Project Name: _____

Date: _____

Project Number: _____ **Weather Conditions:** _____

Location: _____

Sampler: _____ **Wind Speed/Direction:** _____

WELL INFORMATION

Casing Diameter (in): _____ **Groundwater Elevation (ft):** _____

Top of Casing Elevation (ft): _____ **Depth of Well Casing (ft):** _____

Initial Depth to Water (ft): _____ **Actual Purge Volume (gal):** _____

Wellhead Condition: _____

PURGING MEASUREMENTS

WL (ft btoc)	Time	pH (std. units)	SC (ms/cm)	Temp. (^{o}C)	ORP (mv)	DO (mg/L)	Turbidity (NTUs)	Notes

Sample ID No.: _____

Water Level Ind. Model & No.: Horiba U-22

ORP/DO Meter Model & No.: Horiba U-22

Purge Equipment Used: Peristaltic pump

Sampling Equipment Used: Peristaltic pump

Purge Start Time: _____ **Sample Collection Time:** _____

Purge Completion Time: _____ **Purging Method:** low-flow w/peristaltic

Average Purge Rate (mL/min): _____ **Sample Containers Used:** _____

Analytical Lab: ARI **Chemical Analyses:** _____

Other Field Observations: _____

APPENDIX B

Quality Assurance Project Plan

FINAL QUALITY ASSURANCE PROJECT PLAN

8801 East Marginal Way South

Tukwila, Washington

AGREED ORDER Number 6069

Prepared by:

AMEC Earth & Environmental, Inc.

11810 North Creek Parkway North
Bothell, Washington 98011

July 29, 2011

Project No. 9-915-14995-L

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FINAL QUALITY ASSURANCE PROJECT PLAN
8801 East Marginal Way South
Tukwila, Washington
AGREED ORDER Number 6069

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared to support generation of data by AMEC Earth & Environmental, Inc., (AMEC) under activities described in the Data Gaps Work Plan (work plan) for various tasks to be performed at the PACCAR Inc (PACCAR) site located at 8801 East Marginal Way South, Tukwila, Washington (8801 site). This QAPP describes the data quality needs of the project and the quality control, quality assurance, and data management activities needed to achieve these needs.

This QAPP has been prepared following guidance from the Washington State Department of Ecology (Ecology) document "Guidelines and Specifications for Preparing Quality Assurance Project Plans for Environmental Studies," July, 2004, 04-03-030. It is intended to be used only in conjunction with the 8801 site work plan

2.0 BACKGROUND

The Lower Duwamish Waterway (LDW) has been designated as a Superfund site for sediments by the United States Environmental Protection Agency (EPA). Ecology is working with EPA to identify sources of contamination to the LDW.

The 8801 site consists of an upland portion (8801 property) and the adjoining sediments in the LDW. The 8801 site is subject to two separate Agreed Orders: Agreed Order No. 6069, which applies to the 8801 property, and Agreed Order No. 3599, which applies to the sediments. This QAPP fulfills, in part, the remedial investigation conditions in Agreed Order No 6069.

The upland portion of the 8801 site occupies 24.30 acres on the east bank of the LDW at 8801 East Marginal Way South (Parcel 5422600060), Tukwila, Washington. The upland portion of the 8801 site is owned by Merrill Creek Holdings, LLC, (MCH) and is leased to Insurance Auto Auctions, Inc. (IAAI), which uses the 8801 site to store and auction damaged and wrecked vehicles.

Various consultants have performed field activities at the 8801 site since 1986. The field work undertaken since 1986 have included extensive, area wide, and focused investigations. As a result

of the investigations, 42 groundwater monitoring wells were installed and a large number of samples analyzed. Major remedial activities included removal of underground storage tanks (USTs), installation of a groundwater pumping and treatment system, contaminated soil excavation and disposal, application of oxygen-releasing compounds to the subsurface soil, storm-drain inspection and cleaning, and installation of an air sparge (AS) and soil vapor extraction (SVE) system.

An Interim Action Work Plan submitted to Ecology in 2008 (AMEC 2008) identified data gaps on the 8801 site. Since 2008, work on the LDW Superfund site has required cleanup levels on properties adjacent to the LDW to be revised to more stringent levels. AMEC revised preliminary screening criteria (PSCs) for the 8801 site to levels protective of the LDW sediment and surface water cleanup. The revised PSCs were applied to the entire list of chemicals analyzed at the 8801 site; the results were submitted to Ecology in the draft RI report in November, 2010 (AMEC 2010). After revisions, the final chemicals of potential concern (COPCs) for the 8801 site were agreed on in March, 2011.

3.0 PROJECT DESCRIPTION

The objective of the work described in the work plan is to address the identified data gaps in order to commence the Focused Feasibility Study (FFS) for the 8801 site. Further sampling and analysis of soil, groundwater, and surface materials will more precisely identify the locations and extents of COPCs through the use of lower detection limits, will document the lateral and/or vertical extent of contamination, will evaluate impacts to groundwater through leaching, and will identify surface sources that may be contributing to chemicals detected in the storm water solids.

AMEC proposes the following scope of work to achieve these objectives:

- Analyze new samples for selected chemicals under more sensitive methods to achieve significantly lower detection limits.
- Collect soil samples from 23 locations to evaluate lateral and/or vertical extent of known COPCs.
- Install 11 monitoring wells and collect groundwater samples to determine if chemicals are leaching into groundwater.
- Collect groundwater samples at 47 locations to evaluate the distribution of volatile organic compounds (VOCs) in groundwater across the 8801 site.

- Collect groundwater samples at locations across the 8801 site to evaluate the distribution of volatile organic compounds (VOCs) in groundwater and from two wells to determine if polychlorinated biphenyls (PCBs) are present.
- Collect 8 bulk samples of paint, joint compounds, and mastic to determine if these surface materials are the source of tributyl tins (TBTs) and PCBs in storm water solids collected from the site storm water control system.

The revised preliminary screening criteria are significantly lower than detection limits for some of the chemicals previously detected at the 8801 site. The objective of using analytical methods with lower detections limits on some samples is to determine whether trace levels of those chemicals are present. These lower detection limits are primarily related to vinyl chloride.

4.0 ORGANIZATION AND SCHEDULE

The project schedule is discussed in detail in the 8801 site Sampling and Analysis Plan (SAP) (Appendix A to the work plan). Key project personnel with specific quality assurance responsibilities are specified in the following table.

Table 1 Key Project Personnel

Name/Role	Organization	Phone Number	Responsibility
Meg Strong/ Project Manager	AMEC	(425) 368-0966	The AMEC Project Manager is responsible for the entire Site including document generation and field activities being completed in accordance with the SAP and this QAPP. The AMEC Project Manager will communicate with PACCAR and its representatives, and PACCAR will provide the primary communication channel to the Ecology Project Manager. The AMEC Project Manager will also be responsible for communication with the entire AMEC project team, including the Project Field Manager, Project Chemist, and the Quality Assurance (QA) Officer. The AMEC Project Manager will also oversee the proper implementation of the work plan and this QAPP and will delegate tasks as appropriate.
Anastasia Speransky/ Field Manager	AMEC	(206) 342-1760	The Project Field Manager will oversee field data collection and ensure that it is conducted in accordance with the work plan and this QAPP.
Marie Bevier/ Project Chemist	AMEC	(503) 639-3400	The Project Chemist will be responsible for monitoring the data collection process so that data collected for this project meet the quality standards set forth in this QAPP. The Project Chemist will be responsible for overseeing the activities of the subcontract laboratories and for

Name/Role	Organization	Phone Number	Responsibility
			coordination of data management and data validation activities.
Brian Johnson/ Database Manager	AMEC	(503) 639-3400	The Database Manager will be responsible for maintaining the project database and ensuring that all Project data are accurately entered into the database.
Ann Bernhardt/ Quality Assurance Officer	AMEC	(503) 639-3400	The Project QA Officer will provide senior-level review of data management and data validation activities.
Mark Harris/ Laboratory Project Manager	Analytical Resources Incorporated (ARI)	(206) 695-6200	The project laboratory is ARI, located in Tukwila, Washington. The ARI Project Manager will be responsible for communication between ARI and the AMEC Project Chemist and will ensure that ARI performs laboratory analyses in accordance with the appropriate analytical methods and the requirements of this QAPP. The ARI Project Manager will work directly with the Project Chemist.

5.0 QUALITY OBJECTIVES

5.1 PROJECT DATA QUALITY OBJECTIVES

Project-level data quality objectives (DQOs) for data collected during the project are outlined in this QAPP. The primary DQO supported by this QAPP is production of chemical analysis data of known and sufficient quality to support the project-level DQOs defined in this QAPP.

Definitive data are required to achieve the project-level DQOs, and strict adherence to requirements of this document is required so that the data are of known and sufficient quality. The measurement quality objectives (MQOs) discussed in the next section will be used to control data quality. Laboratory compliance with MQO goals, analytical methodology requirements, and good laboratory practice will be assessed during the data verification and validation procedure.

5.2 MEASUREMENT QUALITY OBJECTIVES

The MQOs presented in this section are precision, accuracy, representativeness, comparability, completeness, detectability, and the additional indicator of selectivity. These MQOs can be applied to both field and laboratory analytical measurements to ensure that obtained data are of known and appropriate quality to support specific decisions or regulatory actions. Selectivity is a data quality indicator that applies specifically to laboratory data to ensure that reported data are representative of the reported compound, and not of a positive or negative artifact. Discussion of the project MQOs in this QAPP will be limited to their application and goals for purposes of the project. Except

where specified, the MQO goals discussed below are not intended to be used as criteria for acceptance or rejection of data, but rather as guidance to indicate when further evaluation of data quality is needed.

Performance goals for these MQOs have been established at two levels. The first (more stringent) goal applies to the COPCs for the project, and the second (less stringent) goal applies to other target analytes.

5.2.1 Precision

Precision is defined as the degree of agreement between or among independent, similar, or repeated measurements. Precision will be measured as the relative percent difference (RPD) between duplicate analyses when analyte concentrations are greater than five times the reporting limit (RL), and as an absolute concentration based on the RL when analyte concentration is less than five times the RL.

When analyte concentrations are more than five times the RL, precision will be calculated as the RPD as follows:

$$\%RPD_i = 100 \times \left(\frac{2 \times |X_i - Y_i|}{X_i + Y_i} \right)$$

Where:

$\%RPD_i$ = Relative percent difference for compound i
X_i = Concentration of compound i in original sample or spiked sample
Y_i = Concentration of compound i in duplicate sample, or duplicate spike

If the precision performance goals are not met, the laboratory will investigate the cause of the MQO exceedance and include a discussion of the exceedance and any impact on data usability in the laboratory case narrative. If the cause of the MQO exceedance is determined to be laboratory error, the laboratory will reprepare and/or reanalyze the sample as appropriate.

Precision related to sample collection in the field will be monitored as the difference between field duplicates. The RPD between field duplicates for samples with analyte concentrations greater than the RL will be less than or equal to 40% for aqueous samples. The absolute concentration difference between duplicate samples with concentrations less than five times the RL will be less than or equal to the corresponding RL. If this MQO goal is exceeded, AMEC will investigate possible causes and will discuss the results of the investigation and any effect on data usability in the data quality evaluation report.

Table 2 Laboratory Precision Performance Goals

Analysis	Solid Samples	Aqueous Samples
Petroleum hydrocarbons (TPH)	≤ 50% RPD[1]	≤ 30% RPD[1]
Polychlorinated biphenyls (PCBs)	≤ 50% RPD[1]	≤ 30% RPD[1]
Volatile organic compounds (VOCs)	≤ 30% RPD[1]	≤ 20% RPD[1]
Semivolatile organic compounds (SVOCs)	≤ 30% RPD[1]	≤ 20% RPD[1]
Polycyclic aromatic hydrocarbons (PAHs)	≤ 50% RPD[1]	≤ 40% RPD[1]
Polychlorinated dibenzo-p-dioxins / Polychlorinated dibenzofurans (PCDDs/PCDFs)	≤ 30% RPD[1]	≤ 20% RPD[1]
Metals	≤ 30% RPD[1]	≤ 20% RPD[1]
Tributyl tin (TBT)	≤ 30% RPD[1]	≤ 25% RPD[1]

5.2.2 Accuracy

Accuracy is the amount of agreement between a measured value and the true value. It will be monitored as the percent recovery (%R) of the matrix spike (MS) and/or the matrix spike duplicate (MSD), laboratory control samples (LCSs), also known as blank spikes, and surrogate spike compounds. It will also be measured using the analytical results of instrument calibration and other laboratory internal standards.

Accuracy will be calculated as the %R of analytes as follows:

$$\%R_i = 100 \times \left(\frac{Y_i}{X_i}\right)$$

Where:

$\%R_i$ = percent recovery for compound i
Y_i = measured analyte concentration in sample i (measured - original sample concentration)
X_i = known analyte concentration in sample i

Project-specific MQO goals for each type of accuracy control sample are discussed below and will be applied unless an analytical method contains defined performance criteria for the MQO.

[1] RPD limits for concentrations greater than or equal to five times the RL. The difference between the concentrations should be less than or equal to the RL when concentrations are less than five times the RL.

Table 3 Accuracy Goals for Interference-Free Matrices

Analysis	LCS (COPCs)	LCS (Non-COPCs)	Surrogates
TPH	80% to 120%	Laboratory limits	50% to 150%
PCBs	50% to 130%	Laboratory limits	50% to 130%
VOCs	80% to 120%	Laboratory limits	80% to 120%
SVOCs	45% to 135%	Laboratory limits	45% to 135%
PAHs	60% to 120%	Laboratory limits	60% to 120%
PCDDs/PCDFs	Method-specified limits	Method-specified limits	Method-specified limits
Metals	80% to 120%	Laboratory limits	Not Applicable
TBT	75% to 125%	Laboratory limits	Not Applicable

- Sporadic failure of a single COPC analyte to meet LCS recovery goals may be tolerated as long as the recovery is within non-COPC recovery goals, and the laboratory can prove that the quality control (QC) limit exceedance does not indicate a systematic recovery problem for the analyte.
- Up to 5% of non-COPC analytes may fail to meet the non-COPC recovery goals without requiring re-extraction/reanalysis as long as the laboratory can demonstrate that the recovery outside of acceptance limits does not indicate a systematic recovery problem, but is sporadic in nature.

The laboratory case narrative must include a discussion of the effect of any analyte recovery outside COPC or non-COPC recovery goals. AMEC will evaluate effects on data usability in data validation reports.

Table 4 Accuracy Goals for Sample Matrices

Analysis	MS (COPCs)	MS (Non-COPCs)	Surrogates
TPH	Not Applicable	Not Applicable	50% to 150%
PCBs	40% to 140%	Laboratory limits	40% to 140%
VOCs	70% to 130%	Laboratory limits	70% to 130%
SVOCs	45% to 145%	Laboratory limits	35% to 140%
PAHs	45% to 135%	Laboratory limits	45% to 135%
PCDDs/PCDFs	Method-specified limits	Method-specified limits	Method-specified limits
Metals	75% to 125%	Laboratory limits	Not Applicable
TBT	70% to 130%	Laboratory limits	Not Applicable

Recoveries outside of COPC or non-COPC recovery goals must be reflective of the sample matrix rather than laboratory procedural bias, and that all matrix-related recovery problems are

adequately documented in the laboratory report and raw data. Compliance with this MQO goal will be assessed by comparison of analyte and surrogate recovery in the sample matrix to laboratory performance on method blanks and blank spikes, and by results of the data validation and verification process.

5.2.3 Representativeness

Representativeness is the degree to which data accurately and precisely represent a parameter variation at a sampling point or an environmental condition. The results of all analyses will be used to evaluate the data to determine if the samples were collected in such a manner that the results appropriately describe the area investigated.

Field procedures to ensure that collected samples are representative of the 8801 site are discussed in the work plan and SAP. Representativeness of laboratory data will be achieved by following standardized procedures for subsampling. If an aqueous sample is subsampled for analysis, the sample will be mixed by inversion prior to removal of the analytical aliquot unless doing so would compromise analytical results.

5.2.4 Comparability

Comparability is the degree to which data from one study can be compared with data from other similar studies, reference values (such as background), and screening values. Field procedures to promote comparability of collected samples are discussed in the work plan and SAP. Comparability of laboratory results will be achieved by following standardized analytical procedures, using traceable reference materials, using Class A volumetric glassware or correctly calibrated pipettors for volumetric procedures, using correctly calibrated balances for gravimetric procedures, and following good laboratory practices.

AMEC will insist on strict adherence to method QC and procedural requirements and the requirements of this QAPP, or proper documentation by the laboratory of deviations from the analytical methods. If undocumented method deviations are discovered during data validation, AMEC chemists will evaluate potential effects on data usability and comparability, and will contact the laboratory for corrective action.

5.2.5 Completeness

Completeness is defined as the percentage of usable data out of the total amount of data generated. Analytical completeness is a measure of the number of overall accepted analytical results (valid results), including estimated values, compared to the total number of analytical results requested on samples submitted for analysis after review of the analytical data. Less than 100% completeness could result if sufficient chemical concentrations exist to require sample dilutions,

resulting in an increase in project-required detection/quantitation limits for some parameters. Highly contaminated environments can also be sufficiently heterogeneous to prevent the achievement of specified precision and accuracy criteria. Therefore, the target goal for completeness as a whole shall be 98% for both field and laboratory analytical methods. Completeness for project-specific data needs shall be 95% for each individual method. Project-specific data needs will be defined on an individual batch basis and will consist of data for which all QC criteria were met.

Completeness will be calculated as follows:

$$\%C = 100 \times \frac{A}{I}$$

Where:

%C = Percent completeness (analytical)
A = Actual number of samples collected/valid analyses obtained
I = Intended number of samples/analyses requested

Rejection of data due to severe matrix interference is sometimes unavoidable. AMEC chemists will work with the project laboratories to minimize these problems, if possible, and will document any steps taken to alleviate the problem(s).

Rejection of data due to laboratory performance issues typically is unacceptable. AMEC chemists will closely monitor laboratory performance during project execution in order to minimize the potential for discovery of severe data quality issues only after the data are reported. Project laboratories are expected to pay careful attention to analytical procedures and method requirements, and to implement corrective actions to avoid rejection of results.

5.2.6 Detectability

In this context, detectable sensitivity refers to the ability of project analytical procedures to identify and quantify target analytes at concentrations low enough to meet project data needs. Specific indicators of sensitivity in analytical measurement include RLs and method detection limits (MDLs).

The MDL is a purely statistical value, determined by the analysis of seven or more low level replicate samples, which is defined by EPA as the concentration at which an analytical system has a 99% probability of avoiding false positive results. The MDL lies in a region of high quantitative uncertainty and results near the MDL must be considered estimated values.

The RL is normally set at a factor five to ten times the MDL. The exact number depends on the lowest concentration that a laboratory can successfully use as a low calibration standard. The RL is

considered the lowest concentration that a lab con report with reasonable quantitative accuracy, although results less than five times the RL can still be highly variable.

In a practical sense, adequate sensitivity requires the absence of false positive and false negative signals near the RL, or near the MDL in cases where the RL exceeds an applicable regulatory or screening level. Laboratory blank concentrations will be used to assess the possible effects of false positive and false negative results on reported analytical results for field samples. The MQO goal for blank results is that no blank should contain detectable target analyte concentrations.

Laboratory blank results that exceed the RL will require re-preparation and re-analysis of affected samples, while laboratory results that exceed the MDL require evaluation on a case-by-case basis, and must be communicated by the laboratory to the AMEC Project Chemist before data are reported. It must be noted that blank concentrations that consist of a negative number that exceeds the negative RL or the negative MDL are considered to exceed the corresponding limit.

The definition of an MDL limit in 40 CFR 136 Appendix D states that the MDL represents the concentration that gives a 99 percent confidence of avoiding false positive results. As such, it is the responsibility of the project laboratory to ensure that the MDL is routinely achievable. If AMEC notes evidence of a systematic problem with laboratory ability to achieve their stated MDL, the project laboratory will be required either to institute corrective action and fix the analytical problem or to subcontract the sample for analysis to a laboratory approved by AMEC in advance that can achieve acceptable performance. Evidence that the laboratory cannot routinely achieve the stated MDL for an analyte will consist of a pattern of results, with an absolute value greater than or equal to the MDL for that analyte in multiple laboratory blanks.

For the purpose of the project, the primary MQO goal for sensitivity is that the laboratory RL be less than or equal to the most stringent applicable screening value for project COPCs. If the RL is greater than the most stringent applicable screening value, then the secondary MQO goal is that the laboratory MDL be less than or equal to the most stringent applicable screening value. A list of project COPCs and corresponding most stringent applicable screening values may be found in Appendix A, Table A1.

The laboratory is expected to make every effort to avoid excessive dilution and to preserve RLs or MDLs low enough to meet project needs. If a sample must be diluted due to matrix interference or elevated concentrations of target analytes to such a degree that one or more target analytes must be reported with RLs or MDLs above the most stringent applicable screening values for those compounds, the laboratory must immediately notify the AMEC Project Chemist so that appropriate actions may be taken to generate an adequate data set for the project.

5.2.7 Selectivity

Selectivity refers to the ability of determinative analytical procedures to correctly identify an analyte when it is present, and to discriminate between the analyte and potential interference. The MQO goal for data generated as part of project activities is to minimize or eliminate the reporting of false positive and false negative results by the laboratory.

The MQO for selectivity will be accomplished by (1) using proper preparation and cleanup procedures, as specified in Appendix A, Table A2, (2) using mass selective detection, where possible, (3) requiring that the project laboratory maintain its analytical systems in proper working procedure by following the preventative maintenance schedules outlined in the laboratory's Quality Assurance Manual (QAM), and (4) requiring that the project laboratory strictly follow method requirements for compound identification. Proper compound identification will be monitored during data validation, and the project laboratories will be required to provide additional explanation for any questionable compound identification.

It is expected and required that the laboratory will appropriately flag any data generated from a response that does not meet all required identification as being only presumptively identified. It is also expected that the laboratory will document the reason for rejection of any results in the raw data when examination of the sample spectrum indicates that the compound appears to be present.

6.0 SAMPLING DESIGN, FIELD PROCEDURES, AND CHAIN-OF-CUSTODY

Sampling design and field procedures for the project are discussed in detail in the work plan and SAP. Observations of field activities related to data collection are integral to comprehensive data evaluation. Field forms and notes should be up to date with respect to samples to be collected, sample IDs, QA/QC sample collection requirements, and where the samples are to be submitted for analysis.

Samples shall be maintained under proper chain-of-custody (COC) while in the field and until receipt by the lab. Samples will be transported directly from the field to the contract laboratory. Samples will be considered to be in a person's custody if they are in the person's possession, under the person's control, or stored in a secure area with restricted access. COC forms will be retained with their respective samples at all times and signed and dated appropriately.

7.0 SAMPLE COLLECTION AND PRESERVATION

Sample locations, sample collection procedures, and sample preservation are specified in the work plan and SAP. Appendix A, Table A3 summarizes the sampling requirements for each laboratory method, including sample containers, minimum sample volumes, preservation, and holding times.

8.0 QUALITY CONTROL PROCEDURES AND CORRECTIVE ACTIONS

In order to attain data of sufficient quality to support project DQOs, specific procedures are required to allow evaluation of data quality. These procedures and requirements for their evaluation are described in this section.

8.1 FIELD QUALITY CONTROL

Evaluation of field sampling procedures requires the collection and evaluation of field QC samples. Trip blanks and field replicates will be collected and submitted to the laboratory to provide a means of assessing the quality of data resulting from the field sampling program.

8.1.1 Trip Blanks

Trip blanks will be used to evaluate whether the shipping and handling procedures are introducing contaminants into the samples, and if cross-contamination in the form of VOC migration has occurred between the collected samples. One trip blank will be submitted to the laboratory for analysis each day that volatile samples are collected. Trip blanks are volatile organic analysis (VOA) vials filled with purged, deionized water that are transported to the field and then returned to the laboratory without being opened.

Trip blanks should not contain detectable concentrations of target analytes greater than the RL for the compound. Any detection of target analytes in a trip blank will result in an investigation to determine effect on overall data usability, and affected results will be qualified as estimates or as nondetects at an elevated RL as appropriate.

8.1.2 Equipment Blanks

Equipment blanks are collected to evaluate the potential for cross-contamination of samples during collection. Equipment blanks will be collected at a rate of one at the commencement of the project and one at the completion of the project on the bladder pump and once on the tubing. Equipment blanks will be obtained by passing organic-free water through or over the decontaminated sampling equipment and collecting the water in appropriate sample containers.

Equipment blanks will be analyzed for the same parameters as the associated field samples. Equipment blanks should not contain detectable concentrations of any target analyte greater than the RL for the compound. Any detection of target analytes in an equipment blank will result in an investigation to determine effect on overall data usability, and affected results will be qualified as estimates or as nondetects at an elevated RL, as appropriate.

8.1.3 Field Replicate Samples

Field replicates are co-located samples that are collected simultaneously in separate containers. The purpose of field replicates is to allow evaluation of the contribution of random error from sampling to the total error associated with the data. One set of field replicates will be collected and submitted for every ten field samples collected. Field replicate precision will be evaluated as described in Section 5.2.1 above.

8.1.4 Calibration Requirements

Field-based analytical instruments must be calibrated following manufacturers' instructions and frequency recommendations (or following appropriate standard operating procedures [SOPs]) before they may be used for data collection.

8.2 LABORATORY QUALITY CONTROL

Laboratory quality control samples are used to monitor the laboratory's precision and accuracy of the analytical procedure results. Laboratory QC samples are analyzed as part of the standard laboratory QC protocols and are accomplished through analyzing method blanks, laboratory control samples (blank spikes), surrogate spikes, and internal standards. Not all analyses require the above QC sample types. Typically, these QC samples are not required for non-SW-846 methods. A summary of laboratory QC samples is presented in Appendix A, Table A4. The laboratory's QAM is presented in Appendix B.

8.2.1 Method Blanks

Method blanks will be used to check the level of laboratory background contamination. Laboratory method blanks will be analyzed with each sample batch. Results will be compared to all samples in the analytical batch.

QC criteria require that no contaminants be detected in the blank(s) in concentrations exceeding the RL. If an analyte is detected, the action taken will follow the laboratory SOPs and QAM. Blank samples will be analyzed for the same parameters as the associated field samples.

8.2.2 Laboratory Control Samples

Laboratory control samples (LCSs), also known as blank spikes (BS), are used to monitor the laboratory's day-to-day performance of routine analytical methods, independent of matrix effects. LCSs are prepared by spiking reagent water with standard solutions prepared independently from those used in establishing instrument calibration. LCSs must undergo the same preparation, cleanup (if used), and analyses as the associated field samples. Results are compared on a per-batch basis to pre-established control limits and are used to evaluate laboratory performance for precision and accuracy.

LCS recovery goals may be found in Section 5.2.2 and precision goals may be found in Section 5.2.1.

8.2.3 Matrix Spike/Matrix Spike Duplicate

MSs and MSDs are used to evaluate analytical (preparation and analysis) precision and accuracy. MS/MSD samples measure the effect of a specific sample matrix on analyte recovery. Only MS/MSD samples from this investigation will be analyzed, and not samples from other projects. The MS/MSDs will be collected at a frequency of one per twenty field samples collected. The MS/MSD samples will be analyzed for the same parameters as the primary samples in the same QC analytical batch. Results will be expressed as a percent recovery (%R) of the known spiked amount and as an RPD for the MS/MSD pairs.

MS recovery goals may be found in Section 5.2.2 and precision goals may be found in Section 5.2.1.

8.2.4 Laboratory Duplicates

Precision of the analytical system is evaluated by using laboratory duplicates. Laboratory duplicates are two portions of a single homogeneous sample analyzed for the same parameters. Laboratory duplicates will be prepared and analyzed for all analytical batches requiring duplicates as specified for each method in the laboratory QAM.

Not all methods require laboratory duplicates, and MSDs are preferred for many organic methods. LCS duplicates will be prepared and analyzed for all batches when insufficient sample is collected for matrix spike duplicates. The RPD calculation (precision) is described in Section 5.2.1.

8.2.5 Surrogate Spikes

Surrogate spikes are used to evaluate accuracy, method performance, and extraction efficiency. Surrogate compounds are compounds not normally found in environmental samples; however, they are similar to the target analytes in chemical composition and behavior in the analytical

process. Samples for organic analysis will be spiked with surrogate compounds consistent with the requirements described in the laboratory SOPs and QAM.

Since sample characteristics will affect the percent recovery (%R), %R is a measurement of accuracy of the overall analytical method on each individual sample. The %R of surrogates is calculated concurrently with that of the analytes of interest, using the equation in Section 5.2.2.

8.2.6 Internal Standards

Internal standards are used in gas chromatography / mass spectrometry (GC/MS) and inductively coupled plasma (ICP)-MS analyses. A constant amount of internal standard with a known concentration is added to all standards, samples, extracts, or digestates. The ratio of the peak area, height, or intensity of the target analyte to the peak area, height, or intensity of the internal standard in the sample, extract, or digestate is compared to a similar ratio derived for each calibration standard. The target analyte response is calculated relative to that of the internal standard.

For GC/MS analyses, internal standard areas or heights for all blanks, samples, and spikes must be 50 percent to 200 percent of the internal standard areas or heights from the last passing continuing calibration (CCAL). The laboratory must re-prepare and/or reanalyze any blank, sample, or spike that does not meet this MQO goal. If the internal standard area or height does not meet the MQO goal upon reanalysis, the laboratory must include a discussion of the possible cause and effect on data usability in the case narrative.

For ICP-MS analyses, the intensity of each internal standard must fall between 60% and 125% of the intensity of that internal standard in the initial calibration standard. If the intensity is outside of acceptance limits, the sample must be diluted twofold and reanalyzed with the addition of appropriate amounts of internal standard. This procedure must be repeated until the internal standard intensities are within acceptance limits. If the internal standard intensity level for any calibration blank or instrument check standard is outside of acceptance limits, analysis must be terminated, the problem corrected, the system recalibrated, the calibration verified, and all affected samples reanalyzed.

8.3 INSTRUMENT CALIBRATION AND FREQUENCY

Analytical instrument calibration and maintenance will be conducted in accordance with the QC requirements identified in each laboratory SOP and QAM, EPA guidance, and the instrument manufacturers' instructions. General requirements are discussed below.

8.3.1 Standard Solutions

A critical element in the generation of quality data is the purity/quality and traceability of the standard solutions and reagents used in the analytical operations. To ensure the highest purity possible, the primary reference standards and standard solutions will be obtained from the National Institute of Standards and Technology (NIST), the EPA repository, or a reliable commercial source, and will be traceable to NIST Primary Reference Standards. The laboratories will maintain written records of the supplier, lot number, concentration, receipt date, preparation date, preparer's name, method of preparation, expiration date, and all other pertinent information for all standards, standard solutions, and individual standard preparation logs.

Standard solutions will be validated before use. Validation procedures can range from a check for chromatographic purity to verification of the concentration of the standard solution using another standard solution prepared at a different time or obtained from a different source. Stock and working standard solutions will be checked regularly for signs of deterioration, such as discoloration, formation of precipitates, or change of concentration. Care will be exercised in the proper storage and handling of standard solutions. All containers will be labeled as to compound, concentration, solvent, expiration date, and preparation data (initials of preparer/date of preparation). Reagents will be examined for purity by subjecting an aliquot or sub-sample to the corresponding analytical method.

8.3.2 Balances

Analytical balances will be calibrated annually according to manufacturer's instructions and have a daily calibration check against NIST Class I weights before use by laboratory personnel. Balance calibration shall be documented in appropriate bound logbooks with pre-numbered pages.

8.3.3 Refrigerators

The refrigerators will be monitored for proper temperature by measuring and recording internal temperatures on a daily basis. At a minimum, thermometers used for these measurements will be calibrated annually, against a thermometer traceable to NIST.

8.3.4 Water Supply System

The laboratories will maintain an appropriate water supply system that is capable of furnishing American Society for Testing and Materials (ASTM) Type II polished water to the various analytical areas. This laboratory pure water shall not contain detectable concentrations of target analytes or interfering substances.

8.3.5 Laboratory Instruments

Calibration of analytical instrumentation is required to ensure that the analytical system is operating correctly and functioning at the sensitivity required to meet project-specific DQOs. Each instrument will be calibrated with standard solutions appropriate to the instrument and analytical method, in accordance with the methodology specified and at the QC frequency specified in the laboratory SOPs.

The calibration and maintenance history of the laboratory instrumentation is an important aspect of the project's overall QA/QC program. As such, the initial calibration (ICAL), initial calibration verification (ICV) and continuing calibration verification (CCV) procedures will be implemented by trained personnel following the manufacturer's instructions and in accordance with applicable EPA protocols to ensure the equipment is functioning within the tolerances established by the manufacturer and the method-specific analytical requirements.

Initial Calibration

ICAL of instruments used for the analysis of organic analytes in soil and water samples must be performed using a minimum of five standards for all single-component target analytes and surrogates.

- The relative standard deviation (RSD) shall be less than or equal to 15% for each compound included in the calibration standard, unless the criterion is superceded by method-specific acceptance limits, before an average response factor calibration may be considered valid. AMEC will not accept grand mean calibration models as valid for analytes that exceed RSD criteria.
- If RSD criteria cannot be met, linear or non-linear calibration models will be considered acceptable as long as the correlation coefficients are greater than or equal to 0.99.
- If a first order (linear) regression model is used for organic analytes, the line should not be forced through the origin, but have the intercept calculated from the five calibration points, and the origin (0,0) must not be used as a fictitious calibration point. Additionally, the lowest calibration point must be at a concentration less than or equal to the method quantitation limit.
- If a second order (quadratic) model is used, six calibration standards must be analyzed instead of five. The curve must be continuous, continuously differentiable, and monotonic over the calibration range. The line must not be forced through the origin, but have the intercept calculated from the six calibration points. In addition, the origin (0,0) must not be included as a seventh calibration point.

- Analytes with calibration models which cannot meet any of the above criteria may still be considered valid if they are not COPCs, AMEC has been notified in writing of the calibration difficulties before the start of analysis, and the laboratory qualified all affected data as estimated values.

ICAL of instruments used for the analysis of inorganic analytes will be conducted in accordance with the manufacturer's instructions and QC requirements identified in each laboratory SOP and QAM.

Initial Calibration Verification

Immediately after calibration, the analysis of an ICV standard will be required. The ICV standard will contain the same analytes as the calibration standards, at concentrations close to the middle of the calibration range, and made from a different source, manufacturer, or lot number than the calibration standards. ICV standards serve to verify the preparation and concentration of the instrument calibration standards. A single ICV is required each time the instrument is calibrated.

Continuing Calibration Verification

Continuing calibration verification (CCV – inorganic analyses) or continuing calibration (CCAL – organic analyses) standards will be analyzed (following method requirements) to verify the calibration of the analytical system over time. If the response or calculated concentration for an analyte is within the method-specific acceptance limits of the response obtained during the ICAL or of the expected concentration, the curve is considered valid and analysis may proceed. Samples may not be analyzed unless the calibration curve is proven valid. Once verified, an organic ICAL is valid until a CCAL fails or significant instrument maintenance is performed. Calibration procedure frequency is summarized in Appendix A, Table A4.

8.3.6 Preventative Maintenance

Preventative maintenance on laboratory systems will be performed as needed. No project samples will be analyzed on a system that is not in good working order and properly calibrated.

9.0 DATA MANAGEMENT PROCEDURES

AMEC and the laboratory are responsible for generating, controlling, and archiving project laboratory and field reports. This information will be maintained with a system that is effective for retrieval of any documentation that affected the reported results. This includes record generation and control, security, and maintenance for the project related documents.

9.1 DATA REDUCTION AND REPORTING

The QA Officer, Project Chemist, and Database Manager will work together to perform the final review and approval of the data before its entry into the database system. This will include examining the results for field duplicates, MS/MSDs, laboratory blanks, and laboratory duplicates to ensure they are acceptable. This will also include comparing the sample descriptions with the field sheets for consistency and ensuring that any anomalies in the data are appropriately documented.

9.1.1 Field Data Reduction, Review, and Deliverables

Field data will be reviewed less thoroughly than laboratory data. The Field Manager will debrief field personnel during sampling events, identify anomalous data or observations, evaluate if any action needs to be taken, and make recommendations to the Project Manager.

9.1.2 Laboratory Data Reduction, Review, and Deliverables

The project laboratory shall deliver final results and electronic data deliverables (EDDs) by email or CD no more than 14 days after receipt of the final sample in each SDG. Hard copy and portable document format (PDF) data packages or PDF-only data packages shall be received by AMEC no later than 30 days after receipt of the samples by the laboratory.

Data generated by the project laboratories will undergo data reduction and review procedures described in the laboratory QAM and SOPs. Data generated, reduced, and reviewed by the laboratories will undergo a comprehensive data review by a QA reviewer or designee.

For all analyses, EPA CLP-equivalent deliverable requirements will be employed for documentation and reporting of all data. CLP report forms will not be required.

9.1.3 Laboratory Data Reduction

The laboratory will perform in-house analytical reduction under the direction of the laboratory QA manager. Laboratory reduction procedures will be those adopted, where appropriate, from SW-846 (EPA, 1997 and updates) and those described in the QAM. The data reduction steps will be documented, signed, and dated by the analyst or designee. Data reduction will be conducted as follows:

- Raw data produced by the analyst will be processed and reviewed for attainment of QC criteria as outlined in this document and/or established EPA method for overall reasonableness and for calculation or transcription errors.

- Data will then be entered into the laboratory information management system (LIMS) and a computerized report will be generated and sent to the laboratory QA manager or designee for review.

Laboratory data reduction procedures will be those adopted, where appropriate, from Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods, SW-846 (EPA, 1997 and updates), and those described in the laboratory QAM. The data reduction steps will be documented, signed, and dated by the analyst.

Qualifiers used by the laboratory, as described and defined in the laboratory QAM, will include, but are not limited to:

- Concentrations below required RLs
- Estimated concentrations due to poor spike recovery
- Concentrations of chemicals also found in the laboratory blank
- Other sample-specific qualifiers necessary to describe QC conditions

The laboratory will maintain detailed procedures for laboratory record keeping in order to support the validity of all analytical work. Each data report package submitted to the AMEC Project Manager will contain the laboratory's written certification that the requested analytical method was run and that all QA/QC checks were performed. The laboratory program administrator will provide the AMEC Project Manager with QC reports of the laboratory's external audits, if appropriate, which will become part of the project file.

9.1.4 Laboratory Data Review

The laboratory data review process involves evaluation of both the results of the QC data and the professional judgment of the person(s) conducting the review. This application of technical knowledge and experience to the data evaluation is essential to ensuring the high quality of data. The laboratory has documented procedures, which are to be followed and must be accessible to all laboratory personnel. The laboratory generally reviews data in three steps before submittal:

- Level 1 Analyst/Peer Data Review – The analysts review the quality of their work based on an established set of guidelines. At a minimum, the review will ensure that appropriate preparation, analysis, and SOPs have been followed; analytical results are correct and complete; QC samples are within established control limits; and documentation is complete (for example, any anomalies have been documented).

- Level 2 Supervisory Data Review – A supervisor or data review specialist whose function is to provide independent review of the data package will perform this level of review. This review will also be conducted according to established guidelines (that is, method requirements and laboratory SOPs). The Level 2 review includes review of the qualitative and quantitative data and of documented anomalies.
- Level 3 Administrative Data Review – A laboratory QA/QC officer or program administrator performs the final data review before submittal. This level of review provides a total overview of the data package to ensure its consistency and compliance with project requirements.

The project laboratory QA/QC officer or designee will evaluate the quality of the work based on this QAPP and an established set of laboratory guidelines to ensure the following:

- Sample preparation information is correct and complete.
- Analysis information is correct and complete.
- Appropriate procedures have been followed.
- Analytical results are correct and complete.
- Laboratory QC check results are within appropriate QC limits.
- Special sample preparation and analytical requirements have been met.
- Documentation is complete (all anomalies in the preparation and analysis have been documented; holding times are documented).
- Laboratory qualifiers have been assigned to all samples with data usability limitations.

9.1.5 Laboratory Data Deliverables

Upon acceptance of the data by the laboratory QC manager or designee, deliverables will be generated and submitted to the AMEC Project Manager.

The raw data will be arranged so that the analyses for each method are presented in the chronological order in which they were analyzed. Raw data for samples and QC shall not be separated. Unusable data shall be included in the data package, but the results must be struck out using a single line and the analyst's initials. If a sample requires multiple analyses using the same analytical method (for example, multiple dilutions or second column confirmation), the laboratory shall specify which results were reported by striking through unusable results and/or circling reported results, or otherwise making it clear which results were reported.

9.2 FIELD DOCUMENT CONTROL AND RECORDS MANAGEMENT

Project-specific records that relate to field work performed will be retained for 5 years by AMEC. These records may include correspondence, COC records, field notes, and reports issued as a result of the work. In addition, records that document the field operations will be retained. These may include equipment performance records, maintenance logs, personnel files, general field procedures, and corrective action reports. Either electronic or hard copy records of field operations are acceptable.

9.3 LABORATORY DOCUMENT CONTROL AND RECORDS MANAGEMENT

The laboratory prepares and retains full analytical and QC documentation that can be tracked from initiation to disposal for each sample. The following minimum records should be stored for each project:

- Original work order, COC, and other pertinent documents received with the samples
- Communications between the laboratory, field personnel, and the customer
- Any associated corrective actions
- Laboratory data packages
- GC/MS mass spectra for samples, verified with analyst's initials
- Finalized data reports
- Laboratory log books
- GS/MS tune data, as applicable
- Electronic data

The laboratory should also maintain its QAM and related SOPs for the methods performed.

9.4 MANAGEMENT OF THE PROJECT DATABASE

All project laboratory analytical and field-measured environmental data are stored in a SQL-Server relational database using the EQuIS™ Database Management System. Electronic data storage and retrieval minimizes typographical errors, improves data security, allows rapid retrieval of large and complex data sets, and facilitates efficient data analysis and visualization.

9.4.1 Electronic Data Management Workflow

Each project analytical laboratory supplies AMEC with EDDs in the EQuIS four-file format. Upon delivery to AMEC, the EDDs are electronically checked for (1) completeness against sample and requested-method data collected from the related COC forms, (2) accurate use of project-specific valid values, and (3) compliance with the EQuIS™ four-file format specifications. Inaccurate or incomplete EDDs are returned to the lab for them to repair. Accurate and complete EDDs are imported into the EQuIS™ database and each result record is flagged as "not validated."

After data validation of each data deliverable package, the related database records are updated with any applicable validation qualifiers and flagged as validated.

9.5 REPORTS TO MANAGEMENT

The Project Chemist or QA Officer will provide assessment and oversight reports at the Project Manager's request. These reports will assess whether the data are of sufficient quality to satisfy QAPP requirements. At the specification of the AMEC Project Manager, assessment reports may document data quality for individual samples, entire sampling events, or the entire project data set.

10.0 ASSESSMENT/OVERSIGHT

10.1 PERFORMANCE AND SYSTEM AUDITS

Proper communication between field personnel, project management personnel, and laboratory personnel will help to ensure that the proper methods and techniques are used throughout the project.

The QA Officer will initiate audits, select the audit team, and oversee audit implementation.

The Field Manager will supervise and check that samples are collected and handled in accordance with this QAPP and the SAP and that documentation of work is adequate and complete.

The laboratory QA Manager will ensure that the analytical laboratory follows in-house performance guidelines and will perform system audits under the in-house QA/QC guidelines. The laboratory will immediately deal with any irregularities found in the laboratory's performance or system audits. The laboratory QA Manager or their designee, will also conduct the following internal audits regularly:

- Technical audit, including reviews of calibration and equipment monitoring records, laboratory logbooks, maintenance records, and instrument control charts
- Data quality audit reviews, including all aspects of data collection, reporting, and review

- Management systems audits verifying that management and supervisory staff effectively implement and monitor all QC activities necessary to support the laboratory QA program.

The AMEC Project Manager is responsible for overseeing that the project performance satisfies the QA objectives set forth in this document. Reports and technical correspondence will be peer-reviewed by qualified individuals before being finalized.

10.2 CORRECTIVE ACTIONS

Audits and other assessments may find practices or procedures that do not conform to this QAPP and/or the SAP. The following sections describe appropriate corrective actions for the various data management activities.

10.2.1 Field Corrective Action

The Field Manager will review the procedures being implemented in the field for consistency with the established protocols. Sample collection, preservation, labeling, etc., will be checked for completeness. Where procedures do not strictly comply with the established protocol, the deviations will be field documented and reported to the QA Officer. Corrective actions will be defined and documented, as appropriate, by the Field Manager and reported to the AMEC Project Manager and the QA Officer. The documentation will become part of the project file.

10.2.2 Laboratory Corrective Action

The laboratory QA Manager will be responsible for review of the data generated by their laboratory to ensure that all QC samples have been run as specified in the protocol. Recoveries of LCS, surrogate, and MS samples will be reviewed for method accuracy. The RPD of laboratory duplicates and MSD samples will be reviewed for method precision. The results will be evaluated against the control limits in Table 4 and appropriate corrective action taken if warranted.

Laboratory personnel will be alerted that corrective actions are necessary if any of the following occur:

- The QC data are outside the warning or acceptance limit(s) for precision and/or accuracy established for LCSs. The laboratory QA Manager will consult the Project Chemist or the QA Officer to discuss out-of-control data sets.
- Blanks contain contaminants at concentrations exceeding the detection limit.
- Undesirable trends are detected in the LCS or MS percent recoveries, RPDs, or surrogate recoveries.

- Unusual changes in detection limits are observed.
- The laboratory QA Manager detects deficiencies during internal or external audits, or from the results of performance evaluation samples.

If the analyst identifies any nonconformity in the analytical methodologies or QC sample results, the laboratory will implement corrective actions immediately. Specific corrective actions are outlined in the laboratory QAM (Appendix B).

The analyst will review the preparation or extraction procedures for possible errors check the instrument calibration, evaluate spike and calibration mixes, check instrument sensitivity, and initially handle corrective action procedures at the bench level. The analyst will immediately notify his/her supervisor of the identified problem and the investigation that is being conducted. If the problem persists or cannot be identified, the matter will be referred to the laboratory supervisor and laboratory QA Manager, and if the data are impacted, the Project Chemist and QA Officer will be provided a corrective action memo for inclusion in the project file.

Corrective action may include, but will not be limited to:

- Reanalyzing suspect samples if holding time permits
- Retrieving the archived sample for analysis
- Accepting data with acknowledged level of uncertainty (with consultation)
- Recalibrating analytical instruments
- Evaluating and attempting to identify data limitations
- Resampling

10.2.3 Corrective Actions Following Data Evaluation

Working with the Project Chemist, the QA Officer will be responsible for reviewing the laboratory data generated for this project and ensuring that all project QA objectives are met. If any nonconformance is found in field procedures, sample collection procedures, field documentation procedures, laboratory analytical and documentation procedures, and data evaluation and quality review procedures, the impact of the nonconformance on the overall project QA objectives will be assessed. Appropriate actions, possibly including reanalysis or resampling, will be recommended to the AMEC Project Manager so that the project objectives can be accomplished. Data deemed unacceptable by the AMEC Project Manager, after the implementation of the required corrective actions, will not be accepted and further follow-up corrective actions will be explored.

10.3 REPORTS

A Data Quality Review Report will be prepared at the end of data collection activities for the project. This report will include discussion of data quality as determined during the data assessment process described in Section 9 of this QAPP.

11.0 DATA REVIEW, VERIFICATION, AND ASSESSMENT

11.1 DATA REVIEW

All analytical data may be reviewed by the Project QA Manager, Project Chemist, Field Manager, or QA Officer as part of the process of preparing the information for use in the reporting.

11.2 VERIFICATION AND DATA QUALITY REVIEW OF PROJECT ANALYTICAL DATA

AMEC will verify EDD results against the finalized hard copy deliverables. Discrepancies can occur due to errors identified by the laboratory during final QC review due to systematic problems in generating the EDD. In order to assure accuracy of the database, 100 percent of the data in the database will be verified against the hard copy deliverable.

11.3 DATA QUALITY REVIEW

Data quality review is a data evaluation conducted by experienced analytical chemists. It involves review of the laboratory report associated with the project samples. Data quality review does not include review or validation of the raw analytical data.

Data quality review will be performed according to the current EPA functional guidelines for organic and inorganic data review, the EPA Office of Solid Waste and Emergency Response (OSWER) SOPs for inorganic and organic data review, SW-846 Method requirements, and project-specific requirements specified in this QAPP. Results of the data quality review will be presented in the Data Quality Review Report.

11.3.1 Data Quality Review Report

The Data Quality Review Report will summarize the performance of the project team in meeting the QA criteria outlined in this QAPP. The Data Quality Review Report will include, but is not limited to:

- Compliance with this QAPP
- COC documentation
- Compliance with technical holding times

- Compliance with project-specific reporting limits
- Field and laboratory QC samples (precision and accuracy)
- Field and method blanks
- Discussion of limitations on data usability

11.3.2 Qualification of Data

Data will be qualified based on the findings of the data verification and validation process. The data qualifiers used for this project will be taken from the EPA functional guidelines for data review, and will include:

U The U qualifier indicates that the analyte must be considered to be nondetected at the concentration listed. U qualifiers added during data quality review are typically a result of detection of target analytes in field, trip, or laboratory blanks.

J The J qualifier indicates that the associated result is quantitatively uncertain. J qualifiers added during data quality review indicate a data limitation related to a QC element that exceeds required acceptance limits.

N The N qualifier indicates that an analyte has been presumptively identified. Presumptive detection means that a chromatographic peak was detected at the correct retention time for an analyte, but that not all required identification criteria were met. The associated result is both qualitatively and quantitatively uncertain.

R The R qualifier indicates that a result has been rejected due to serious QC problems. It is not possible to definitively determine whether the analyte is present or absent in the sample.

11.4 FINAL DATA QUALITY ASSESSMENT

The Project QA Officer will perform a final data quality assessment as part of the commencement of the focused feasibility study for the 8801 site. Any data usability issues identified by the Project QA Officer will be communicated to the Project Chemist or Project Field Manager for further investigation and corrective action.

12.0 REFERENCES

Ecology, 2004. *Guidelines for Preparing Quality Assurance Project Plans.* July 2004, Publication No. 04-03-030.

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EPA, 2005. National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs) Data Review, Final, EPA-540-R-05-001, September 2005.

EPA, 2006. EPA QA/G-4, Guidance on Systematic Planning Using the Data Quality Objective Process. EPA/240/B-06/001, February 2006.

EPA, 2007. EPA QA/G-6, Guidance for Preparing Standard Operating Procedures. EPA/600/B-07-001, April, 2007.

EPA, 2008. EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, Final, EPA-540-R-08-01, June 2008.

EPA, 2002b. EPA QA/G-5, Guidance for Quality Assurance Project Plans, EPA/240/R 02/009, December 2002.

APPENDIX B.1

Additional Tables

TABLE 1
Potentially Applicable Screening Criteria
8801 East Marginal Way South Site

Analyte	Soil Human Health or Ecological Exposure mg/kg	Vadose Soil mg/kg	Saturated Soil mg/kg	Groundwater µg/L	Surface Water µg/L	Sediment mg/kg DW	Air ppbV
Total Petroleum Hydrocarbons							
Total Petroleum Hydrocarbons		1.25E-03	8.94E-05		2.08E-01	5.70E+00	
Gasoline	1.00E+02				1.00E+03		3.00E+05
Gasoline (with benzene)	3.00E+01						
Diesel	2.00E+03*				1.00E+04		
Heavy Oil	2.00E+03				5.00E+02		
Polychlorinated Biphenyls							
PCB - Aroclor 1016	5.60E+00	3.19E-03	1.60E-04	4.43E-01	5.82E-03	2.40E-01	
PCB - Aroclor 1221	6.56E+01	2.98E-03	1.51E-04		1.40E-02		
PCB - Aroclor 1232	6.56E+01	2.98E-03	1.51E-04		1.40E-02		
PCB - Aroclor 1242		2.10E-04	1.23E-05		1.40E-02		
PCB - Aroclor 1248	6.56E+01	1.24E-02	6.21E-04	2.73E-01	1.40E-02	2.40E-01	
PCB - Aroclor 1254	1.60E+00	2.52E-03	1.26E-04	1.59E-01	1.66E-03	2.40E-01	
PCB - Aroclor 1260		5.80E-02	2.90E-03	5.80E-02	1.40E-02	2.40E-01	
PCB mixtures	3.00E-01	5.78E-05	2.90E-06	2.68E-01	6.40E-05	2.20E-04	3.39E+01
Volatile Organic Compounds							
Acetone	8.00E+03				8.00E+02		3.29E+04
Benzene	3.00E-02	1.16E-02	7.15E-04		1.20E+00		2.63E-02
Bromodichloromethane	1.60E+01	1.85E-03	1.26E-04		2.70E-01		
Bromoform	1.30E+02	2.90E-02	2.00E-03		4.30E+00		2.30E+00
Carbon disulfide	8.00E+03						3.20E+02
Carbon tetrachloride	7.70E+00	2.04E-03	1.10E-04		2.30E-01		9.20E-03
Chlorobenzene	4.00E+01	2.32E-01	1.40E-02		2.00E+01		1.74E+00
Chloroethane	4.50E+04	2.98E-03	1.86E-04		4.10E-01		2.36E+02
Chloroform (trichloromethane)	1.60E+02	3.97E-02	2.65E-03		5.70E+00		2.23E-02
Chloromethane	7.70E+01	9.19E-01	5.91E-02		1.33E+02		6.73E-01
2-Chlorotoluene	1.60E+03						
4-Chlorotoluene							
1,2-Dichlorobenzene	7.20E+03	7.79E-02	4.53E-03	5.19E+00	5.19E+00	3.50E-02	1.06E+01
1,3-Dichlorobenzene					3.20E+02	2.10E-02	
1,4-Dichlorobenzene	2.00E+01	7.16E-02	4.17E-03	7.14E+00	4.82E+00	4.80E-02	6.09E+01
1,1-Dichloroethane	1.60E+04	5.68E+00	3.72E-01		8.00E+02		3.95E+01
1,2-Dichloroethane (EDC)	1.10E+01	2.64E-03	1.80E-04		3.80E-01		2.38E-02
1,1-Dichloroethene	4.00E+03	4.87E-04	2.65E-05		5.70E-02		1.26E-02
cis-1,2-Dichloroethene	8.00E+02				8.00E+01		1.60E+01
1,2-Dichloropropane	1.50E+01	3.78E-03	2.49E-04		5.00E-01		1.80E+00
Ethylbenzene	6.00E+00	8.96E+00	5.02E-01		5.30E+02	1.00E-02	1.06E+02
Hexachlorobutadiene	7.00E+02	4.35E-02	6.26E-04	3.92E+00	4.40E-01	1.10E-02	1.07E-02
n-Hexane	4.80E+03						3.20E+02
4-Isopropyltoluene							
Methylene chloride (dichloromethane)	2.00E-02	3.15E-02	2.09E-03		4.60E+00		1.53E+00
4-Methyl-2-pentanone (MIBK)	6.40E+03						3.20E+01
Styrene	3.30E+01						1.03E+00
1,1,2,2-Tetrachloroethane	5.00E+00	1.39E-03	9.13E-05		1.70E-01		4.30E-02
Tetrachloroethene (PCE)	5.00E-02	3.64E-03	2.08E-04		3.87E-01	5.70E-02	6.08E-02
Toluene	7.00E+00	1.52E+01	9.07E-01		1.30E+03		4.86E+01
1,1,1-Trichlorethane	2.00E+00	1.99E+04	2.73E+02		4.17E+05		4.20E+02
1,1,2-Trichlorethane	1.80E+01	1.21E-02	6.77E-04		5.90E-01		2.86E-02
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	2.40E+06						1.40E+04
1,2,4-Trichlorobenzene	2.00E+01	8.36E-03	5.61E-04	1.13E+00	1.13E+00	1.30E-02	1.23E+01
Trichloroethene (TCE)	3.00E-02	1.23E-02	7.61E-04		1.53E+00	1.60E+02	9.58E-02
1,3,5-Trimethylbenzene	4.00E+03						2.96E+02
1,2,4-Trimethylbenzene							
Vinyl chloride	6.70E-01	2.11E-04	1.13E-05		2.50E-02		1.22E-02
m,*p*-Xylene							
o-Xylene	1.60E+05						4.60E+01
Xylene	9.00E+00	2.41E+02	1.40E+01		1.60E+04	4.00E-02	1.06E+01
Total Xylenes	1.60E+05						4.60E+01

TABLE 1
Potentially Applicable Screening Criteria
8801 East Marginal Way South Site

Analyte	Soil Human Health or Ecological Exposure mg/kg	Vadose Soil mg/kg	Saturated Soil mg/kg	Groundwater µg/L	Surface Water µg/L	Sediment mg/kg DW	Air ppbV
Semivolatile Organic Compounds							
Benzoic acid	3.20E+05	1.35E+01	9.66E-01	2.24E+03	2.24E+03	6.50E-01	
Benzyl alcohol	2.40E+04	1.15E+00	8.11E-02	1.82E+02	1.82E+02	5.70E-02	
Bis(2-ethylhexyl) phthalate	7.10E+01	9.39E-01	4.70E-02	2.85E-01	2.85E-01	7.30E-01	
Butyl benzyl phthalate	1.79E+02	1.01E-01	5.12E-03	5.24E-01	5.24E-01	6.30E-02	
Carbazole	5.00E+01						
Dibenzofuran	1.60E+02	3.08E-01	1.56E-02	1.33E+00	1.33E+00	2.30E-01	6.24E+02
Dibutyl phthalate	2.00E+02	2.85E-01	2.85E-01	1.51E+02	1.51E+02	1.40E+00	4.40E+02
Diethyl phthalate	2.80E+06	4.13E+00	2.69E-01	4.84E+02	4.84E+02	6.00E-03	5.51E+02
Dimethyl phthalate	3.50E+06	8.57E-01	6.14E-02	1.43E+02	1.43E+02	7.10E-02	6.30E+02
2,4-Dimethylphenol	7.00E+04	4.11E-02	2.32E-03	2.02E+00	2.02E+00	2.90E-02	
4,6-Dinitro-2-methylphenol							
Di(*n*-octyl) phthalate	7.00E+04	1.11E-02	5.91E-04	2.96E-01	2.96E-01	6.10E-02	
2-Fluorobiphenyl							
Hexachlorobenzene	3.10E+01	2.06E-05	1.07E-06	1.12E-01	2.80E-04	5.90E-03	4.66E-04
2-Methylphenol (*o*-cresol)	4.00E+03	5.56E-02	3.70E-03	7.11E+00	7.11E+00	5.50E-02	5.00E+03
4-Methylphenol (*p*-cresol)	4.00E+02	4.63E-01	3.32E-02	7.72E+01	7.72E+01	1.10E-01	5.00E+03
4-Nitrophenol							
n-Nitrosodiphenylamine	2.04E+02	2.53E-01	1.29E-02	1.96E+00	1.96E+00	2.80E-02	
Pentachlorophenol	4.50E+00	1.99E-02	1.03E-03	5.33E+00	2.70E-01	1.20E-02	4.59E+01
Phenol (total)	3.00E+01	4.99E-01	3.51E-02	7.84E+01	7.84E+01	1.80E-01	5.00E+03
2,4,6-Trichlorophenol	1.00E+01	4.16E-02	2.26E-03		1.40E+00		9.98E-02
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	2.00E+01	3.36E-01	1.71E-02	2.61E+00	2.61E+00	2.50E-01	
Acenaphthylene	NC	1.39E+00	7.07E-02	1.08E+01	1.08E+01	5.60E-01	
Anthracene	2.40E+04	4.46E+00	2.25E-01	1.08E+01	1.08E+01	9.60E-01	2.00E+02
Benzo[*g h i*]perylene		6.21E-01	3.11E-02	1.16E-02	1.16E-02	4.80E-01	
Benzo[*a*]anthracene	1.40E-01	1.30E-02	6.49E-04	2.58E-01	2.80E-03	1.50E-02	2.14E+01
Benzo[*a*]pyrene	1.00E-01	4.41E-02	2.20E-03	1.26E-01	2.80E-03	1.50E-02	1.40E-04
Benzo[*b*]fluoranthene	1.40E-01	4.50E-02	2.25E-03	2.86E-01	2.80E-03	1.50E-02	
Benzo[*k*]fluoranthene	1.40E-01	4.41E-02	2.20E-03	2.92E-01	2.80E-03	1.50E-02	
Chrysene	1.40E-01	1.32E-02	6.62E-04	4.66E-01	2.80E-03	1.50E-02	2.14E+01
Dibenz(*a*,*h*)anthracene	1.40E-01	1.47E-01	7.34E-03	4.58E-03	2.80E-03	1.50E-02	1.76E+01
Fluoranthene	3.20E+03	3.21E+00	1.61E-01	2.26E+00	2.26E+00	1.70E+00	
Fluorene	3.00E+01	4.72E-01	2.39E-02	2.04E+00	2.04E+00	3.60E-01	
Indeno[1,2,3-cd]pyrene	3.42E+00	1.50E-01	7.49E-03	1.27E-02	2.80E-03		
1-Methylnaphthalene							
2-Methylnaphthalene	3.20E+02	1.19E+00	6.19E-02	1.82E+01	1.82E+01	5.90E-01	3.02E+03
Naphthalene	5.00E+00	2.30E+00	1.22E-01	5.38E+01	5.38E+01	1.50E+00	1.37E-02
Phenanthrene		2.03E+00	1.02E-01	4.81E+00		1.50E+00	2.00E+02
Pyrene	2.40E+03	2.01E+01	1.01E+00	1.44E+01	1.44E+01	2.60E+00	2.00E+02
Light PAHs						5.20E+00	
Heavy PAHs						1.20E+01	
Polychlorinated Dibenzo-*p*-Dioxins/Polychlorinated Dibenzofurans							
2,3,7,8-TCDD	2.00E-06	1.47E-08	7.34E-10		5.00E-09	1.41E-07	4.43E-09

TABLE 1
Potentially Applicable Screening Criteria
8801 East Marginal Way South Site

Analyte	Soil Human Health or Ecological Exposure mg/kg	Vadose Soil mg/kg	Saturated Soil mg/kg	Groundwater µg/L	Surface Water µg/L	Sediment mg/kg DW	Air ppbV
Metals							
Aluminum	NV	NC	NC		NC	7.70E+03	9.06E+03
Antimony	5.00E+00	5.07E+00	2.54E-01		5.60E+00	3.10E+00	1.83E-02
Arsenic (total)	2.40E-01	1.05E-02	5.30E-04		1.80E-02	2.30E-05	1.90E-04
Arsenic (III)	7.00E+00						
Arsenic (V)	1.00E+01						
Barium	1.02E+02					1.50E+03	2.85E-02
Beryllium	1.00E+01	4.32E+03	2.16E+02		2.73E+02		2.01E-04
Cadmium	4.00E+00	3.50E-02	1.78E-03	2.56E+00	2.50E-01	3.30E-01	3.02E-04
Chromium, total (or III)	4.20E+01	1.48E+03	7.40E+01	3.06E+02	7.40E+01	3.90E+01	2.35E+02
Chromium VI	1.90E+01	3.86E+00	1.94E-01		1.00E+01		1.72E-03
Cobalt	3.20E+03					1.00E+01	2.07E+01
Copper	5.00E+01	1.07E+00	5.38E-02	1.23E+02	2.40E+00	3.50E+01	3.85E+01
Iron						5.50E+03	4.38E+02
Lead	5.00E+01	5.00E+02	2.50E+01	1.13E+01	2.50E+00	1.00E+01	2.09E-03
Manganese	1.10E+03					1.80E+02	1.02E-02
Mercury	1.00E-01	5.40E-03	2.71E-04	5.16E-03	5.16E-03	4.10E-01	3.66E-03
Mercury (organic)	4.00E-01						1.13E+00
Molybdenum	2.00E+00					3.90E+01	1.27E+03
Nickel	3.00E+01	6.53E+00	3.27E-01		5.00E+00	2.80E+01	4.33E-02
Selenium	3.00E-01	5.30E-01	2.72E-02		5.00E+00	1.00E+00	6.19E+01
Silver	2.00E+00	2.64E-01	1.34E-02	1.53E+00	1.53E+00	5.60E-01	2.27E+00
Thallium	1.00E+00	3.42E-01	1.71E-02		2.40E-01	5.10E-01	1.20E+01
Tin	5.00E+01						4.12E+02
Vanadium	2.00E+00					3.90E+01	2.40E+01
Zinc	8.60E+01	4.06E+01	2.03E+00	3.26E+01	3.26E+01	2.60E+02	
Tributyl Tin							
Tributyl tin						1.70E-02	1.00E+02

Notes:
µg/L = micrograms per liter
DW = dry weight
mg/kg = milligrams per kilogram
ppbV = parts per billion by volume

TABLE 2
Analytical Methods, Preparation Methods, and Cleanup Methods
8801 East Marginal Way Site

Analyte	Method Reference	Preparatory Method	Cleanup Method	Instrument/Detector
GRO	NWTPH-Gx	NWTPH-Gx	Purge and trap	GC/FID
DRO	NWTPH-Dx	NWTPH-Dx	NWTPH-Dx or EPA 3611	GC/FID
Phenols	EPA 8041A	EPA 3510C, EPA 3520C, EPA 3540C, EPA 3541, EPA 3545A, EPA 3550C, EPA 3562	EPA 3630C, EPA 3640A, EPA 3650B, EPA 8041A	GC/FID
PCBs	EPA 8082A	EPA 3510C, EPA 3520C, EPA 3540C, EPA 3541, EPA 3545A, EPA 3550C	EPA 3620C, EPA3630C, EPA 3665A	GC/ECD
VOCs	EPA 8260B	EPA 5030B or EPA 5035	Purge and trap	GC/MS
SVOCs	EPA 8270D	EPA 3510C, EPA 3520C, EPA 3540C, EPA 3541, EPA 3545A, EPA 3550C, EPA 3562	EPA 3640A, EPA 3650B, EPA 3660B	GC/MS
PAHs	EPA 8270-SIM	EPA 3510C, EPA 3520C, EPA 3540C, EPA 3541, EPA 3545A, EPA 3550C	EPA 3640A, EPA 3650B, EPA 3660B	GC/MS
PCDDs/PCDFs	EPA 1613B	EPA 1613B	EPA 1613B	HRGC/HRMS
ICP-AES Metals	EPA 6010C	EPA 3005A, EPA 3010A, EPA3015A, EPA 3050B, EPA3051A	NA	ICP-AES
ICP/MS Metals	EPA 6020A	EPA 3005A, EPA 3010A, EPA3015A, EPA 3050B, EPA3051A	NA	ICP-MS
Mercury	EPA 7470A or EPA 7471B	EPA 7470A or EPA 7471B	NA	CVAAS
Tributyl Tin	PSEP/Krone	PSEP/Krone	NA	GC/MS

Notes:
AES= atomic emission spectrometer
CVAAS = cold vapor atomic fluorescence spectrometer
DRO = diesel-range organics
ECD = electron-capture detector
EPA = United States Environmental Protection Agency
FID = flame-ionization detector
GC = gas chromatograph
GRO = gasoline-range organics
HRGC = high resolution gas chromatography
HRMS = high resolution mass spectrometry
ICP = inductively-coupled plasma
MS = mass spectrometer
NA = not applicable
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
PCDD/PCDF = polychlorinated dibenzo-*p*-dioxin/ polychlorinated dibenzofuran
PSEP = Puget Sound Estuary Program
SIM = selective ion monitoring
SVOC = semivolatile organic compound

TABLE 3
Laboratory Containers, Preservation, and Holding Times
8801 East Marginal Way Site

Analyte	Method Reference	Minimum Volume [a]	Container [b]	Preservation	Holding Time
Aqueous Samples					
GRO	NWTPH-Gx	40 mL	3 x 40 mL VOA	No headspace HCl to pH <2 Cool to ≤ 6°C	14 days
DRO	NWTPH-Dx	1 L	2 x 1 L amber glass	HCl to pH <2 Cool to ≤ 6°C	7 days
PCBs	EPA 8082A	1 L	2 x 1 L amber glass	Cool to ≤ 6°C	1 year
VOCs	EPA 8260B	40 mL	3 x 40 mL VOA	No headspace HCl to pH <2 Cool to ≤ 6°C	14 days
SVOCs	EPA 8270D	1 L	2 x 1 L amber glass	Cool to ≤ 6°C	7/40 days [c]
PAHs	EPA 8270-SIM	1 L	2 x 1 L amber glass	Cool to ≤ 6°C	7/40 days [c]
Total Metals	EPA 6010C or EPA 6020A	200 mL	500 mL HDPE	HNO_3 to pH <2	180 days
Dissolved Metals	EPA 6010C or EPA 6020A	200 mL	500 mL HDPE	Field filter HNO_3 to pH <2	180 days
Solid Samples					
GRO	NWTPH-Gx	5 g	1 to 3 x 40 mL VOA [d]	Varies [d]	14 days [d]
DRO	NWTPH-Dx	10 g	125 mL glass jar with Teflon-lined lid	Cool to ≤ 6°C	14 days
Phenols	EPA 8041A	10 g	125 mL glass jar with Teflon-lined lid	Cool to ≤ 6°C	14 days
PCBs	EPA 8082A	20 g	125 mL glass jar with Teflon-lined lid	Cool to ≤ 6°C	1 year
VOCs	EPA 8260B	5 g	1 to 3 x 40 mL VOA [d]	Varies [d]	14 days [d]
SVOCs	EPA 8270D	20 g	125 mL glass jar with Teflon-lined lid	Cool to ≤ 6°C	14/40 days [c]
PAHs	EPA 8270-SIM	20 g	125 mL glass jar with Teflon-lined lid	Cool to ≤ 6°C	14/40 days [c]
PCDDs/PCDFs	EPA 1613B	20 g	125 mL glass jar with Teflon-lined lid	Cool to ≤ 6°C	1 year
Metals	EPA 6010C or EPA 6020A	2 g	125 mL glass jar with Teflon-lined lid	Cool to ≤ 6°C	180 days
Mercury	EPA 7471B	1 g	125 mL glass jar with Teflon-lined lid	Cool to ≤ 6°C	28 days
Tributyl Tin	PSEP/Krone	10 g	125 mL glass jar with Teflon-lined lid	Cool to ≤ 6°C	14 days

Notes:

[a] Triple sample volume is needed for MS/MSD analysis.

[b] Samples with identical preservation and container requirements may be collected in the same container as long as there is sufficient sample volume or mass to perform all required tests and the tests are being performed by the same laboratory.

[c] Time from sample collection until extraction/time from extraction until analysis.

[d] Soild samples for volatile analyses must be collected as core samples, then preserved using one of the following techniques:

(1) Cores can be collected in air-tight coring devices, cooled to ≤ 6°C, and sent to the lab for preservation or analysis within 48 hours.

(2) Cores can be extruded into empty VOA vials or VOA vials containing reagent water and cooled to ≤ 6°C for 48 hours or less. Freezing the vials to < -7°C extends the maximum hold time to 14 days.

(3) Cores can be extruded into vials of reagent water preserved with sodium bisulfate or vials containing methanol and cooled to ≤ 6°C for a maximum holding time of 14 days.

°C = degrees Celsius
DRO = diesel-range organics
EPA = United States Environmental Protection Agency
g = gram
GRO = gasoline-range organics
HCl = hydrochloric acid
HDPE = high-density polyethylene
HNO_3 = nitric acid
L = liter
mL = milliliter
PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
PCDDs/PCDFs = polychlorinated dibenzo-*p*-dioxins/ polychlorinated dibenzofurans
SVOCs = semivolatile organic compounds
TPH = total petroleum hydrocarbons
VOA = volatile organic analyte
VOCs = volatile organic compounds

TABLE 4
Laboratory quality Control Sample Summary
8801 East Marginal Way Site

Method	Method Blank	Laboratory Duplicate	MS/MSD	LCS	Surrogate	Initial Calibration	Initial Calibration Verification	Continuing Calibration Standard
NWTPH-Gx	1/batch or 10%	1/batch or 10%	NA	1/batch or 10%	Every sample	5-point	1/curve	Every 10 samples [a]
NWTPH-Dx	1/batch or 10%	1/batch or 10%	NA	1/batch or 10%	Every sample	5-point	1/curve	Every 10 samples [a]
EPA 8041A	1/batch or 5%	NA	1/batch or 5%	1/batch or 5%	Every sample	5-point	1/curve	Every 10 samples [a]
EPA 8082A	1/batch or 5%	NA	1/batch or 5%	1/batch or 5%	Every sample	5-point	1/curve	Every 10 samples [a]
EPA 8260C	1/batch or 5%	NA	1/batch or 5%	1/batch or 5%	Every sample	5-point	1/curve	Every 12 hours
EPA 8270D	1/batch or 5%	NA	1/batch or 5%	1/batch or 5%	Every sample	5-point	1/curve	Every 12 hours
EPA 8270-SIM	1/batch or 5%	NA	1/batch or 5%	1/batch or 5%	Every sample	5-point	1/curve	Every 12 hours
EPA 1613B	1/batch or 5%	NA	1/batch or 5%	1/batch or 5%	Every sample	5-point	1/curve	Every 12 hours
EPA 6010C	1/batch or 5%	1/batch or 5%	1/batch or 5%	1/batch or 5%	NA	1-point + blank	1/curve	Every 10 samples [a]
EPA 6020A	1/batch or 5%	1/batch or 5%	1/batch or 5%	1/batch or 5%	NA	1-point + blank	1/curve	Every 10 samples [a]
EPA 7470A	1/batch or 10%	1/batch or 10%	1/batch or 10%	1/batch or 10%	NA	5-point + blank	1/curve	Every 10 samples [a]
EPA 7471B	1/batch or 10%	1/batch or 10%	1/batch or 10%	1/batch or 10%	NA	5-point + blank	1/curve	Every 10 samples [a]
PSEP/Krone	1/batch or 5%	NA	1/batch or 5%	1/batch or 5%	Every sample	5-point	1/curve	Every 12 hours

[a] Continuing calibration standards should also be analyzed before the first and after the last sample of the day.
NA = not applicable

APPENDIX B.2

Analytical Resources, Inc.
Quality Assurance Manual

Analytical Resources Inc. Quality Assurance Plan

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Quality Assurance Plan

Analytical Resources, Inc.
4611 S. 134th Place, Suite 100
Tukwila, WA 98168-3240

Revision 013-000
8/17/09

Uncontrolled Copy

A web page is configured to inform you if this is the most recent version of ARI's LQAP. Click on the link or type the URL into your web browser. No web access? Phone 206-695-6200

http://arilabs.com/cgi-bin/rcheck.cgi?f=LQAP&r=R13000

This Quality Assurance Plan is approved and authorized for release by:

Mark Weidner
Laboratory Technical Director

Brian N. Bebee
Organic Analysis Section Technical Director

Jay Kuhn
Inorganic Analysis Section Technical Director

David Mitchell
Quality Assurance Manager

Quality Assurance Plan

Analytical Resources Inc.

Table of Contents:

SECTION 1: INTRODUCTION

Quality Assurance Policy and Objectives

Analytical Resources, Inc. (ARI) is dedicated to providing accurate and reliable data in a timely and cost effective manner. The management of ARI is committed to analytical excellence and will provide the facilities and a professional environment to achieve this goal. The quality assurance program detailed in this document sets forth the policies and procedures that are followed by ARI to ensure that all reported results are both legally defensible and of the highest quality.

To ensure that data quality goals are achieved, the following characteristics must be considered:

Precision, Bias and Accuracy

For all analyses, there is a degree of uncertainty or error in the measurement process. This measurement error is generally one of two types: random error (precision) or systematic error (bias). Precision is a measure of agreement between replicate measurements. Bias is considered to be the difference between the expected value and the true value for a measurement or series of measurements. Accuracy is a determination of how closely a measurement is to the expected value. Both precision and bias are considered when determining the accuracy of measurements. Precision, bias and accuracy are evaluated through the use of method guidelines, and project and laboratory control limits.

Representativeness

Representativeness is an indicator of how closely one sample aliquot resembles another aliquot from the same bulk source or sample site. Sample representativeness is more easily obtained for particulate-free water samples than for solid samples or viscous liquids. Representativeness is an important consideration in achieving other data quality objectives.

Completeness

Completeness is an indicator of the number of valid (useable) data points compared with the overall number of data points obtained. Valid data are normally obtained when sample collection and analysis is performed in accordance with specified methods and procedures. Completeness is often expressed as a percentage: the higher the number of valid data points, the higher the overall completeness percentage. Conversely, fewer valid data points will result in an overall lower percentage of completeness. Project specifications will dictate the required level of completeness.

Comparability

Comparability is an indicator of how confidently one data set can be compared with another, as well as the consistency between data sets. Stable analytical conditions and adherence to standard procedures, combined with high levels of accuracy; help ensure that results obtained over a period of time will be comparable.

Timeliness

To ensure that the most accurate results possible are obtained, samples must be processed within specified time periods. Analytical holding times have been established to allow sufficient time for sample processing without compromising sample integrity. It is important that, while meeting timeliness requirements, other data quality objectives are still considered and met.

Documentation

Complete and accurate documentation is essential for verifying the integrity of analytical results. Achievement of other quality objectives cannot be used to substantiate data quality without full documentation of the analytical process. Documentation must be concise and readily available for subsequent review.

The quality assurance program at ARI has been developed to ensure that the specified data quality objectives are met for all reported results and the highest degree of completeness possible is achieved.

1.2 Ethics Policy on Data Quality and Confidentiality

To ensure that data quality or confidentiality is not compromised, ARI has established the following policy on corporate ethics. These steps must be taken when the quality or confidentiality of data is suspected or known to be compromised. This policy applies to all ARI employees at every organizational level.

General

ARI's corporate commitment to integrity and honesty in the workplace is clearly stated in the ARI Employee's Handbook, under "Standards of Conduct". The Standards of Conduct statement is attached as Appendix O. The ARI commitment to excellence in data quality extends to and includes all aspects of data production, review and reporting.

Any attempt by management or any employee to compromise this commitment presents a case for serious disciplinary action. Any indications or allegations of waste, fraud or abuse will be rigorously investigated by ARI management, with the penalties for verified cases to be employment termination, and if appropriate, prosecution. In addition to these steps, any such

charges related to data generated for the federal government will also be reported to the Inspector General of the appropriate department.

Circumstances

All ARI employees will immediately report to management any information concerning the misrepresentation or possible misrepresentation of analytical data (or any associated components).

Misrepresentation of data includes (but is not limited to) the following:

Altering an instrument, computer or clock to falsify time or output
Altering the content of a logbook or data sheet in order to misrepresent data
Falsifying analyst identity
Changing documents with correction fluid with the intent of falsifying information
Preparing or submitting counterfeit data packages or reports
Unauthorized release (either written or verbal) of confidential data
Illegal calibration techniques (peak shaving, fraudulent integrator parameters)
Any attempt to misrepresent data or events as they actually occur in the course of data production or reporting

Responsibilities

It is the responsibility of all ARI employees to report any situation which may be adverse to data quality or confidentiality, or which may impact the final data quality. All ARI employees have the obligation to discuss known or suspected violations of this policy with laboratory management, who in turn are obliged to inform the ARI Laboratory Manager. If a satisfactory resolution is not obtained or is not possible at laboratory level, all ARI employees have the right and responsibility to discuss the matter directly with the ARI Laboratory Manager.

It is the responsibility of the ARI Laboratory Manager to promptly investigate any reports of known or suspected violations. The ARI Laboratory Manager has the authority and responsibility to resolve all known or potential violations of the policy.

It is the responsibility of ARI management to provide all of its employees with the facilities, equipment, and training to achieve the quality goals stated in the policy. It is the responsibility of ARI to provide our clients with data of known and documented quality.

Documentation

To reaffirm an awareness of and commitment to the highest standards of data quality, excellence, and integrity, all employees are required to sign the following "Commitment to Excellence in Data Quality" statement:

"As an ARI employee, I have the right and responsibility to report any situation which may be adverse to quality or which may impact the final quality or integrity of data produced for our clients."

"I will report immediately to management any information concerning the misrepresentation or possible misrepresentation of analytical data (or any of its associated components). Examples of this include (but are not limited to): alteration of an instrument computer or clock, alteration of the contents of logbooks and/or data sheets in order to misrepresent data, misrepresentation of analyst identity, intentional falsification of documents with correction fluid ("white-out"), preparation and submittal of counterfeit data packages, use of illegal calibration techniques (peak shaving, use of fraudulent integrator parameters, etc.), or any attempt to misrepresent data or events as they actually occur in the course of an analysis."

"I will likewise alert management of any situation or activity which may be adverse to the confidentiality of clients' data."

"I will not knowingly participate in any such activity, nor fail to report such activities of which I may become aware. I understand that any voluntary participation on my part in such activities may result in the termination of my employment, and possible legal prosecution."

"Where circumstances permit, I will report any actual or suspected violations of this policy to my lab or section supervisor. If a satisfactory resolution is not obtained or is not possible at that level, I have the right and obligation to discuss the matter directly with the ARI Laboratory Manager."

Confidentiality

All information related to client projects, such as client work plans, documentation and analytical data will be considered confidential. This information will be released only to the

client or an authorized representative. Should an outside agency request information related to a client project, the client will be contacted for approval prior to releasing any information.

Some programs or contractual agreements (such as the USEPA Contract Laboratory Program) may have specific requirements for protecting a client's confidentiality Project Managers will be responsible for strict control of access to any such confidential information or documentation. All data generated from the analysis of confidential samples will also be considered confidential.

SECTION 2.0: QA MANAGEMENT AND RESPONSIBILITIES

The principal tenet of the Quality Assurance Program at Analytical Resources Inc. (ARI) is that every employee knows she/he is a vital component of the program, and holds a responsibility to produce high-quality, defensible data in a timely manner. While production of quality data is a global philosophy, held by the entire laboratory, each section is responsible for ensuring that the data produced within that section meets the required quality objectives.

2.1 Overall Structure

The Board of Directors shall direct ARI's QA Policy and shall determine the Philosophy of the QA Program. It shall be the responsibility of the Laboratory Director to translate this policy into practical procedures with respect to the business plan developed for ARI, and direct the Laboratory Manager and Section Managers regarding the incorporation of these procedures into daily laboratory activities.

The Laboratory Manager is responsible for coordination of laboratory activities to result in an integrated approach to quality data production. The Laboratory Manager will coordinate Client Services, Laboratory Section Management, Computer Services, and Data Services to ensure that project requirements and data quality objectives are met.

The Laboratory Section Managers and Supervisors shall hold the final authority in decisions concerning implementation of QA policy, with the contributions of the Laboratory Director, Laboratory Manager, QA Manager and Project Managers. Section Managers and Section Supervisors shall instruct employees in the proper employment of QA policies.

Each Section Supervisor will ensure that analyses are completed within required holding times, that data is submitted within required submission times, and all analyses are performed according to the current Standard Operating Procedures (SOPs). They will ensure that any client modifications or QA issues are well documented for each sample set and that all required documents are complete when submitted with each data set.

The analytical staff shall execute all methods following QA policies, and will write SOPs reflecting the methods exactly as performed. These SOPs will be reviewed for compliance by Section Managers and the Laboratory Director, and once approved will be submitted to the Quality Assurance Program Manager (QAPM).

The QAPM will be responsible for controlling Company SOPs and other internal documents, overseeing the scheduling and completion of detection limit studies. The QAPM will coordinate the production of control charts and distribution of control limit data to all laboratory sections. The QAPM will administer the blind QA proficiency tests and performance samples as described in the QA Program. The QAPM will verify that QA policies and procedures are followed through out ARI.

Data reviewers will be responsible for ensuring that all samples have been analyzed by the approved and requested methods, that data calculations are performed correctly, and that analyses meet the Data Quality Objectives of the client. They shall also be responsible for ensuring that the documentation from each laboratory section is intact and complete.

Computer Services is responsible for ensuring that the Laboratory Information Management System (LIMS) correctly reflects the preparations and analyses performed and that the LIMS is updated with the current SOP, MDL, RL and QL data as submitted from the QAPM. Computer Services personnel are also responsible for ensuring that all electronic deliverables for clients are formatted correctly as requested by the Project Managers and that this data matches the hardcopy deliverables submitted.

Client Services (Project Management, Sample Receiving), shall be responsible for ensuring that the laboratories understand and can meet project specific analytical requirements and DQO.

2.2 Hierarchical Responsibilities

Technical Director

> *It shall be the responsibility of the Laboratory Director to translate QA policy into practical procedures with respect to ARI's business plan, and to direct the Laboratory Manager and Section Managers in the implementation of these procedures in daily laboratory activities.*

The Director shall interpret overall QA Policy, and determine the broad practicality of policies based on methodologies, technological advances, and the current environmental market. It shall be the interpretation of these policies that will, in turn, direct the growth ARI, the addition or withdrawal of methods to ARI's repertoire, and ARI's marketing focus.

At a minimum of once a year the Technical Director shall include on the agenda of the Board of Directors meeting a discussion of ARI′s QA Policy. This discussion will include the reputation of ARI for producing quality analyses, the affect of QA policies on turn-around time, competitive edge and cost-of-analysis, needs for stricter or more flexible policies, and the response of employees to the QA policies in place at that time.

At a minimum of once every six months the Director shall attend management meetings, which include on the agenda the subject 'QA Program'. This format will allow for the dissemination of information on any QA issues addressed in the laboratory or by the Board of Directors. Management shall also use these meetings to discuss requirements of clients that are not met by ARI′s present QA Program, and the appropriate response to these requirements.

The Technical Director may be required to act as a technical advisor at any impromptu meetings called by management to address QA issues that cannot be immediately resolved within a laboratory section.

It shall also be the Director's authority and responsibility to hold final review approval for all SOPs of ARI. Once an SOP has been updated and reviewed by the laboratory section, it shall go through the Section and Laboratory Managers for approval, and then to the Laboratory Director for final approval before the SOP is released.

Laboratory Manager

> *The Laboratory Manager is responsible for coordination of laboratory activities to result in an integrated approach to quality data production. It shall be the Laboratory Manager's responsibility to coordinate Client Services, Laboratory Management, Computer Services, and Data Services to ensure that QA Program requirements and data quality objectives are met.*

The Laboratory Manager is required to attend all management meetings, at which the QA Program will be an agenda item. Management shall use these meetings to discuss requirements of clients that are not met by ARI′s present QA Program, the appropriate response to these requirements, and dissemination of information on any QA issues addressed in the laboratory or by the Board of Directors.

It is the responsibility of the Laboratory Manager, along with the QA Manager, Laboratory Director, Section Managers and Client Services, to determine in which QA Proficiency

Programs the Laboratory will participate, and those accreditations that ARI will pursue. It is the responsibility of the Laboratory Manager, with the Section Managers, to ensure that all laboratory sections perform the tasks required by the QA Manager to pursue each accreditation or to complete a scheduled audit.

The Laboratory Manager has the authority to direct Client Services to discontinue the bidding/contracting process for a new project, refuse samples, or to re-schedule projects based on Data Quality Objectives or current workload. The Laboratory Manager also shall evaluate staffing and equipment needs based on information from the Section Managers and Client Services and may elect to meet new project requirements by increasing staffing levels or purchasing additional equipment.

The Laboratory Manager serves as a senior-level technical reference for all laboratory activities, and as such will be brought in to advise on out-of-control events and trends, corrective actions, and/or other QA issues that require his/her expertise.

Laboratory Section Managers

> *The Section Managers shall hold the final authority in decisions concerning implementation of QA policy, with the contributions of the Laboratory Director, Laboratory Manager, QAPM and Project Managers. Section Managers are responsible for correcting out of control events within their respective laboratories. Section Managers and supervisors shall instruct employees in the proper employment of QA Policies.*

Laboratory Sections Managers shall have the final authority in decisions concerning QA policy. It is their expertise that will determine the final acceptable format of each method SOP, as they are the best resource to integrate methods into ARI's philosophy.

Laboratory Section Managers are responsible for completing or delegating updates of laboratory procedures and quality assurance manual sections as scheduled by the QA Manager.

The Section Managers are best able to determine capacity of the Laboratory Sections. To ensure that analyses are completed within required hold times, the Section Managers will give Supervisors the authority to balance employee workloads and modify employee work schedules. It is the Section Manager's responsibility to take reports from supervisors and work

with the Laboratory Manager to increase staffing levels or reject samples as needed. It is the Section Manager's responsibility to work with the Laboratory Manager and the section supervisor and analysts to ensure that sample capacity does not affect the quality of data generated from that laboratory section.

It is the responsibility of the Laboratory Section Managers, along with the QA Manager, Laboratory Director, Laboratory Manager and Client Services, to determine in which QA Proficiency Programs the Laboratory will participate, and which accreditation processes ARI will pursue. It is the responsibility of the Section Managers, with the Section Supervisors, to ensure that all laboratory sections perform the tasks required by the QA Manager to pursue each accreditation or to complete a scheduled audit.

The Section Manager will be responsible for reviewing training records of analysts produced by the Section Supervisor. Training shall be the responsibility of the Section Supervisor, but it is the responsibility of the Section Manager to oversee this training.

It is the Section Managers' responsibility to work with the Section Supervisor and Project Manager to assure that Project Requirements are achievable and valid for the given methods. At times, ARI′s clients have requests or requirements for methods that are 1) not the method of choice in the laboratory, 2) not presently performed by the laboratory, or 3) unachievable by the instrumentation used in the laboratory. It is the responsibility of the Section Supervisor, Section Manager and Project Manager to work with the client to resolve these issues before samples are accepted.

Clients may also request modifications to the methods that must be approved by the Section Supervisor, the Section Manager and the QAPM. These modifications must be thoroughly documented and all pertinent information on modifications must be conveyed to the analysts, sample preparation sections, sample receiving, and computer services, as needed for implementation.

The Section Manager is responsible for resolution of out-of-control events that have not or cannot be resolved by the analysts or Section Supervisor.

The Section Manager has the authority to re-classify analysts or require additional training of analysts based on their performance.

The Section Manager has the responsibility of balancing client requests and requirements with the QA policies of ARI. It is the Section Manager's task to evaluate a client's Data Quality Objectives (submitted through Client Services), and with the Project Managers, Laboratory Supervisors and Quality Assurance Manager to determine the feasibility of laboratory performance. Feasibility will be based on the quality objectives requested, current QA Manual, present workload (in-house and scheduled/pending), the technology in place, and staffing levels available. Current workload in-house will be evaluated using reports from Computer Services, and scheduled/pending workload will be evaluated using written and verbal input from Client Services.

Section Supervisors

> *It is the responsibility of each section Supervisor to ensure that analyses are completed following the most current version of ARI's SOP, within required holding and turn around times, and assure that analyses meet the Data Quality Objectives of each project. They will ensure that any client modifications or QA issues are well documented for each sample set, and that all documentation is complete when submitted with each data set.*

To ensure that analyses are completed within required hold times, the Supervisors have the authority to balance employee workloads and modify employee work schedules. The Section Supervisors, with the input of the Section Manager, have the authority to request overtime from employees should the workload warrant the additional effort, or to modify employee schedules to extend the operating hours of the laboratory section.

The Section Supervisors shall oversee the day-to-day section operations, using LIMS printouts and verbal or written workload estimates and requests from Project Managers to adjust section efforts as needed. It is also the Section Supervisors' responsibility to inform management (Section Manager, Data Review, and Project Managers), when capacities are limited, so that the appropriate adjustments can be made to reduce workloads or increase laboratory capacities. At no time should sample capacity be allowed to affect the quality of data generated from any laboratory section.

It is the Section Supervisor's responsibility to assure that employees have the proper training for their positions. This training will include training in the methods, use of the LIMS system if applicable, training in correct documentation procedures, and all information necessary for

adherence to the ARI QA Program. The Supervisor shall either perform the training personally, or designate the trainer for given methods or procedures. It is the Supervisor's responsibility to test each employee for each method or procedure, and to thoroughly document each employee's advances and current capabilities. The Supervisor shall have the authority to require further training or supervision for any employee, and shall be the authority to approve each employee for working without supervision. There will be a training record for each employee. These will be kept in the laboratory section; copies will be submitted to the QA Manager for record keeping.

It is the Supervisor's responsibility to work with the Section Manager and Project Manager to ensure that Project Requirements are achievable and valid for the given methods. At times clients have requests and/or requirements for methods that are 1) not the method of choice in the laboratory, 2) not presently part of the method as performed by the laboratory, or 3) unachievable by the instruments used in the laboratory. It is the responsibility of the Supervisor, Section Manager and Project Manager to work with the client to resolve these issues before samples are accepted.

It is the responsibility of the Section Supervisor to ensure that each analyst reads and understands all requirements submitted with each sample set, including those for any special analyte, calibration, or data deliverable. It is the Section Supervisor’s responsibility to clarify any issues, with the input of the Section Manager and the Project Manager for the client.

Clients also at times will request modifications to methods, which must be approved by the Supervisor and Section Manager. These modifications must be thoroughly documented and all pertinent information on modifications must be conveyed to the analysts, sample preparation sections, sample receiving, and computer services as needed for implementation.

It is the Supervisor's responsibility to ensure that each employee understands the requirements of all projects they work with. This may necessitate section meetings or project-specific cross-section teams to work with Project Managers for large, specialty projects to ensure that everyone has the same understanding of project requirements.

The Supervisor is responsible for resolution of out-of-control events that have not or cannot be resolved by the analysts, and for ensuring that the analysts complete all documentation. If the

Supervisor and laboratory section analysts cannot resolve the issues in a timely manner, the Supervisor's will request the assistance of laboratory management to bring the section into compliance. The Supervisor will also inform Project Management and his/her Section Manager of possible delays, and inform Data Review of possible time constraints they may face in preparation of data submissions from the lab section.

The Section Supervisors shall have the authority, usually in consultation with Laboratory or Project Management to use professional judgment in requiring samples be re-prepared, and shall determine which analysts have the authority to require re-preparation of samples.

It is the responsibility of the Section Supervisor to inform the QAPM, Section Manager and the Computer Services section of any changes in methodologies that will require revision of SOPs, MDLs, Control Limits or the LIMS programming. This includes changes in spiking compounds, spiking levels, preparation methods and analytical methods.

Analysts

> *The analytical staff shall execute all methods following QA Policies, and will write SOPs reflecting the methods exactly as performed. These SOPs will be reviewed for compliance by Section Managers, the Laboratory Manager, and the Laboratory Director, and once approved will be submitted to the QA Manager.*

The analysts are responsible for following the current SOPs (with project-specific modifications if required) in preparing and analyzing client samples and quality control samples to meet the project specific Data Quality Objectives. It is the analyst's responsibility to ensure that he/she understands all requirements of a project before proceeding with sample preparation or analysis.

Analysts are responsible for working with the Supervisor to ensure that all sample preparations and analyses are performed within required holding times and required turn-around times, and that all documentation is completed in a timely fashion. It is each analyst's responsibility to bring any recurrent or anticipated problems to the attention of laboratory management.

It is each analyst's responsibility to correct his/her own errors, to document corrective actions thoroughly, to perform peer review, and to ensure that fellow employees within the section follow documentation procedures.

The Section Supervisor may give lead analysts responsibility for training and evaluation of new staff members. This training will include instruction in the methods, use of the LIMS system if applicable, correct documentation procedures, and all information necessary for adherence to the ARI QA Program. Analysts will be responsible for maintaining all instruments and equipment in optimum operating condition and documenting this maintenance as required by the QA Program.

It is the responsibility of each analyst to request the assistance of Supervisors or Managers in resolving out-of-control situations that cannot be corrected in a timely manner, and to perform the documentation of all corrective action activities.

Quality Assurance Program Manager (QAPM)

> *The QAPM will be responsible for controlling Company SOPs and other internal documents. The QAPM will oversee the scheduling and completion of detection limit studies and control charts. The QAPM will administer the training program, analyst's proficiency documentation and performance evaluation analyses as described in the QA Program. The QAPM will verify that QA policies and procedures are followed at all levels in the Company. The QAPM will produce a "Quality Assurance report to Management" each calendar year.*

The QAPM is responsible for the oversight of the QA Program as defined by the Board of Directors and interpreted by the Laboratory Director and Laboratory Managers.

Part of this oversight will be monitoring of the QA Program through submission of performance evaluation samples, blind QA samples and double-blind QA samples. It is the responsibility of the QAPM, along with the Laboratory Manager, Laboratory Director, Section Managers and Client Services, to determine in which QA Proficiency Programs the Laboratory will participate. The QAPM will be responsible for submitting these samples to the laboratory for analysis, overseeing submission of the results to the appropriate agencies, and for control of documented proficiency results.

The QAPM will be responsible for scheduling laboratory section SOP and procedural reviews and revisions, and section updates of the Quality Assurance Manual. It is the responsibility of the QAPM to work with each Section Manager to attempt to stagger these review schedules across the year within each laboratory section. The QAPM will also be responsible for

maintaining document control of all SOPs, bench sheets, logbooks, and other forms used within the laboratory.

All laboratory sections, on an annual basis, will perform detection limit studies for each method used within each section. It is the responsibility of the QAPM to schedule, review, compile, and distribute the results of these studies.

The QAPM is responsible for evaluation of the laboratories' adherence to defined protocols through periodic audits of completed projects and of the laboratory facilities. Following the audit schedule (Appendix K), the QA Manager will perform the scheduled audit and prepare an evaluation that will be submitted to the Board of Directors in the Annual QA Report to Management.

The QAPM will be responsible for evaluation of outside accreditation requested by Client Services. The QA Manager will deliberate with the Laboratory Managers and Laboratory Director on the feasibility of pursuing accreditation based on the scope of the accreditation, the effort required to pursue accreditation and the scope of work that might become available once the accreditation is obtained. If a decision is made to pursue an accreditation, it is the responsibility of the QAPM to coordinate laboratory efforts towards the accreditation.

The QAPM will produce an annual "Quality Assurance Report to Management" to be distributed to ARI management personnel as described in Section 13 of this LQAP.

The QAPM will serve as a resource for quality-related issues for all Laboratory Sections, and will serve management in an advisory capacity.

The QAPM will have documented training in elementary statistics and Quality Systems theory.

Data Reviewers

> *Data reviewers will be responsible for ensuring that all samples have been analyzed by the approved and requested methods, that data calculations are performed correctly, and that analyses meet the Data Quality Objectives of the client. They shall also be responsible for ensuring that the documentation from each laboratory section is intact and complete.*

Data reviewers shall ensure that all samples are analyzed according to approved methods by reviewing the data released by each laboratory section. The data will be evaluated for compliance with all Data Quality Objectives as defined in the method SOP or in the project-

specific quality assurance plan, including instrument tuning and calibration, holding time, spiking level, and spiking recovery criteria. Data reviewers will also verify 100% of manual calculations, spot check computer calculations, check electronic data for correct sample matching, and do a 100% check on any manually entered data. Analytical parameters, which have concentration interdependence, will be evaluated in relationship to each other.

Final reports generated will be evaluated to ensure that laboratories are using the current detection limit/reporting limit values and the current control limits. Data will be checked to ensure that all QA issues are addressed and fully documented. Reviewers are responsible for working with Laboratory Supervisors, Laboratory Managers and Project Managers when out-of-control events are incompletely documented, or if data is found to not meet Data Quality Objectives of a project without documentation.

It is the responsibility of data reviewers, the QAPM and section supervisors to work with Computer Services to ensure that the LIMS is updated to the current limits and methods used within the laboratory.

Computer Services

> *Computer Services is responsible for ensuring that the LIMS correctly reflects the preparations and analyses performed and that the LIMS is updated to include the current SOP, MDL, RL and QL data, as submitted by the QA Manager. Computer Services personnel are also responsible for ensuring that all electronic deliverables for clients are formatted correctly as requested by the Project Managers and that electronic data matches the hardcopy deliverables submitted.*

It is the responsibility of the Computer Services Manager to update, or to designate the task of updating, the LIMS as determined by Laboratory Management, including adjustment to current MDL/RL data, additions of analytes to methods, changes in method designations or changes in calculations for methodologies.

Computer Services will be responsible for generating the work list scripts required to allow analysts to enter data into the LIMS, and for generating the report scripts that produce final hardcopy or electronic reports for clients.

Computer Services Management and personnel are also responsible for generation and review of electronic data deliverables (EDD), as requested by clients through Project

Management. Computer Services personnel will review the EDD for compliance with the Software Quality Assurance SOP before it is released to the client.

Computer Services will be responsible for informing laboratory Section Managers and Project Managers of any discrepancies found between the EDD and the hardcopy, and for following up on corrections to hardcopy and EDD as required.

Client Services

> *Client Services (CS) (Project Managers, Sample Receiving, and Sales Management) personnel are the primary interface between ARI's clients and the laboratory sections. CS staff shall be responsible, with the assistance of the Section Managers and Supervisors, for ensuring that the laboratories understand and can meet the Data Quality Goals and Requirements of each Project before committing laboratory services to the project. CS will monitor the quality of sample processing after they are received.*

Client Services Management and Project Managers shall ensure that the laboratories can meet the data quality objectives for a project. The Project Managers are responsible for knowing the capabilities of the laboratory, in order to develop project proposals or accept samples without consultation with laboratory management. It is the responsibility of Client Services to consult with the Laboratory Manager and Section Managers, or supervisors designated by Management, when data quality goals are not included in standard Company policies. Clients may, at times, request modifications to methods that must be approved by the Supervisor and Section Manager. These modifications must be thoroughly documented and all pertinent information on modifications must be conveyed to the analysts, sample preparation sections, sample receiving, and computer services as needed for verification of feasibility. Laboratory Management may determine that a project should not be pursued based on the specific Data Quality Objectives and on current or projected laboratory capacity.

Project Managers shall be responsible for ensuring that project requirements and analytical requests are submitted correctly to all laboratory sections. Once samples have been logged into the laboratory, it is the responsibility of the Project Managers to ensure that all information is available to the laboratories concerning the Data Quality Objectives and deliverables requirements. It is also the responsibility of the Project Managers to convey changes in client

requirements to the laboratories and ensure that all paperwork reflects the changes if necessary.

It is the responsibility of Project Managers and Client Services Management to assure that specific EDD formats are submitted to Computer Services and approved as feasible before contracting with a client to provide the EDD.

It is the responsibility of Project Managers to notify clients of out-of-control events, “problem” samples, or anticipated turn-around time delays, as conveyed to them by Laboratory Management. It is also the responsibility of Project Management to work with Laboratory Management in setting priorities during times of heavy sample workloads.

Project Managers shall be responsible for coordinating data submissions and compiling hardcopy data for final submission to the client. This involves conducting a fourth level data review, from which any data which is found to contain errors that were not found earlier in the review process is returned to the Data Reviewer for correction and/or corrective action. The Project Manager will be responsible for compiling all analyst notes into a project narrative. This will include discussion of any sample receipt discrepancies, sample preparation and analysis difficulties or non-compliance, and any corrective actions that may have been required during processing. It will also discuss quality control analyses and results if applicable to the sample set.

Project Managers shall work with Laboratory Management in determination of the direction of growth for ARI, as the Project Managers are best able to define the analytical needs of clients based on new technologies and new environmental regulations.

SECTION 3: PERSONNEL QUALIFICATIONS AND TRAINING

The production of quality analytical data is dependent upon a laboratory staff with qualifications and training necessary to perform assigned tasks. All personnel employed by ARI will receive adequate training and instruction specific to their responsibilities. Prior to assigning a staff member full responsibility for performing a laboratory procedure, her/his skills will be evaluated and verified acceptable. It is the obligation of ARI′s supervisors and managers to ensure that personnel are qualified to successfully perform all assigned duties.

ARI′s training program is described in SOP 1017S (*Training and Demonstration of Proficiency*). The procedures described in this SOP assure that all ARI employees are proficient at the tasks required to produce quality analytical data. The SOP also provides for periodic review of each employees training and proficiency status, which may indicate any need for additional or remedial training. All training and review procedures are documented as described in the SOP.

Basic elements of ARI′s training program are:

1. All employees are required to read and document their knowledge of non-technical documents that describe general policies in place at ARI. These documents include ARI′s *Employee Manual* and ARI′s *Chemical Hygiene Plan*.
2. All technical employees are required to read and document their knowledge of ARI′s *Laboratory Quality Assurance Plan* and quality assurance policies.
3. All new employees must attend a Quality Assurance Orientation during which ARI′s general and specific requirements for the production of quality analytical data are emphasized.
4. All new technical employees will attend a laboratory specific technical orientation conducted by their laboratory supervisor or manager that provides specific information about laboratory operation.
5. All employees will complete an ‘on the job’ training program designated by their supervisor. The training program will be laboratory, SOP and employee specific. The training is

incremental with each step documented in an employee Training File. While an analyst is in the training period, her/his supervisor or trainer must approve all analytical work.

6. Upon completion of the training program a technical employee must complete an Initial Demonstration of Capability (IDOC) as described in ARI SOP 1017S. An analyst is considered proficient and may perform analytical procedures without supervision only after they have completed training and a successful IDOC.

7. The proficiency of each employee performing a given laboratory SOP will be continually monitored and documented as described SOP 1017S. An employee must continually generate data that meets all of ARI's published acceptance criteria for a given SOP to be considered proficient. Unacceptable results or insufficient number of analyses performed in a calendar quarter will result in revocation of proficiency. This will result in a remedial training program.

8. Each analyst is responsible for maintaining a training record as described in SOP 1017S. The training record will document an employee's experience, training and capability. The training file will be maintained in the analysts' laboratory.

SECTION 4: FACILITIES AND EQUIPMENT

4.1 Facilities

ARI's facilities have been designed to allow for efficient sample processing and analysis while maintaining consideration for the health and safety of the staff. The facility accommodates the following operations:

Sample receipt and storage
Sample container preparation and shipment
Sample preparation and analysis (organic and inorganic)
Project planning and management
Quality assurance
Data review and report generation
Computer programming and operations
Records storage
Instrument spare parts storage
Frozen sample archive
Short-term hazardous waste storage

A detailed description of ARI's facilities is included as Appendix C.

4.2 Security

Facilities

To ensure that security at ARI is maintained, access to the facilities is limited to employees and escorted visitors. Upon arrival, ARI visitors are required to register at the reception desk, and must sign out prior to leaving. Visitors will be escorted at all times. A receptionist constantly monitors the main entrance. Other laboratory entrances remain closed at all times and can only be opened from the outside by key. Key access to the facility is controlled; keys are issued on a limited basis depending on access needs.

As a result of controlled access and a monitored alarm system, the entire facility is considered a secure area. This eliminates the need for locked sample storage refrigerators, data storage areas or file cabinets.

Data Access

The Computer Services Manager controls security of, and access to, electronic data on the LIMS. Security measures are required to ensure data integrity, but must not be so restrictive

as to prevent data accessibility. The security measures taken at ARI are to prevent intentional intrusion by outside parties. These measures include building security, limited computer system access, password systems, encryption, firewalls and the use of virus protection programs. ARI's Intranet is protected from outside tampering by a proxy server (firewall) connection to the Internet.

LIMS - System Security

Building/Computer Room Security

Access to the building is restricted to employees, vendors with security passes, and escorted visitors. Room 203 contains the computer and main console for the LIMS system. This room is closed and locked at all times. Access to this room is limited to Computer Services personnel, escorted repair technicians, and escorted visitors. Only Computer Services personnel will be allowed access to the main console.

System Password Policy

User name and password restrict access to the LIMS computer. Remote access to the LIMS server is not allowed.

Database Access Restrictions

Interaction with the database is menu-controlled and allows the LIMS Manager to restrict access. Technicians may be given the ability to fill a limited number of work lists, with no authorization to distribute data. Some users may be given "read only" access to the database.

Users will be given access to the database only to complete tasks for those analyses for which they are responsible. No users are to be given access to the shell or command prompt unless 1) they have completed the appropriate training and 2) administrative access to the computer systems is required by their job function

4.3 Safety

Ensuring that all sample processing and analysis procedures are performed under safe conditions is an important consideration at ARI. While safety is the responsibility of all staff members, ARI's Safety Committee meets monthly to review the safety activities of all laboratory sections and to ensure that all operations and equipment meet safety criteria. *The*

Chemical Hygiene Plan details those safety procedures and requirements that must be followed at ARI. *The Chemical Hygiene Plan* is reviewed annually and updated as needed to incorporate any changes to ARI's safety program.

4.4 Instrumentation and Support Equipment

4.4.1 Instrumentation

Generation of quality data is dependent upon instrumentation and support equipment that is in optimum operating condition. All instrumentation and support equipment will be optimally maintained following method requirements and/or manufacturer's recommendations. Preventative maintenance is performed on a scheduled basis, with more frequent maintenance during periods of increased sample load or after analysis of highly contaminated samples. Separate, permanently bound logbooks are provided for and kept at or near each instrument. The logbooks are used to record all instrument maintenance, routine and non-routine. When non-routine maintenance is required the following information must be recorded:

1. A statement of the problem or symptom that requires correction.
2. Details of the maintenance procedure including listing the parts repaired or replaced.
3. Documentation that the instrument has returned to routine performance.

Spare parts are kept on hand when possible; necessary parts are ordered on an expedited basis to minimize downtime.

Currently available Laboratory Instrumentation is detailed in Appendix D.

4.4.2 Support Equipment

4.4.2.1 Thermometers in use at ARI are traceable to an NIST standard and are calibrated or verified annually. The procedures are described in SOP 1020S. When appropriate, thermometers are assigned a correction factor based upon the most recent calibration. ARI personnel must calculate and record corrected temperatures.

4.4.2.2 Water Bath temperatures are recorded before each use to assure the temperature is acceptable for its intended use.

4.4.2.3 Incubator temperatures (corrected) are recorded and at least twice a day while in use. The date and time of each observation is recorded.

4.4.2.3 Oven temperatures are recorded before and after each use.

4.4.2.4 Refrigerator and Freezer temperatures are recorded automatically every 30 minutes by ARI's "ThermoLogger" computer system. The temperature of several refrigerators and freezers not connected to "Thermologger" are recorded daily.

4.4.2.4 Balance accuracy is verified daily prior to use with two Class S weights that bracket the normal weighting range of the balance. A balance must be accurate to ±0.1% or ±0.5 mg whichever is greater. All analytical balances are professionally cleaned and calibrated annually by an outside contractor. Class S weights are calibrated every five years by an outside contractor. Calibration reports are filed in the QA Office.

4.4.2.5 pH Meters are standardized prior to each use with at least two standards, one at 4.0 and one at 7.0 pH units. The meters are checked prior to each use with a pH 7.0 buffer.

4.4.2.6 Variable Volume Pipette accuracy is verified monthly following the procedure in SOP 1015S.

4.4.2.7 Mechanical Burettes are calibrated quarterly following the procedure in SOP 1015S.

4.4.2.8 Sample Containers – Upon client request ARI supplies containers for collection of field samples. All containers supplied for organic and trace metals analyses are certified pre-cleaned by the manufacturer. When the manufacturer's certified concentration is greater than ARI's reporting limit for a specific project, a container is used to prepare a method (bottle) blank. ARI certifies that the containers from the same lot are suitable for sample collection when target analytes are not detected in the bottle blank. Containers for conventional analyses are not pre-cleaned and are certified internally by ARI following the procedures in Appendix 12.3 of ARI SOP 001S (Sample Receiving).

Container lot numbers are recorded when containers are sent to a client.

4.4.3 Chemical Standards and Reagents

4.4.3.1 Reagent Water Supply

ARI maintains a centralized water purification system. The quality of the water produced is monitored and documented daily in a bound logbook. All reagent / de-ionized water used within the laboratory meet or exceed ASTM Type II Standards. Water used in the Volatile Organic Laboratory is also filtered through activated charcoal to remove organic compounds.

4.4.3.2 Chemical Standards

Most standards used to determine the concentration of target analytes are purchased as certified solutions. In general the standards are traceable to a National Institute of Standards & Technology standard. A Certificate of Analysis and/or traceability for quantitative standards is filed in the QA Section when available. All standards (traceable, non-traceable and those prepared by ARI) are verified by comparison with standard reference materials or existing standards in use. ARI documents the source, date of receipt, required storage conditions and an expiration date for all standards. Containers used to store standards are labeled with an expiration date. Receiving, storage and preparation of calibration standards is described in SOPs 526S (Metals Analysis), 620S (Conventional Analysis), 704S (Volatile Organic Analysis) and 1012S (GC and GC-MS Analyses).

4.4.3.3 Chemical Reagents

Many of the analytical processes in use at ARI require chemical reagents that are not directly used in the calibration process. These reagents are used for analyte preservation, adjustment of pH, formation of colorimetric indicators, etc. The reagents are purchased in a grade and purity sufficient for their intended use. The receipt of all reagents is recorded in the Chemical Receiving Logbook where a unique Inventory Number is assigned to each reagent. Each original reagent container is labeled with an Inventory Number, the date it is opened and an expiration date as appropriate. A Certificate of Analysis is obtained for reagents when available and archived in the QA Office.

Solutions prepared from reagents are recorded in the Reagent Preparation Logbook. The logbook includes a unique Reagent Number that is traceable to the Chemical Receiving

Logbook. Reagent containers are labeled with Reagent Number, date of preparation, expiration date, and preparer's identification.

Procedures for Reagent Receiving and Preparation are detailed in SOP 1013S.

Trace Metals Acids

To ensure the quality of acids, nitric and hydrochloric, used for trace metals analyses, only the highest quality, certified "metals free" acids are purchased. Each lot received is analyzed for purity prior to use in the laboratory to assure that it is acceptable for use. Whenever possible, entire lots will be reserved for use exclusively by ARI. This minimizes the possibility of receiving contaminated or unacceptable acid.

Solvents

To ensure the quality of solvents used for sample preparation and analysis, the highest purity of solvents required for sample processing will be used. Purity checks are performed on solvent lots received by the laboratory. Only those solvent lots determined acceptable will be used for sample processing. Whenever possible, entire solvent lots will be reserved for use. This minimizes the possibility of receiving contaminated or unacceptable solvents.

Compressed Gases

To reduce the possibility of system contamination, compressed gases and liquids used for operating analytical instrumentation will be of a specified purity level. Any cylinder suspected of introducing contamination into a system will be promptly replaced.

4.5 Computer Systems

ARI maintains several data systems. These are used to automate such diverse functions as accounting, payroll, sales and marketing, sample receiving, instrument data collection, production of hardcopy and electronic data deliverables, intra- and internet applications and project management. Specific information about these systems is contained in Appendix D and various SOPs.

ARI maintains a Laboratory Information Management System (LIMS) that stores analytical data, calculates final results and produces final reports (both hardcopy and electronic). The LIMS

system is the major data system used at ARI. A separate Software Quality Assurance Plan outlines the QA/QC procedures for the LIMS system.

SECTION 5: LABORATORY DOCUMENTATION AND RECORDS

All laboratory operations and procedures performed during sample processing are documented in logbooks, notebooks and on laboratory forms and bench sheets. Analytical data and copies of paper documents are also stored electronically. Consistent use of standard documents throughout the laboratory ensures that all activities will be traceable and serves as objective evidence of the work performed.

All procedures performed at ARI will be detailed in Standard Operating Procedures (SOPs). Sample preparation and analysis SOPs will reference approved analytical methods and detail the actual procedures followed by ARI staff. SOPs for non-analytical activities will detail the procedures developed specifically for use at ARI.

5.1 Responsibilities

All staff members are responsible for complete and accurate documentation of laboratory activities. Each laboratory section develops a comprehensive set of documents (bench sheets, forms, etc.) to record all activities performed in that section. All staff members are responsible for reviewing and understanding SOPs, and must sign a record to document this fact. The QAPM is responsible for maintaining control of laboratory documents and ensuring their consistent use.

To ensure that all documents, SOPs in particular, accurately reflect the activities performed at ARI, section supervisors and managers are required to review all documents annually and recommend changes to the QAP. The QAPM is responsible for coordinating document revisions and ensuring that all staff members have access to the most current laboratory documents.

5.2 Document Control

ARI's Quality Assurance Program requires that all forms and SOPs used within the laboratory be monitored to ensure that only the currently approved version of the documents are in use, centrally organized, and readily available to all staff members. All documents will include a revision date. The LQAP and SOPs will also have an effective date. The time between the revision and effective dates will be used for training and orderly implementation of changes.

Electronic copies of laboratory documents will be maintained as part of the quality assurance files. Each laboratory section maintains working copies of pertinent forms and SOPs. The QAPM coordinates the generation of new forms or SOPs and modifications to existing documents. Log number assignments will be as follows:

Laboratory Section	Form Number	SOP Number
Client Services	0001 - 0999	001 - 099
Computer Systems	1000 - 1999	100 - 199
Data Services	2000 - 2999	200 - 299
Extractions	3000 - 3999	300 - 399
GC Laboratory	4000 - 4999	400 - 499
Metals Laboratory	5000 - 5999	500 - 599
Conventional Laboratory	6000 - 6999	600 - 699
Volatile Organic Laboratory	8000 - 8999	700 - 799
Semi-volatile Laboratory	7000 - 7999	800 - 899
Quality Assurance Monitoring	10000 - 10999	1000 - 1099
GeoTech Laboratory	11000 - 11999	1100 - 1199

Document numbers will be include an F for forms and an S for SOPs i.e. 101F or 1234S. Document Control Logs of all forms and SOPs, detailing the form name and number, revision number and revision date will be maintained by the QA Officer. Outdated documents will be maintained in an electronic archive file.

The QAPM will distribute new and revised documents to the appropriate laboratory sections. Section staff will replace outdated copies of the document with the revised version. Laboratory forms and SOPs will be generated or revised on an “as needed” basis, and will be reviewed and revised as at least annually. Only the latest version of a form or SOP will be available in each laboratory. Section supervisors will periodically review these documents and recommend changes to be implemented by the QAPM. A comprehensive review of all laboratory documentation will be performed annually at the direction of the QAPM.

To maintain document security, release of documents to clients or other outside agencies will be controlled by the QAPM. The QAPM will record the document to be released, revision number, person and agency receiving the document, and the release date. All documents generated by the laboratory will be considered proprietary. ARI permission must be obtained by anyone releasing the document to other agencies or including the document in a project or quality assurance plan.

5.3 Reference Documentation

To provide an understanding of the procedures employed to generate quality data, a comprehensive set of reference materials is available to staff members. All activities performed within the laboratory can be referenced to a method or SOP. The laboratory maintains copies of the following method compilations:

Code of Federal Regulations (Section 40)
Test Methods for Evaluating Solid Waste (USEPA SW-846)
USEPA Contract Laboratory Program Statement of Work for Organics Analysis
USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis
Methods for Chemical Analysis of Water and Waste (USEPA 500 and 600 series methods)
Standard Methods for the Examination of Water and Wastewater
Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP)
US Naval Facilities Engineering Support Activity –NFESC (formerly NEESA).
Hazardous Waste Remedial Actions Program (HAZWRAP)
State of Alaska Department of Environmental Conservation (ADEC)
Oregon Department of Environmental Quality (DEQ) Petroleum Hydrocarbon Methods
Washington Department of Ecology (WDOE) Guidance for Remediation of Releases from Underground Storage Tanks (Appendix L)
Washington State SARA
AFCEE Project Quality Assurance Plan
Washington State EPH/VPH Methods
National Environmental Laboratory Accreditation Conference
Department of Defense Quality Systems Manual
Washington State Sediment Sampling and Analysis Plan

Other methods followed within the laboratory are also available. Published modifications to analytical methods will be reviewed and incorporated into laboratory SOPs. If a method for a parameter is developed by ARI, it will be detailed in an SOP. SOPs will be available for all laboratory activities. Each laboratory section will maintain a file or notebook of SOPs pertinent to that section. A compilation of all laboratory SOPs is maintained as part of the Quality Assurance Program files. A listing of laboratory SOPs is included as Appendix E.

The Quality Assurance Manual provides an overview of the laboratory-wide Quality Assurance program. A copy of the Quality Assurance Manual is distributed to all laboratory sections. Distribution of the QAP is coordinated by the QAPM.

ARI maintains a file of various laboratory and environmental publications and reference texts. These reference materials are available to all staff members. Operation and maintenance manuals are available for all equipment and instrumentation used within the laboratory. Additionally, senior level staff members are available to serve as reference sources. These staff members have numerous years of pertinent experience and can provide insight and guidance for all procedures and laboratory activities.

5.4 Quality Assurance Policies

Quality Assurance Policies provide standards and procedures to guide ARI employees in proper implementation of the QA Program. Appendix P includes current QA Policies.

5.5 Worksheets and Logbooks

Use of Laboratory Forms and Logbooks

All activities noted on laboratory forms and logs are recorded in blue ink. Initials of the staff member performing the activity, as well as the date the activity is performed are noted on all forms and logs. Any supplementary information about the activity, such as unusual observations or suspected procedural errors are noted on the forms and logs. The QAPM or his/her designee prepares and controls laboratory logbooks.

Changes to existing information is annotated by drawing a single line through the original entry and initialing and dating the deletion. Correct information is written above the deleted entry. When appropriate to clarify the intent of the change a note describing the reason for the change is added. The use of correction fluids or other techniques that cover an entry in its entirety is forbidden on laboratory documents.

Since sample processing within an analytical laboratory involves many detailed steps, documentation can be quite extensive and varied. The following guidelines will be followed to encourage consistency in laboratory record keeping:

Standard Logbooks

Preparation of all stock and working standards is documented in the appropriate standards logbook. Each entry includes preparation date, initial and final concentrations (including solute and solvent amounts), standard ID number, expiration date and the identity of the person preparing the standard. Stock solution entries include standard lot number and supplier. Working solution entries include the stock solution ID number. Commercially prepared stock standards are recorded in the stock standard logbook.

Sample Storage Temperature Logs

The temperature of all refrigerators and freezers used for sample and standards storage is monitored daily. The temperature and recorder's initials are recorded on the temperature log attached to each unit. The acceptable temperature range for each unit is noted on the log sheet. Any out of control temperatures and/or corrective actions, must be noted on the log sheet and reported to appropriate personnel (Lab Supervisor and QA Manager)

Balance Calibration Logs

The true and measured values for each calibration check weight are recorded, along with the date and recorder's initials. Any actions taken, such as notifying the QAPM of malfunctions is indicated alongside the entry for that date.

Instrument Logs

The Instrument Run Logs must detail all samples analyzed on a given instrument for a given parameter. Instrument conditions, analysis date and time for each sample, analyst initials and standard or sample identifications in the analytical sequence must be recorded in the log. Comments related to sample analysis and minor maintenance are noted on the instrument logs. For GC/MS analyses, instrument performance is documented by recording internal standard response alongside the sample identification.

Sample Preparation/Analysis Worksheets

Sample preparation and analysis activities are documented on appropriate worksheets. Sample identifications, weights or volumes used, intermediate cleanups, final volumes, preparation dates and analyst initials will be noted as well as any observations about

sample condition. Any issues encountered during sample preparation are also noted. Surrogate and spiking solution ID numbers, and concentrations added to the samples, must be indicated on the bench sheet.

For some parameters, analytical results are summarized on an analysis worksheet. Sample identifications, sample preparation information, sample results, quality control results, analysis date, analyst initials and reported detection limits must be indicated on the worksheet. Any necessary data qualifiers are also noted on the worksheet.

Maintenance Logs

All major maintenance performed on instrumentation or laboratory equipment must be documented. Maintenance performed, date and analyst performing the maintenance, and steps taken to verify that the maintenance was successful are detailed in the log. Routine maintenance of GC-MS instruments is documented on "maintenance cards" attached to each instrument. The demonstration that GC instruments are in-control following maintenance is documented in the instrument run log.

Individual Laboratory Notebooks

Staff members preparing USEPA CLP samples must maintain unique laboratory notebooks for these analyses. Each case submitted is documented on a separate, sequentially numbered page. A listing of all samples prepared as part of the case, the date and the preparer's initials, and any notes specific to sample preparation must be annotated in the logbook. Individual notebooks are used only when required by a specific contract. All sample preparation information is recorded on a laboratory bench sheet.

5.5 Document /Data Storage and Archival

Logbooks

All active logbooks will remain in the appropriate laboratory sections. Completed logbooks will be forwarded to the QAPM for archival.

Magnetic Tapes and Diskettes

When instrument capabilities permit, all data generated is archived and stored on magnetic tapes or disks. The electronic media remains on file for five years.

Chromatograms and Instrument Documentation

Electronic or paper copies of chromatograms, instrument calibrations, quantification reports and any other printed documentation generated during sample analysis are maintained as part of the permanent data files. All hardcopy data remain on file at ARI for five (5) years or as specified by contract.

Project Data and Documentation

Project data and support documentation, electronic or paper copies, will be filed a minimum of five years, or as specified by contract.

SECTION 6: SAMPLE CONTROL

All samples analyzed by the laboratory will be monitored in accordance with sample control procedures. Sample control includes operations such as container preparation, sample collection, receipt and storage, and tracking of the sample throughout all processing steps. Documentation of all sample control activities and adherence to standard procedures is an important aspect of ensuring that data quality objectives are met.

6.1 Sample Collection

Production of quality analytical data begins with proper sample collection. Improper sampling procedures may result in inaccurate final results. Although the laboratory is not routinely involved with sample collection, it will minimize the possibility for error by providing clients with appropriate sample containers and sampling instructions for the requested parameters. If, upon receipt, sample integrity appears to be compromised, the client will be immediately notified to allow for re-sampling if necessary.

6.2 Sample Container Preparation and Shipment

To minimize the possibility of contamination from containers furnished by outside sources, the laboratory will furnish all necessary sample containers for client projects when requested by the client. Sample containers, pre-cleaned to EPA specifications, or certified clean by the manufacturer or ARI, are supplied for most parameters. Containers for special purposes may be acquired upon request. Lot numbers for containers are tracked to link bottle orders to lot numbers.

A blank sample label is affixed to each sample container prior sending the container to a client. The sample label allows for recording of the following information at the time of collection: client name, client sample identification, sampling site, date and time of sample collection, analytical parameters, and any preservatives used. Sample labels provided by ARI are coated to prevent bleeding of recorded information if labels become wet.

To ensure that the correct number of appropriate sample containers are prepared and submitted to the client, a Bottle Request is completed by a Client Services staff member or Project Manager at the time sample containers are ordered by the client. All necessary preservatives are also noted on the Bottle Request. The Bottle Request is then forwarded to

appropriate personnel in the Sample Receiving Section for order preparation. All required containers will be gathered and preservatives added as specified. A copy of the Bottle Request accompanies the sample containers to allow the client to verify that the order is properly filled. Additional containers will be supplied for quality control purposes and in case of container breakage or sampling complications. A complete listing of containers and preservatives used within the laboratory is included as Appendix F.

To facilitate transportation of containers to the sampling site, sample containers will be placed in coolers along with appropriate packing material. The inclusion of packing materials, such as vermiculite or "bubblewrap", is provided to minimize the possibility of container breakage and cross-contamination. Sample containers will be organized in the coolers per analytical or client specifications. Depending on client preference and project requirements, coolers and sample containers will be shipped to a specified location, delivered by ARI courier, or held at the laboratory for pick up. To ensure that sample identification, analytical parameters, and sample custody are properly documented, Chain of Custody records will accompany all sample container shipments. When appropriate, as for drinking water source sampling events or for parameters that require preservation in the field, sample collection instructions will also be included with shipments.

6.3 Sample Admission

All samples received by the laboratory are processed in a central Sample Receiving area. To ensure the safety of staff members receiving samples, coolers will be opened under a hood or in a well-ventilated area. Appropriate protection, such as disposable gloves, safety glasses and laboratory coats will be worn during sample receipt and log-in. Additionally, all general safety practices as specified in ARI's Chemical Hygiene Plan will be employed.

Upon receipt, sample coolers will be inspected for general condition and custody seals. Time and date of sample receipt, as well as identification of the staff member receiving the samples, will be indicated on each Chain of Custody record accompanying the shipment. Cooler temperatures will be determined using an IR temperature measuring device or by placing a thermometer in the cooler immediately after the cooler is opened. If samples cannot be logged-in within 30 minutes after receipt, the sample coolers will be tagged and placed in the walk-in sample storage refrigerator for short-term storage. Chain of Custody records for the

stored coolers will remain in Log-In to ensure that processing of the stored samples is not overlooked.

Samples to be processed will be removed from the coolers and organized by sample identification. The number and type of sample containers received will be verified against the Chain of Custody record. Each sample container will be examined to verify that the condition is acceptable and that sample integrity has not been compromised during shipment. Sample containers broken during shipment should be handled according to procedures detailed in the Chemical Hygiene Plan (Section 5, Waste Disposal Procedures).

After sample organization and initial inspection has been completed, sample information will be entered into the LIMS, and a Service Request will be generated for the sample set. The Service Request serves as a work order for the laboratory. The Service Request will contain the following information:

Client Name
Client Project Name and/or Number
Client Contact
Verified Time of Sample Receipt (VTSR)
Required Turnaround Time
Laboratory Job Number
Client Sample Identifiers(s)
Laboratory Sample Number(s)
Required Parameters
Additional Analytical Requirements/Comments

Also entered into the LIMS are the number of sample containers for each sample, sample conditions, and cooler temperatures.

A sequential laboratory job number will be assigned to each sample set. Laboratory sample numbers, determined by the job number and a sequential letter, will be assigned to each sample. Containers for each sample will also be numbered sequentially. The accuracy of sample container labeling is verified by a second person. These identifiers will be used to monitor the sample set and container throughout sample processing. All samples logged for the sample set and the analytical parameters required for each sample will be indicated on the Service Request. Client specific quality control requirements and any other pertinent information indicated on the Chain of Custody Record will also be noted. Discrepancies

between the Chain of Custody record and sample containers will be noted, as well as discrepancy resolutions. To reduce the possibility of inaccurate sample processing, the sample receiving staff working with the Project Manager will resolve all noted discrepancies prior to releasing the samples to the analytical sections.

Upon completion of sample log-in, all documentation will be placed in a master folder and forwarded to the assigned Project Manager for review and approval. The master folder will be color-coded as follows:

Master File Color	Designation
Red	Accelerated Turnaround (≤ week)
Blue	Accelerated Turnaround/Fuels
Clear	Routine Turnaround

The Project Manager will review all aspects of the documentation, specify any additional analytical requirements and resolve any remaining discrepancies before sample processing begins. After Project Manager final approval has been obtained (indicated by the Project Managers initials and the date on the Service Request and laboratory-specific parameter sheets), the master file will be returned to Log-In for preparation of laboratory job folders. A job folder will be created for each laboratory section involved in sample processing for a given project. Laboratory job folders are color-coded as follows:

Job Folder Color	Designation
Red	Accelerated Turnaround (≤ 10 days)
Manila	Normal Turnaround (11 to 14 days)
Blue	Accelerated Turnaround (≤ 7 days) for Fuels Analyses (NWTPH, AK103 etc.)
Yellow	Extended Turnaround (>14 day TAT)
Other (Green, Purple ,etc)	Client or Project Specific Analyzes

Copies of the Service Request and all pertinent laboratory-specific documentation required to accurately complete sample analysis will be placed in each laboratory job folder. Laboratory

job folders will then be distributed to appropriate laboratory sections for analysis and incorporation into the section tracking system.

Subcontracting Policies

ARI may be required to subcontract work to other laboratories. The following policies are followed to assure that data produced by a subcontractor is high quality, defensible and will meet the client's expectations.

1. ARI's client must be made aware that samples will be subcontracted and what laboratory will perform the analyses.
2. Subcontractor laboratories must qualify to perform the analyses using the same criteria applied to ARI. When appropriate, subcontracted laboratories must submit proof of certification or accreditation, quality assurance plans, standard operating procedures, results of method detection limit studies, control limits to ARI. ARI may at its discretion perform an on-site assessment of subcontracted laboratories. Failure to submit requested documents or refusal of an on-site assessment will disqualify laboratories from subcontracting ARI sample analyses.
3. ARI will not subcontract Department of Defense work to be performed under the Quality Systems Manual (DoD-QSM) unless the subcontract lab is approved to perform DoD-QSM analyzes.
4. The sample information and analytical requirements are first entered into the ARI LIMS in the same way that samples for in-house analyses are processed. Subcontractor laboratories are contacted to verify their preparedness, and samples are then submitted to them using ARI chain-of-custody forms. These chain-of-custody documents are included in the master folder for the project.
5. ARI may request that subcontract laboratories analyze, on double blind performance testing (PT) sample obtained from commercial vendors at the subcontractor's expense.
6. The laboratory must be willing to maintain an annual contract with ARI, and must list ARI as a co-insured on the subcontract laboratory's liability insurance policies.
7. Financial stability is also evaluated on a lab-by-lab basis.

6.4 Sample Custody

To ensure the traceability of sample possession, chain of custody is documented from sample collection to completion of final analysis, and is maintained during sample storage in archive prior to disposal. This is achieved through completion of a written chain of custody record. Custody of all samples and extracts processed by the laboratory is documented at each step of the analytical process.

The National Enforcement Investigations Center (NEIC) of EPA defines custody in the following ways:

It is in your actual possession, or
It is in your view, after being in your physical possession, or
It was in your possession, then you locked or sealed it up to prevent tampering, or
It is in a secure area.

Sample handling may vary and specific custody procedures have been developed for each laboratory section.

Custody at Sample Log-in

A Chain of Custody Record must accompany all samples received by the laboratory. This record documents all sampling activities as well as persons handling the samples prior to receipt by the laboratory. Sample receiving staff assumes custody of samples upon receipt from the client or courier. Samples will remain in the custody of Sample receiving until the samples are delivered to a laboratory section. Should samples require shipment to a subcontracting laboratory, a separate Chain of Custody Record will be completed to document the sample transfer. Chain of Custody records will be included with sample data reports in the final analytical package submitted to the client. Copies of these records will be filed with project data.

Custody of Volatile Organic Analysis (VOA) Samples

Upon completion of sample the sample receiving process, samples requiring analysis for volatile organic analysis will be placed in the VOA refrigerator designated for incoming samples and logged into the VOA sample receipt logbook. The samples are now in the custody of the VOA laboratory. To avoid possible cross-contamination of low level samples,

those samples known or suspected to contain high levels of contaminants, such as underground storage tank (UST) samples, will be stored in a separate refrigerator prior to analysis.

VOA Laboratory analysts complete the receiving process and move the samples to a refrigerator designated for “active” samples. Samples removed from storage for analysis are considered to be in the custody of the analyst responsible for sample processing. All samples to be analyzed will be listed in the analytical logbook for the selected instrument. Laboratory and client sample identifications, the bottle number and identification of the analyst performing the analysis will be indicated in the logbook. If it is necessary for sample custody to be transferred to another instrument or analyst, the second analyst will record this information. Thus, custody of a given sample can be traced throughout the analytical process, regardless of the number of instruments or analysts involved. Analysts will initial all raw data generated from sample analysis, to further document sample custody.

After completion of sample analysis, soil and intact water sample containers will be placed in the refrigerator designated for sample archival. Any water sample remaining in the container after completion of analysis will be considered compromised and will be discarded. The samples will remain in archive and in the custody of the VOA laboratory until final disposal.

Custody of Semi-volatile Organic Analysis (SVOA) Samples

Upon completion of sample log-in, samples requiring extraction for organic parameters will be placed in walk-in cooler number 5. All samples placed in the cooler will be logged into the *Walk-in Admission Logbook*. Removal of samples from the refrigerator for processing by Extractions or Conventional personnel must be indicated in the *Walk-in Admission Logbook*. Samples stored in this walk-in refrigerator remain in Log-In custody until removed to a laboratory for processing.

The analyst responsible for the custody and initial handling of samples within the sample preparation laboratory will be indicated on the Sample Preparation Worksheet. All analysts involved in the subsequent steps of sample processing will also be indicated on the worksheet. Residual sample volumes will be archived in the refrigerator designated for extractable organic samples. Transfer of residual samples to this refrigerator will be documented in the *Sample*

Archive Refrigerator Logbook. Transfer of prepared sample extracts to the appropriate analytical sections will be documented in the Extract Log in the preparation laboratory and in the Extract Log in the analytical section. Upon extract transfer, the analytical section receiving the extract assumes custody.

Extracts removed from storage for analysis are considered to be in the custody of the analyst responsible for analysis. Removal of extracts for analysis will be indicated in the Extract Log in the analytical section. All extracts to be analyzed will be indicated in the analytical logbook for the selected instrument. Laboratory and client sample identifications, as well as the analyst performing the analysis will be indicated in the logbook. Analysts will initial raw data generated from extract analysis to further document sample custody. After completion of analysis, extracts will be placed in the refrigerator designated for archive. Extracts will remain in storage and in the custody of the analytical section until final disposal.

Custody of Inorganic and Metals Samples

Upon completion of the sample receiving process, samples requiring preparation or analysis for inorganic parameters will be placed in the designated walk-in cooler. Selected samples such as those requiring a critical analysis are placed directly in the laboratory. Removal of samples from the refrigerators for digestion and/or analysis will be indicated in the *Walk-in Admission Logbook* for the appropriate refrigerator. Samples stored in the walk-in refrigerators remain in Log-In custody until the laboratory removes the samples for processing.

The analyst responsible for custody and initial handling of samples within the metals preparation laboratory will be indicated on the Sample Digestion Worksheet. All analysts involved in the subsequent steps of sample processing will also be indicated on the worksheet. Transfer of completed sample digests to the metals instrument (analysis) laboratory will be documented by the metals preparation laboratory. Upon transfer of digests, custody is considered to be the responsibility of the analytical section receiving the digests.

Digests removed from storage are considered to be in the custody of the responsible analyst. All digests to be analyzed will be indicated in the analytical logbook for the selected instrument. Laboratory sample identifications and the analyst performing the analysis will be indicated in the logbook. If it is necessary for digest custody to be transferred to another instrument or

analyst, the second analyst records this information. Thus, custody of a given digest can be traced throughout the analytical process, regardless of the number of instruments or analysts involved. Analysts will initial all raw data generated from digest and analysis to further document sample custody. After completion of analysis, digests will be stored by and remain in the custody of the analytical laboratory personnel until final disposal.

The analyst performing the sample analysis will remove samples requiring analysis for other inorganic (conventional) parameters from storage. Removal will be documented in the *Walk-in Admission Logbook*. Custody of the sample will be considered to be the responsibility of that analyst. All samples to be analyzed will be indicated on the worksheet for the required parameter. Laboratory sample identifications and the analyst performing the analysis will be indicated on the worksheet. If it is necessary for sample custody to be transferred to another instrument or analyst, the second analyst will record this information. Thus, custody of a given sample can be traced throughout the analytical process, regardless of the number of instruments or analysts involved. The analysts' initials will be indicated on the worksheet to further document sample custody.

Special Chain of Custody Requirements

Should a client project require additional or more detailed custody documentation, requirements will be incorporated into the procedures for that project. Samples processed as part of the USEPA Contract Laboratory Program require more stringent chain of custody procedures. For this program, removal of samples and extracts for analysis (or any reason) will be documented in the Sample Control Log. Date, time and reason for removal, and date and time of return, will be fully documented. Removal of samples or extracts for permanent archiving or disposal will also be fully documented in the Sample Control Log.

6.5 Sample Archival and Disposal

After completion of analysis, unused sample aliquots are routinely stored for a specified period of time: 30 days for water samples and 60 days for soil samples. Colored markers are placed on samples with specific storage requirements during the sample receiving process. The color-coding is defined in the following table:

Label Color	Storage Requirement
Red	Hold until further notice
Orange	Suspected Hazardous
Yellow	Shared Sample Containers
Blue	Samples to be frozen

Samples submitted for archival will be logged into the Sample Archive Logbook. Laboratory and client identifications, as well as archive date will be indicated in the logbook. The anticipated disposal date for the sample set will also be noted. The logbook will be reviewed several times during each week to determine samples scheduled for disposal. On or soon after the scheduled disposal date, the samples will be removed from archive storage and disposed.

In consideration of disposal requirements for hazardous samples, each sample processed by the laboratory will be evaluated for contamination levels based on final analytical results. Those samples containing analytes of interest at or above regulated disposal levels will be identified and handled as hazardous waste. A designated staff member coordinates periodic pickup and disposal of hazardous waste by an USEPA approved TSD (Treatment, Storage, and Disposal) Company and maintains hazardous waste disposal records. Specific guidelines for handling hazardous samples and waste are detailed in the Chemical Hygiene Plan (Section 5, Waste Disposal Procedures)

SECTION 7: PROJECT MANAGEMENT AND TRACKING

7.1 Project Management

Concise and accurate communication between a client and ARI, and within the laboratory, is an extremely important requirement for generating quality analytical results. All clients contracting with ARI will be assigned to a Project Manager. The Project Manager confirms that project requirements are consistent with laboratory capabilities, and coordinates with laboratory sections to provide analytical results within specified project timelines. Project organization, monitoring, and follow-up is the responsibility of Project Management staff.

Client project requirements and Project Managers' areas of expertise will be considered for client assignment. To ensure that all clients and projects receive the attention necessary for successful project completion, Project Manager workloads will also be considered. Project Managers will serve as the central focus for all project related activities and communications.

The Project Manager will review work plans and requirements for all pending projects. Any questions related to the work plan will be addressed prior to project commencement. The Project Manager will consult with appropriate analytical sections to clarify any issues regarding procedures and capabilities. Project deliverables requirements will also be addressed at this time. Upon receipt and log-in of project samples, the Project Manager will review all documentation to ensure that samples were properly logged in, and that analytical and QC requirements were correctly specified. The Project Manager will also provide any additional project related information that will assist the analytical sections with sample analysis. Laboratory sections will not process a sample until Project Manager approval has been given. Exceptions are parameters with critical (less than 48 hour) holding times or those that arrive on weekends or holidays when none of the Project Managers can be contacted.

Throughout the project, the Project Manager will monitor all analytical activities to help ensure that the project is completed and delivered on schedule. Any issues arising during sample processing will be promptly discussed with the client. Likewise, the analytical staff will be informed of any client concerns or project modifications. The Project Manager will also address any issues that arise during subsequent review of the analytical data by the client.

7.2 Project Tracking

Monitoring the laboratory workload ensures that adequate staffing and equipment will be available to produce quality analytical data and meet client needs. At the time a client project is tentatively scheduled, information regarding the project will be documented in the Project Management Database. Project particulars, sample quantities, parameters and anticipated sample delivery dates will be specified, as well as any prearranged analytical costs. Project work plans and any other project information will be kept on file with the Project Manager. Schedules for pending projects are communicated to the lab sections through periodic distribution of database printouts. Upon receipt of project samples, the project Inquiry number will be referenced to ensure project requirements are accurately specified. The original project documentation will be placed in the master folder as part of the project file.

Each laboratory section analyzing project samples will be responsible for ensuring that all analyses are accurately completed by the required date. All staff members are required to be aware of holding times, special analytical requirements, and required turnaround times. Analytical sections will remain in close communication with the Project Management staff so that any issues arising during sample analysis can be promptly addressed or discussed with the client.

Project Managers or their designee are responsible for monitoring project status. Sample status reports are generated as needed from LIMS and are distributed to lab sections and Project Managers. These reports allow the Project Managers to review project status and identify any samples which must be expedited to meet project timelines. Additionally, verbal communication between Project Managers and lab sections provides information about project status.

After sample analysis, report generation, and final review have been completed, data and final reports will be forwarded to the Project Manager. If requested, preliminary and interim results will be forwarded to the client. When all final data are available, the Project Manager will assemble the final package, verifying that all analyses were completed and project requirements met. A project narrative detailing the particulars of sample processing will be generated. After assembly and prior to shipment, the Project Manager will perform a final, cursory review of the package for any inconsistencies or incorrect information. The package will then be forwarded to clerical

personnel for photocopying and shipment. The Project Manager will determine final analytical costs and submit this information to the Accounting department for invoicing. Upon completion, all raw data and documentation associated with each client project will be compiled and stored as part of the laboratory project files. A chart detailing laboratory workflow as described in this section is included as Appendix G.

SECTION 8: ANALYTICAL METHODS

To ensure that all data generated are consistent and comparable, clearly defined procedures will be followed for all aspects of sample processing, control and management. Standard Operating Procedures (SOPs) provide detailed guidelines for completing a procedure. Document control procedures and periodic audits will ensure that operations are performed in accordance with the most current SOPs. All routine deviations from published will be noted in the SOPs. Analysis specific deviation will be noted in Analyst Notes and in the Analytical Narrative.

8.1 Responsibilities

It is the responsibility of staff members to perform all procedures in accordance with the guidelines specified in the Standard Operating Procedures. Laboratory management is responsible for ensuring that SOPs are followed throughout the laboratory. The QAPM is responsible for coordinating periodic review and revision of existing SOPs and generation of additional SOPs. The QAPM is also responsible for maintaining SOP document control and ensuring that the most current versions of all SOPs are available to staff members.

8.2 Methods

Laboratory procedures may reference any established methods specified in the following publications:

1. Code of Federal Regulations (Section 40)
2. Test Methods for Evaluating Solid Waste (USEPA SW-846)
3. USEPA Contract Laboratory Program Statement of Work for Organic Analysis
4. USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis
5. Methods for Chemical Analysis of Water and Waste (USEPA 500 and 600 series)
6. Standard Methods for the Examination of Water and Wastewater
7. Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP)
8. Navy Installation Restoration Laboratory Quality Assurance Guide(February 1996)
9. Hazardous Waste Remedial Actions Program (HAZWRAP)
10. State of Alaska Department of Environmental Conservation (ADEC)
11. Oregon Department of Environmental Quality (DEQ) Petroleum Hydrocarbon Methods
12. Washington Department of Ecology (WA-Ecology) Guidance for Remediation of Releases from Underground Storage Tanks (Appendix L)
13. The Department of Defense Quality Systems Manual (DoD-QSM)
14. Washington State Sediment Sampling and Analysis Plan

The laboratory will adhere to established methods whenever possible. Occasionally, however, procedures determined to provide more accurate final results will be incorporated into the method. Should the laboratory procedures deviate from the established method, all modifications will be detailed in the associated SOP. A listing of laboratory SOPs is included as Appendix E.

8.3 Standard Operating Procedures

Standard Operating Procedures (SOPs) are detailed, step-by-step instructions for completing a laboratory operation. An SOP is available for all procedures within the laboratory, from initial project identification to final data archival. SOPs are generated for procedures developed within the laboratory and for those that follow established methods.

To ensure consistency in defining procedural guidelines, all SOPs that describe analytical procedures will contain the following sections:

1) Method, matrix or matrices, detection limit, scope & application, components to be analyzed
2) Summary of the test method
3) Definitions
4) Interferences
5) Safety
6) Equipment and supplies
7) Reagents and standards
8) Sample collection, preservation, shipment and storage
9) Quality control
10) Calibration and standardization
11) Procedure
12) Data analysis and calculations
13) Method performance
14) Pollution prevention
15) Data assessment and acceptance criteria for quality control measures
16) Corrective actions for out of control data
17) Contingencies for handling out-of-control or unacceptable data
18) Waste management
19) References
20) Appendices, tables, diagrams, flowcharts and validation data.

SOPs will be monitored through the laboratory document control system. Each SOP will be assigned a document control number as detailed in Section 5.2 of this LQAP. SOPs are revised whenever a laboratory procedure is changed or modified. All SOPs are reviewed and revised as necessary at least once a year. Personnel normally performing the procedure or

analysis perform the review. SOPs will be generated for each new procedure implemented within the laboratory. Review, modification, new SOP generation, and distribution will be coordinated through the QAPM. The QAPM will periodically audit the laboratory sections to verify that the most current versions of all SOPs are in use. Document release will be controlled as detailed in section 5.2.

8.4 Method Selection and Use

Method selection will be based on availability of analytical instruments and equipment, chemical standards, expected method performance and marketability. Methods that are defined and accepted by regulatory agencies and familiar to ARI's clients are preferred. The Laboratory Manager and QAPM in consultation with marketing, client service, and laboratory supervisory staff are responsible for selecting appropriate methods. Client or project-specific methods may be used when appropriate.

The most recently promulgated method will be used for all procedures. Non-promulgated methods will be investigated if requested by a client. Section supervisors and managers are responsible for ensuring that the procedures in use reflect the requirements of the promulgated methods. Any modifications made to the method must be documented in the SOPs. Method modifications may be acceptable, provided all acceptance criteria specified in the method are met.

Section supervisors and managers review newly promulgated methods. SOPs will be modified as necessary to reflect the new methods. When possible, the annual SOP review will be coordinated with anticipated method promulgation dates. This is especially useful for large method compilations, such as SW-846. If the annual SOP review and method promulgation cannot be coordinated, SOPs will be revised as soon as possible after a method has been promulgated, especially when method changes are significant.

SOPs will be generated to reflect the most commonly used methods and protocols. If more than one method is used for an analysis, separate SOPs should be generated. Several methods may be incorporated into one SOP, provided that each method is clearly identified and defined in the SOP. Method modifications or special requirements for ongoing projects, or for specific programs (Navy, CLP, etc.), will be incorporated into the SOP. These

requirements will be annotated to indicate that they are project/program specific. Analysts and technicians will be responsible for ensuring that, when required, project or program specific procedures are followed. SOPs will be controlled as specified in section 5.2.

8.5 Method Performance

Method performance must be demonstrated for all new methods prior to using methods for sample analysis. Section supervisors and managers are responsible for ensuring that method performance is demonstrated and support procedures have been performed.

Method performance will be demonstrated in the following manner:

A draft SOP will be generated for the method. The SOP must provide sufficient detail to perform the analysis and must accurately reflect the published method. Any steps in the method for which analyst discretion is allowed must be clearly defined.

A method detection limit (MDL) study must be performed for the method. Method detection limits must be verified to be at or lower than any method-specified detection limits. Method detection and reporting limits must be established.

Method precision and accuracy must be evaluated. This may be determined using an MDL or IDL study. Replicates will be evaluated for precision; analyte values will be compared with spike amounts to determine accuracy. Any method-specified precision and accuracy criteria must be met.

All method performance results will be reviewed and compiled by the section supervisor. Results will be filed with the QA section. A final SOP will be generated and distributed. MDL updates will be communicated to Computer Services for LIMS updates and distributed to laboratory sections as needed.

SECTION 9: INSTRUMENT CONTROL

9.1 Detection Limits

To verify that reported limits are within instrument and method capabilities, three levels of detection have been established: instrument detection limits, method detection limits, and reporting limits. Instrument and method detection limits are statistically based values, determined from replicate analyses of analytical standards. Reporting limits are based upon the experience and judgment of an analyst. Reported values will be qualified based on the established limits. All limits will be summarized and controlled by the QAPM and are included as Appendix I.

Instrument Detection Limits

The instrument detection limit (IDL) is considered to be the smallest signal above background noise that an instrument can reliably detect. This limit reflects whether or not the observed signal has been caused by a real signal or is only a random fluctuation of noise from the blank. The IDL does not take into consideration the performance or efficiency of analytical methods.

Instrument detection limits are determined annually, or when ever a major change has been made, for each instrument in the metals analysis laboratory. Seven replicates, of a blank, or standards containing analytes at levels three to five times the expected IDLs are analyzed on three non-consecutive days. The IDL value for an analyte is three times the average of the standard deviations from the three replicate sets of analyses.

Method Detection Limits

The method detection limit (MDL) is considered to be the lowest concentration of an analyte that a method can detect with 99% confidence. Method detection limits will be established for all analytical parameters according to the guidelines specified in the Code of Federal Regulations, Section 40. Seven replicate samples are fortified with target analytes at levels that are one to five times (but not exceeding 10 times) the expected detection limits. The MDL for an analyte is determined to be the standard deviation of the replicates times the appropriate

student's t-test value. More than seven replicates may be processed, but all replicates must be used in the MDL determination. MDLs are verified by analyzing a sample spiked at a concentration 3 to 5 times the calculated MDL concentration. When the analyte(s) are detected the MDL is verified. When the analytes is not detected, the concentration in the verification sample is increased until it is detected. The concentration at which the analytes is first detected then becomes the MDL.

Laboratory supervisors or managers review all statistically determined MDLs for accuracy and validity. The section supervisor or manager is responsible for ensuring that any unusable MDL studies are reprocessed. Once accepted, MDL study results and associated raw data will be forwarded to the QA section for further review and additional approval. MDLs approved by both section management and QA will be considered final and acceptable for use. Finalized MDL values are forwarded to Computer Services for incorporation into ARI's LIMS.

MDL studies will be conducted for all analyses performed by the laboratory on representative water, sediment and, tissue samples when appropriate and suitable sample matrices are available. MDL studies will be performed on all instruments used for sample analysis. To allow for reevaluation of method performance, MDL studies will be performed on an annual basis. The QAPM is responsible for ensuring that all MDL studies are performed at least annually. Section supervisors and managers are responsible for determining if and when additional MDL studies should be performed due to changes in analytical methods, instrumentation or personnel.

Reporting Limits

Reporting Limits (RL) are the lowest quantitative value routinely reported. Analytical results below the RL will be expressed as "less than" the reporting limit. RLs are estimated values based upon the MDLs, experience and judgment of the analyst, method efficiency, and analyte sensitivity. No reporting limit will be lower than its corresponding MDL. RLs will be verified on a regular basis either by having a calibration standard at the limit or by analyzing a standard at the RL immediately following initial calibration.

Analytical Standards

Generation of high quality results is dependent upon the use of accurately prepared analytical standards. Many stock standards used within the laboratory are commercially prepared solutions with certified analyte concentrations. Neat standards used for stock standard preparation are of the highest purity obtainable. Standard preparations are fully documented in appropriate logbooks.

Responsibilities

It is the responsibility of each laboratory employee involved with standards preparation to ensure that all standards are correctly and accurately prepared through the use of good laboratory practices and analytical verification. It is also the responsibility of these staff members to properly document the receipt and/or preparation of all standards. Management is responsible for ensuring that all staff members follow specified standards preparation and inventory procedures. The QAPM is responsible for periodically auditing standard preparation records to verify compliance with the laboratory Quality Assurance Program.

Organic Standards Preparation

Two types of standards are utilized for extractable organic compounds: neat standards from which stock solutions are prepared, and commercially prepared stock solutions from which working solutions are prepared. The type of standard depends upon availability. Commercially prepared standards are preferred when available.

Preparation of stock solutions will be documented in the Stock Solutions Log. To ensure traceability, commercially prepared stock solutions will also be documented in the Stock Standard Solutions Log. Each solution will be assigned a unique stock number determined by the page number and entry number on the page, preceded by “S” to indicate the solution is a stock, volatile stock standard are labeled “VS”. For example, the third entry on page 44 will be assigned the stock number S44-3. For stock solutions prepared from neat standards, the compound(s), supplier, lot number, preparation schematic, preparation date, expiration date, and analyst initials will be recorded. After preparing the standard, another analyst should review the preparation information to verify accuracy. For commercially prepared stock solutions, the compound, supplier, lot number and expiration date will be recorded. As a stock

solution is not actually prepared in-house for these commercial solutions, it is not necessary to record or verify a preparation schematic.

Preparation of working solutions (including spike and surrogate solutions) will be documented in the Working Standard Solutions Logbook. Each solution will be assigned a working standard number determined by the page number and entry number on the page. For example, the second entry on page 73 will be assigned the working standard number 73-2. For volatile organic standards, the working standard number is preceded by "VW". The compound, stock solution reference, preparation schematic, preparation date, expiration date, and analyst initials will be recorded. After preparing the standard, another analyst will review the preparation information to verify accuracy. After analyzing the standard and confirming that it is acceptable, analytical verification will be documented in the logbook.

Discarded or consumed standards will be annotated in the logbook by drawing a single line through the entry, indicating "discarded" or "consumed" above the line with confirming initial and date. Existing standard numbers will not be reused. Instead, each new stock or working solution made will be assigned a new number.

Standards preparation will be performed in accordance with good laboratory practices. Syringes, glassware and other preparation equipment will be thoroughly cleaned prior to and after use. Standard material weights and solution volumes will be accurate to ± 3%. Neat standards that are less than 97% pure must be corrected for concentration. Standard solutions will be stored in amber bottles with Teflon-lined caps. Each standard solution will be labeled with the solution number, compound, analyst initials and expiration date. Stock solutions will be stored in the appropriate standards freezer; working solutions will be stored in the appropriate standards refrigerator.

Metals Standard Preparation

Commercially prepared single element stock solutions are used for all elements. Preparation of working solutions from these single element stocks will be documented in the Solutions Logbook. Preparation of check standards will also be documented in the Solutions Logbook. The element, preparation schematic, preparation date, expiration date, and analyst initials will be recorded. Working calibration standards are prepared weekly for furnace and ICP analyses

and as needed for ICP-MS. Calibration verification standards are prepared daily for GFA analyses and as needed for ICP and ICP-MS analyses.

Standards preparation will be performed in accordance with good laboratory practices. All preparation equipment will be thoroughly cleaned prior to and after use.

Inorganic (Wet Chemistry) Standard Preparation

Working standards for wet chemistry parameters will be prepared on a daily basis, prior to starting an analysis. Stock and check standard solutions will be replaced as solutions expire or are consumed. Stock and check standard solutions will be labeled with the compound, preparation data (weight and volume), units of concentration, preparation date, expiration date, and analyst initials.

Standards preparation will be performed in accordance with good laboratory practices. Glassware and other preparation equipment will be thoroughly cleaned prior to and after use. Standard material weights and solution volumes will be accurate to ± 3%. Stock standards will be stored in containers appropriate for the parameter.

9.3 Calibration

Instrumentation and equipment used for sample processing and analysis must be operating optimally to ensure that accurate analytical results are generated. Verification of optimum operation is accomplished through various tuning and calibration procedures. Criteria for determining the accuracy of calibration are specified for all instrumentation and equipment. Prior to sample analysis, calibrations will be analyzed and evaluated against specified acceptance criteria. Acceptance criteria are either published as part of the method or generated at ARI using control charts. Calibration verifications will also be analyzed throughout an analytical sequence to ensure that instrument performance continues to meet acceptance criteria.

Gas Chromatography/Mass Spectrometry (GC/MS)

All GC/MS systems will be evaluated through analysis of an instrument performance check solution and calibration standards. The composition of the standards varies depending on the analysis performed on the system. System evaluation will be performed prior to sample

analysis. Evaluation criteria used for GC/MS analyses are as specified for the SW846 methods.

Instrument Performance Check Solution - Prior to analysis, the system will be evaluated to ensure that mass spectral ion abundance criteria are met. Bromofluorobenzene (BFB) is analyzed for volatile organic analyses and Decafluorotriphenylphosphine (DFTPP) is analyzed for semi-volatile organic analyses. All ions must meet method-specified criteria.

The instrument performance check solution will be analyzed at a minimum of every 12 hours during the analytical sequence. Each analysis of the check solution will be verified against the specified criteria.

Calibration - After instrument performance has been verified, each GC/MS system will be calibrated to verify response linearity. For volatile organic analyses, up to eight standards ranging from 1 to 200 µg/L will be analyzed. For semi-volatile organic analyses, five to seven standards ranging from 2 to 80 µg/L will be analyzed. The standard levels evaluated will vary depending on the compound. Initial calibration results will meet percent relative standard deviation acceptance criteria.

A continuing calibration verification standard at a mid-level concentration (routinely 50 µg/L for VOA and 250 µg/L for SVOA) will be analyzed at a minimum of every 12 hours during the analytical sequence. For continuing calibrations, minimum response factor and percent difference criteria will be considered in evaluating the acceptability of the calibration. Initial and continuing calibration acceptance criteria for volatile and semi-volatile organic analyses are presented in Appendix J. All calibration data printouts will include the following documentation:

Date of calibration,
Identification of standard used
Identification of person performing the calibration

The analyst performing the calibration will include documentation of any problems encountered during the calibration analyses with the data, and will also note any corrective actions taken. The calibration data will be tabulated, and summary statistics will be generated. These results will be kept on file with the raw data in the Data Services section.

Internal Standard Responses - Internal standard responses and retention times in all standards will be evaluated immediately after analysis. This will serve as a baseline from which all sample internal standard responses and retention times will be evaluated.

Gas Chromatography (GC)

Each GC and HPLC system will be calibrated to verify response linearity. Depending on the parameter, five to seven standards at concentrations covering the linear range of the

instrument will be analyzed. Percent relative standard deviations for initial calibrations will not exceed SW-846 limits or 25% when those limits are not applicable.

A continuing calibration standard at mid-range concentration will be analyzed after every 10 samples or more frequently if the method or conditions warrant. Percent differences between initial and continuing calibrations will not exceed SW-846 limits or 25% when those limits are not applicable.

Calibration for organochlorine pesticides will follow SW-846 guidelines. The initial calibration sequence specifies the analysis of Resolution Check, Performance Evaluation, five-point initial calibration, individual standards and instrument blanks. Criteria for evaluating these standards are as follows:

> Performance Evaluation - The Performance Evaluation standard will be analyzed immediately following the Resolution Check standard. All standard peaks will be completely resolved. Individual breakdowns of DDT and Endrin will be less than or equal to 15% on both columns. A Performance Evaluation standard will also be analyzed at the end of the calibration sequence.
>
> Initial Calibration - The percent relative standard deviation (RSD) will not exceed SW-846 guidelines or 20% on each column.
>
> Continuing Calibration - A midpoint Aroclor 1660 and or a midpoint pesticide standard along with a performance evaluation standard are analyzed after every ten (10) sample analyses. The continuing calibration standards will be within 85 - 115% of the initial calibration. The Performance Evaluation standard will meet previously specified criteria.

The analytical sequence may continue indefinitely, provided that calibration criteria are met throughout the sequence. Additionally, retention times for all compounds will fall within the retention time windows established by the initial calibration sequence of the three standard concentration levels.

All calibration data printouts will include the following documentation:

> *Date of calibration,*
> *Identification of standard used, and*
> *Identification of person performing the calibration.*

The analyst performing the calibration will include documentation of any problems encountered during the calibration analyses with the data, and will note any corrective actions taken. The calibration data will be tabulated, and summary statistics will be generated.

Metals

Analytical instrumentation for metals will be evaluated through the analysis of calibration standards, calibration blanks, and calibration verification standards. Initial calibrations will be performed prior to sample analysis.

Inductively Coupled Plasma Atomic Emission Spectrometry (ICP)

Initial standardization is performed daily, or more frequently as required, by analyzing a blank and four multiple element standards with a single concentration for each analytical wavelength. The calibration is immediately verified with the analysis of an initial calibration verification standard (ICV) obtained from a source independent from the IC standard. The calibration will then be verified throughout the analytical sequence by analyzing a continuing calibration verification standard (CCV) after every 10 sample analyses. The calibration check standard values will be within ± 10% of the true value.

After initial calibration, a calibration blank (ICB) will be analyzed to check for baseline drift or carryover. The level of analyte in the calibration blank should be ±2 RL. Calibration blanks (CCB) will be analyzed immediately following each calibration verification standard analysis.

Following calibration verification a standard at the reporting limit (CRI) is analyzed for all elements. Warning limits have been set at ±1RL and any sample determined to have a concentration below this standard will be reported as undetected.

The upper limit of the calibration range, linear dynamic range, is established for each analytical wavelength using standards of increasing concentrations. These standards are analyzed against the normal calibration curve and must be within 10% of their true value to verify linearity. At a minimum this upper range will be checked every six months or whenever major changes are made to the instrument. Any sample analyzed with a concentration above this linear dynamic range will be diluted and reanalyzed.

Also to verify the inter-element correction equations, inter-element correction standards (ICS) are analyzed both at the start and end of the analytic run. Both the major interfering and the interfered with elements are evaluated.

Atomic Absorption Spectroscopy (Graphite Furnace and Cold Vapor)

Atomic absorption instrumentation is initially calibrated using a minimum of three standards of varying concentrations and a calibration blank. Initial calibration is

performed daily or more frequently if conditions warrant. The calibration is immediately verified with the analysis of an independent source initial calibration verification standard (ICV). The calibration will then be verified throughout the analytical sequence by analyzing a continuing calibration verification standard (CCV) after every 10 sample analyses. The initial calibration verification standard value will be within ± 10% of the true value whereas the CCV will be considered in control if it is within ±10% for Graphite Furnace analysis or ±20% for Cold Vapor analysis.

After initial calibration, a calibration blank (ICB) will be analyzed to check for baseline drift or carryover. The level of analyte detected in the calibration blank should be ±1 RL. Calibration blanks (CCB) will be analyzed immediately following each calibration verification standard analysis.

Following calibration verification a standard at the reporting limit is analyzed for all elements. Warning limits have been set at ±1RL and any sample determined to have a concentration below this standard will be reported as undetected. Any sample determined to have a concentration above the high calibration standard will be diluted and reanalyzed.

Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

Initial standardization is performed daily, or more frequently as required, by analyzing a blank and four multiple element standards. The calibration is immediately verified with the analysis of an independent source initial calibration verification standard (ICV). The calibration will then be verified throughout the analytical sequence by analyzing a continuing calibration verification standard (CCV) after every 10 sample analyses. The calibration check standard values will be within ± 10% of the true value.

After initial calibration, a calibration blank (ICB) will be analyzed to check for baseline drift or carryover. The level of analyte in the calibration blank should be ±1 RL. Calibration blanks (CCB) will be analyzed immediately following each calibration verification standard analysis.

Following calibration verification a standard at the reporting limit (CRI) is analyzed for all elements. Warning limits have been set at ±1RL and any sample determined to have a concentration below this standard will be reported as undetected.

The upper limit of the calibration range, linear dynamic range, is established for each analytical wavelength using high level standards. These standards are analyzed daily, or as necessary, against the normal calibration curve and must be within 10% of their true value to verify linearity. Any sample analyzed with a concentration above this linear dynamic range will be diluted and reanalyzed.

Also to verify the inter-element correction equations, inter-element correction standards (ICS) are analyzed both at the start and end of the analytic run. Both the major interfering and the interfered with elements are evaluated.

Inorganic Analyses other than Metals (Conventional Analyses)

Instrumentation and equipment used in analyzing samples for conventional wet chemical parameters (predominantly inorganic anions and aggregate organic characteristics) will be evaluated through the analysis of either internally prepared primary standards or externally derived Standard Reference Materials.

Depending upon the analysis, calibration is based upon direct stoichiometric relationships, regression analysis, or a combination of the two. Stoichiometry generally involves standardization of a titrant against a known primary standard and then the use of that titrant for determining the concentration of an unknown analyte (e.g. the use of sodium thiosulfate in the iodometric titration of dissolved oxygen). Regression analysis involves the determination of the mathematical relationship between analyte concentration and the response produced by the measurement being employed. Regression analysis is used for colorimetric determinations, ion specific electrode analysis and ion chromatography. The curve of response versus concentration is fit by the method of least squares using linear, polynomial or logarithmic regression dependant upon the pattern of response being measured.

Calibration is repeated for each analytical batch. Immediately following calibration, the standardized titrant or the calibration curve will be verified by the analysis of an Initial Calibration Verification standard (ICV) and Initial Calibration Verification Blank (ICB). The verification standard will be derived from a source other than that used for standardization or development of the standard curve. The ICV must return a value within 10% of its known concentration. The ICB must be less than the Reporting Limit (RL) or the lowest point on the standard curve, whichever is less. Initial calibration verification must be successfully completed prior to the analysis of any samples.

Calibration verification will be repeated after every ten samples processed during an analytical run. This Continuing Calibration Verification (CCV) will validate the method performance through an analytical sequence. If the continuing calibration values for either the standard or blank are out-of-control, the analyst will verify the outlying condition and, if verified, the analysis will stop and the method will be re-calibrated. All samples run between the outlying

CCV and the preceding in-control CCV will be re-analyzed. In-control verification standards and blanks must bracket all samples within an analytical run.

Initial calibration depending upon the analysis is based on a direct stoichiometric relationship, a linear regression analysis or a combination of the two. Stoichiometry generally involves standardization of a titrant and use of that titrant for determining the concentration of an unknown analyte (e.g. the use of thiosulfate in iodometric determination of dissolved oxygen). Regression analysis involves the determination of the mathematical relationship between the analyte concentration and the response produced by the measurement being employed. The curve is fit by the method of least squares using a linear, polynomial or logarithmic regression depending on the response being measured. The regression coefficient will be greater than or equal to 0.995 for the calibration to be considered acceptable.

Initial calibration curve is verified throughout the analytical sequence by analyzing a calibration verification standard after every 10 sample analyses. The calibration verification standard value will be within ± 10% of the initial calibration.

After initial calibration, a calibration blank will be analyzed to determine target analyte concentration levels. The level of analyte detected in the calibration blank will be less than the lowest standard concentration in the initial calibration.

SECTION 10: DATA VALIDATION and REVIEW

One hundred percent (100%) of laboratory data generated at ARI are subjected to a four level validation (review) process prior to release from the laboratory. The four levels of review are:

1. Analyst review
2. Peer review
3. Supervisory review
4. Administrative review

The data review process is outlined below and detailed in SOPs 200S through 206S.

In addition, Quality Assurance Personnel review 10% or more of all completed data packages for technical accuracy, project compliance and completeness. The data validation outlined below is completed in addition to the initial project review explained in Section 7 and QA specific reviews outlined in Section 11. If it is determined at any point during the analysis, reporting, or review process that data are unacceptable, prompt and appropriate corrective action must be taken. The corrective action will be determined by the situation. It is the responsibility of all staff members involved in data reporting and review to be aware of the quality control requirements and to be able to identify occurrences that require corrective action.

Analyst review:

Each analyst is responsible for producing quality data that meets ARI's established requirements for precision and accuracy and is consistent with a client's expectation.

Prior to sample preparation or analysis an analyst will verify that:

1. Sample holding time has not expired.
2. The condition of the sample or extract is described accurately on the laboratory bench sheet.

3. Specified methods of analysis are appropriate and will meet project required Data Quality Objectives.

4. Equipment and Instrumentation are in proper operating condition.

5. Instrument calibration and/or calibration verification are in control.

During sample preparation or analysis an analyst will:

1. Verify that Method Blanks and Laboratory Control Samples are in control.

2. Verify that QC (replicate, matrix spike analyses, SRM, etc.) samples meet precision and accuracy requirements.

3. In addition to verifying that quality control requirements are met, the analyst will review each sample to determine if any compound of interest is present at levels above the calibrated range of the instrument.

5. Check for data translation or transcription errors

6. Record all details of the analysis in the appropriate bench sheet or logbook.

7. Note any unusual circumstances encountered.

Following the analysis or sample preparation an analyst will:

1. Examine each sample and blank to identify possible false positive or false negative results.

2. Determine whether any sample requires reanalysis due to unacceptable quality control.

3. Review data for any unusual observances that may compromise the quality of the data, such as matrix interference

4. Review and verify that data entry and calculations are accurate and no transcription errors have occurred.

5. Document anomalous results or other analytical concerns on the bench sheet, corrective action form or Analyst Notes for incorporation into the case narrative.

6. Note data with qualifying flags as necessary.

7. Enter reviewed data into LIMS as appropriate, incorporate all necessary sample and quality control information into the data package and forward it for further review.

Peer review:

A second analyst trained in the appropriate SOPs will complete a peer review. Peer review will include at a minimum:

1. Verification that all QA (holding times, calibrations, method blanks, LCS, spiked sample analyses, etc.) criteria are in control.
2. Examination the data for possible calculation and transcription errors.
3. Review bench sheets and analyst notes for completeness and clarity.
4. Approve the analytical results or recommend corrective action to the laboratory supervisor.

When a second trained analyst is not available a peer review is not completed.

Supervisory Review:

Following analyst and peer review the data is forwarded to the laboratory section supervisor for review. The supervisor will:

1. Review the data package for completeness and clarity.
2. Follow-up on the peer review recommendations.

Designated reviewers normally perform the peer and supervisory reviews for GC-MS data. The reviewers are identified on the organizational chart in Appendix A.

Administrative Review:

The results of all analyses are reviewed for compliance with quality control criteria and technical correctness before data is released to the Project Manager for distribution to clients. Designated reviewers in the Metals, Conventional and Organic laboratories perform administrative reviews. Personnel responsible for administrative reviews are noted in the Organizational Chart in Appendix A to this LQAP.

Administrative review is the final data validation process. Personnel performing the administrative review are responsible for the final sign-off and release of the data. Following administrative review the data is released to Project Managers for incorporation into the final data deliverable package.

Administrative review will:

1. Verify that the analytical package submitted for reporting is complete and contains all necessary information and documentation.
2. Verify that appropriate and necessary data qualifying flags (Listed in Appendix N) have been used.
3. Verify that method blank and LCS data are acceptable, quality control requirements were met for surrogates in all samples and blanks, and that all necessary re-analyses or dilutions were performed.
4. Check the technical validity (i.e. are total metal ≥ dissolved metals, is the cation/anion balance correct, etc.) of the complete data set.
5. Verify that all necessary final data reports have been generated and that all necessary data and documentation are included in the package.
6. Approve data reports for release.

10.2 Quality Assurance Review

10% (1 out each 10) final data packages are reviewed by ARI's QA staff for compliance with ARI's QA Program. This assessment includes, but is not limited to, review of the following areas:

1. Reporting and analysis requirements
2. Initial and continuing calibration records
3. Quality control sample results (method blank, LCS, spikes, replicates, reference materials)
4. Internal and surrogate standard results
5. Detection and reporting limits
6. Analyte identifications.

Data review activities are summarized and documented by the reviewer. The review notes are filed with the associated raw data in the project file. Any QA-related deficiencies identified during the data review will be forwarded to the QAPM for corrective action.

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SECTION 11: QUALITY CONTROL SAMPLE ANALYSIS AND EVALUATION

Routine analysis of quality control (QC) samples is necessary to validate the quality of data produced in ARI's laboratory. ARI routinely utilizes the following quality control analyses as defined in Section 11.3:

1. method blank (MB)
2. holding blank (HB)
3. surrogate standard analyses (SS)
4. laboratory control sample (LCS)
5. laboratory control sample duplicate (LCSD)
6. standardized reference material (SRM)
7. sample(matrix) replicate (MD)

8 matrix spike (MS)

9. matrix spike duplicate (MSD)

The number and type of QC analyses depend on the analytical method and/or the QA/QC protocol required for a specific project. A range of acceptable result is defined for each type of QC analysis. When all quality control sample results are acceptable, the analysis is considered to be "in-control" and the data suitable for its intended use. Conversely, quality control sample results that do not meet the specified acceptance criteria indicate that the procedure may not be generating acceptable data and corrective action may be necessary to bring the process back "in-control".

Detailed information concerning sample preparation batches, QC analyses and surrogate standards follow:

11.1 Sample Preparation Batch

All QC samples will be associated with a discrete sample preparation batch. A preparation batch is defined as 20 or fewer field samples of similar matrix processed together by the same analysts, at the same time, following the same method and using the same lot of reagents. Additional batch requirements are detailed in ARI's method specific standard operating procedures. Each preparation batch will be uniquely identified. All samples, field and QC, will be assigned an ARI LIMS ID number and will be linked to their respective preparation batch. Each sample batch will contain all required QC samples in addition to a maximum of twenty field samples.

ARI will accommodate client, QC protocol or QAPP specific sample batching schemes.

11.2 QC Sample Requirements

Each preparation batch will include, at a minimum, a method blank (MB) and a laboratory control sample (LCS). Additional QC samples will be analyzed based upon the specific QC protocol required, data deliverable requirements or client request. ARI recommends that QC samples used to measure analytical precision also be included in each sample batch. These may include: a matrix spike and a matrix spike duplicate pair; a sample duplicate and a matrix spike pair or an LCS duplicate (LCSD) for comparison with the LCS.

11.3 QC Sample Definitions

11.3.1 Method Blank (MB)

A method blank is an aliquot of water or solid sample matrix that is free of target analytes and is processed as part of a sample batch. The method blank is used to verify that contaminants or compounds of interest are not introduced into samples during laboratory processing. Method blanks will be spiked with surrogate standards for all organic analyses.

ARI defines an acceptable method blank as one that contains no target analytes at a concentration greater than one-half ARI's reporting limit or 5% of an appropriate regulatory limit or 10% of the analyte concentration in the sample which ever is greatest.

A minimum of one method blank will be included in each preparation batch. A maximum of twenty samples may be associated with one method blank. An acceptable method blank is

required prior to analysis of field samples from a preparation batch. For methods not requiring pre-analysis sample preparation, a minimum of one method blank will be analyzed immediately prior to sample analysis, periodically throughout the analytical sequence, and also at the end of the sequence.

The results of the method blank analysis will be reported with the sample results.

11.3.2 Holding Blank (HB)

Holding blanks are organic-free water samples that are placed in each volatile organic sample storage refrigerator to monitor for possible cross-contamination of samples within the storage units. A holding blank from each refrigerator will be analyzed every 14 days. Holding Blank analyses will be reviewed by laboratory management and archived in ARI's electronic document archive.

11.3.3 Laboratory Control Sample (LCS)

An LCS is processed as part of each preparation batch, and is used to determine method efficiency. An LCS is an aliquot of water or solid matrix free of target analytes to which selected target analytes are added in known quantities. The analytes spiked into LCS samples are listed in ARI's method specific SOPs. LCS will be spiked with surrogate standards for all organic analyses.

Following analysis the percent recovery of each added analyte is calculated and compared to historical control limits. Current control limits are listed in Appendix K of this document. When calculated recovery values for all spiked analytes are within specified limits, the analytical process is considered to be in control. Any recovery value not within specified limits requires corrective action prior to analysis of any field samples from the associated preparation batch.

A minimum of one LCS will be prepared for each sample preparation batch. LCS analysis for those methods not requiring pre-analysis sample preparation will be performed after each continuing calibration. The results of all LCS performed will be reported with the sample results. A maximum of twenty samples may be associated with one LCS.

Specific clients or QA protocol may require the analysis of a duplicate LCS. When LCS duplicates are analyzed the failure of any analyte in either LCS to meet QC limits must trigger a corrective action.

11.3.4 Replicate Analysis

Replicate analyses are often used to determine method precision. Replicates are two or more identical analyses performed on subsamples of the same field sample at the same time. Replicate analyses should be performed on samples that are expected to contain measurable concentrations of target analytes.

The calculated percent difference between replicates must be within specified limits or corrective actions are required. Percent differences exceeding the specified limit signal the need for procedure evaluation unless the excessive difference between the replicate samples is clearly matrix related.

For inorganic analyses, a minimum of one replicate set should be processed for each analytical batch. Replicate sample analyses are not routinely performed for organic parameters. Instead, analytical precision is evaluated through the analysis of a duplicate matrix spike sample (MSD).

In order to perform replicate analyses, ARI's must receive sufficient volume to prepare the replicate aliquots.

Field replicates submitted to the laboratory will be analyzed as discrete samples.

11.3.5 Matrix Spike

A matrix spike is an environmental sample to which known quantities of selected target analytes have been added. The matrix spike is processed as part of an analytical batch and is used to measure the efficiency and accuracy of the analytical process for a particular sample matrix. The analytes spiked into MS samples are listed in ARI's method specific SOPs. MS samples will be spiked with surrogate standards for all organic analyses.

Following MS analysis the percent recovery of each spiked analyte is calculated and compared to historical control limits. If recovery values for the spiked compounds fall within specified

limits, the analytical process is considered to be in control. When calculated recovery is outside of historical limits corrective action is recommended.

Matrix spike duplicate (MSD) analyses are often used to measure method precision and accuracy. In this case the relative percent difference for recovery of spiked compounds is calculated and compared to established criteria.

Unless directed otherwise, ARI's policy is to prepare a matrix spike and a duplicate with each batch of samples for inorganic analysis and an MS/MSD set for each batch of samples for organic analyses. Analyte recovery and RPD values are reported with sample data.

11.3.6 Standardized Reference Material (SRM)

An SRM is material analyzed and certified by an outside organization to contain known quantities of selected target analytes independent of analytical method. SRMs are normally purchased from outside suppliers outside of ARI and are supplied with acceptance criteria. Analysis of SRM is used to assess the overall accuracy of ARI's analytical process. SRM are routinely analyzed with each batch of samples for wet chemistry (conventionals analysis) samples. External reference samples are analyzed after instrument calibration and prior to sample analysis. Compound recovery values not within the specified limit signal the need to evaluate either the calibration standards or instrumentation.

11.3.7 Other Quality Indicators

In addition to analyzing the quality control samples outlined previously, various indicators are added to environmental samples to measure the efficiency and accuracy of ARI's analytical process. Surrogate standards are added to extractable organic samples prior to extraction to monitor extraction efficiency. Surrogate standards will also be added to volatile organic samples prior to analysis to monitor purging efficiency. Internal standards are added to metals digestates for ICP-MS analyses and to organic samples or extracts prior to analysis to verify instrument operation.

The calculated recovery of surrogate analytes is compared to historical control limits to aid in assessing analytical efficiency for a given sample matrix.

11.4 Control Limits

To provide a means for evaluating whether or not a process is in control, acceptance limits have been established. These are based on internal, historical data for organic analyses and method specified limits for inorganic analyses. Samples associated with a specific program or contract (such as the USEPA Contract Laboratory Program) will be evaluated against program/contract-specified criteria. Routine samples will be evaluated against internally generated control limits. Project specific control limits will be used as required provided they have been reviewed for feasibility and approved by laboratory management.

Results of QA analyses are transferred from the LIMS to a control limit and chart generation program. The QAPM coordinates control chart and control limit generation. Control limits will be generated for LCS compound recoveries, surrogate recoveries, and matrix spike compound recoveries, on a method and matrix specific basis. Advisory control limits will be utilized for analyses performed on an infrequent basis until a sufficient number of usable data points are collected. Control limits are updated at least annually, but may be updated more frequently if method or instrument changes have been made. Laboratory control and acceptance limits are detailed in Appendix K.

Two levels of control limits are utilized in evaluating process control: warning limits and action limits. Limits are statistically determined from values obtained from LCSs or other control samples. Warning limits, within which 95% of all results are expected, equal $\pm$ two standard deviations from the average result. Action limits, within which 99.7% of all results are expected, are equal to $\pm$ three standard deviations from the average result. Mean values, warning limits, and action limits are necessary for thorough evaluation of process control.

11.5 Control Charts

Control charts, in conjunction with other control sample analyses, are useful in verifying that an analytical procedure is performing as expected. The control chart provides a pictorial representation of how closely control sample results approximate expected values, as well as showing analytical trends. Indicated on the control chart are the mean and upper and lower warning and action limits. The warning and action limits are used to determine whether or not an analytical process is in control. The mean is used to determine whether results obtained for

a procedure are trending upward or downward, which may ultimately affect the accuracy of sample results.

The QA Officer will coordinate generation of control charts based on laboratory data at least semi-annually. These control charts will be distributed to and reviewed by section supervisors and managers. Any significant trends or variations in results will be identified, and the source of the trend corrected. Copies of control charts will remain on file in the QA section. At the bench/instrument level, individual results from quality control samples are evaluated against the limits.

SECTION 12: CORRECTIVE ACTIONS AND REESTABLISHMENT OF CONTROL

To produce quality data, it is important that all aspects of the analytical process are under control and that all specified quality control criteria are met. On occasion, however, procedures, reagents, standards, and instrumentation can fail to meet specified criteria. Should any of those situations occur, the quality of data produced may be compromised. When procedures no longer appear to be in control, sample processing will be halted and appropriate actions will be taken to identify and rectify any instrument malfunctions or process-related issues. Prior to resuming sample analysis, verification of control will be made through the analysis of various control samples. Actions taken and observations made during reestablishment of control will be fully documented on the bench sheet or as an Analyst Note. Only when control has been regained and all actions documented will sample processing resume. This ensures that no results generated during the suspect period will be reported.

12.1 Responsibilities

It is the responsibility of all laboratory personnel involved with sample processing to be able to determine whether or not a procedure is in control and to verify that all data are produced under conditions that are “in control”. It is at the analytical level that unacceptable conditions are most easily detected and addressed. These personnel are also responsible for employing and documenting all necessary corrective actions taken to regain control of a procedure. Samples processed during suspect periods will be reprocessed, and suspect data will be appropriately annotated to indicate that it is of questionable quality. The analytical staff will verify that all data submitted for review has been generated under acceptable conditions. All anomalies will be documented on the Analyst Notes form and will include such information as: type and source of anomaly, reasons for the anomaly, and actions taken to correct the problem. All personnel involved with subsequent and final data review are responsible for verifying that data were generated under acceptable conditions. If suspect data are identified at the review level, responsible analysts should be contacted to determine whether additional actions (such as reanalysis) will be taken. In addition, reviewers will confirm that anomalies

noted by the analyst were indeed addressed and that appropriate corrective actions were taken.

On occasion, it is not possible to generate data that meet all Quality Control Standards. This may be due to sample volume limitations or sample matrix effects. It is the responsibility of the analytical and data review staff to document these situations and to maintain communication with the Project Management staff. The Project Management staff, in turn, is responsible for notifying the client or specifying additional actions to be taken. Project Managers are further responsible for ensuring that clients fully understand which data are questionable and the reasons why acceptable results could not be generated.

It is the responsibility of the QAPM to perform regular reviews of corrective action procedures to ensure that unacceptable conditions or suspect data will be identified prior to releasing results. Section managers and supervisors are responsible for ensuring that appropriate corrective action procedures are in place and that all staff members are trained to identify and act upon “out of control” situations.

12.2 Corrective Actions

There are various stages of the analytical process where the procedure may fall out of control and require corrective action. In general, all procedures and equipment will be monitored to verify that control is maintained during sample processing. The following details those stages as well as the actions taken to reestablish and verify control.

Sample Preparation

During sample preparation, all glassware associated with a specific sample will be clearly labeled to eliminate the possibility of sample mix-up or mislabeling. Laboratory staff will ensure that sample-identifying labels are accurately completed and that correct sample identification is maintained at all times. If a sample appears to have been misidentified or mixed with another sample during preparation, the suspect samples will be discarded and new aliquots taken. If there is insufficient sample for a second preparation, the situation will be documented on the bench sheet and the Project Manager will be immediately notified.

Addition of surrogate standards or matrix spiking solutions will be carefully monitored to ensure that all samples are accurately fortified. Volumes and standard solution numbers of all

standards added to samples will be recorded on the bench sheet. If there is suspicion that a sample has been incorrectly spiked a new sample aliquot should be prepared. If there is insufficient volume for re-preparation, the bench sheet will be annotated to indicate which samples may be inaccurately fortified.

If sample matrix hinders processing per standard procedures, the section supervisor or manager will be consulted for guidance on appropriate actions. Preparation of smaller sample aliquots or employment of different procedures may be necessary. Any deviations from normal protocols will be documented on the bench sheet.

If at any time during sample preparation sample integrity is compromised or a procedural error is noted, the sample will be discarded and re-prepared. If insufficient sample volume is available for re-preparation, the situation will be documented on the bench sheet and the Project Manager will be immediately notified.

Calibration and Tuning

Prior to sample analysis, all instrumentation will be calibrated and tuned to ensure that equipment meets all criteria necessary for production of quality data. Equipment must meet the calibration criteria specified in the section entitled “Calibrations”, per manufacturer specifications or per project/contract requirements. If these criteria are not met, corrective actions must be employed. Any corrective actions taken will be fully documented in the appropriate logbook, indicating the problem, the actions taken, and verification. Samples will not be analyzed until initial verification of system performance has been made. In the event that continuing calibration results do not meet criteria, sample analysis will not resume until corrective actions have been employed or the system has been re-calibrated.

GC/MS Analyses - Analysis of the instrument performance check solution (BFB or DFTPP) will meet the specified ion abundance criteria. Initial calibration standards at a minimum of five concentrations will meet specified response factor and percent relative standard deviation criteria. It criteria are not met for initial calibration, the system will be inspected for malfunction. The initial tuning and calibration will be repeated, with all necessary corrective actions taken, until calibration criteria are met.

A check of the calibration curve will be performed at a minimum of once every 12 hours. All response factor criteria will be met. Additionally, the percent difference between the initial and continuing calibrations will meet specified criteria. If criteria

are not met, the system will be inspected for malfunction. The initial tuning and calibration verification will be repeated, with all necessary corrective actions taken, until calibration criteria are met.

Internal standard responses and retention times for standards will meet specified criteria. Any sample not meeting internal standard criteria will be reanalyzed. If reanalysis yields the same response and the instrument is determined to be functioning correctly, the failure to meet criteria will be attributed to sample matrix interference. No further re-analyses will be required.

GC Analyses - Organochlorine pesticide calibrations will be evaluated using either USEPA CLP or SW-846 guidelines. The Resolution Check standard will meet resolution criteria and Endrin and DDT breakdown in the Performance Evaluation standard will meet breakdown criteria. Initial calibrations will meet percent relative standard deviation criteria. If, during the initial calibration sequence, criteria are not met, the system will be inspected for malfunction and the initial calibration be reanalyzed. Samples will not be analyzed until all initial calibration criteria are met.

Continuing calibrations of either the mid-level calibration standard or Performance Evaluation standard will be analyzed every 12 hours. If continuing calibration criteria are not met, the system will be inspected for malfunction and corrective actions will be taken to bring the system back into compliance. If, after corrective actions, the system is still not in compliance, re-calibration will be performed. After the system has been successfully corrected or re-calibrated, all samples previously analyzed between the acceptable and unacceptable continuing calibration will be reanalyzed.

If, during the analytical sequence, retention time shifting occurs, the system will be inspected for malfunction and corrective actions will be taken to bring the system back into compliance. If, after corrective actions, the system is still not in compliance, re-calibration will be performed. After the system has been successfully corrected or re-calibrated, all samples with retention times outside the specified windows will be reanalyzed.

For all other analyses, initial calibration standards analyzed at a minimum of five concentrations will meet percent relative standard deviation criteria. If criteria are not met for initial calibration, the system will be inspected for malfunction. The calibration will be repeated, with all necessary corrective actions taken, until calibration criteria are met.

A check of the calibration curve will be performed after every 10 samples. All percent differences between the initial and continuing calibrations will meet specified criteria. If criteria are not met, the system will be inspected for malfunction and re-calibration will be performed. Samples analyzed between an acceptable and unacceptable calibration check will be reanalyzed.

Metals and Inorganic Analyses - Initial calibrations will be verified by analyzing a calibration check standard immediately after calibration. The percent differences between the initial calibration and calibration check standard will meet specified percent difference criteria. If criteria are not met, the system will be inspected for

malfunction. The initial calibration and calibration check will be reanalyzed until acceptance criteria are met.

The calibration check standard analyzed after every 10 samples will meet percent difference criteria. If the calibration check standard is not acceptable, the system will be inspected for malfunction and re-calibration will be performed as necessary. Samples analyzed between acceptable and unacceptable calibration check standards will be reanalyzed.

Instrument Blanks

Prior to sample analysis, instrument and/or calibration blanks may be evaluated for the presence of target analytes. If analytes are detected, the concentrations must be below the reporting limits for those analytes. If analytes are detected at levels above the reporting limits, the source of contamination will be identified. Sample analysis will not commence until analyte levels in instrument and calibration blanks are below the reporting limits. Instrument and calibration blanks are analyzed for VOA analysis only if sample carryover is suspected.

Instrument and calibration blanks will also be analyzed throughout the analytical sequence. These will not contain target analytes at levels above the method detection limits for organic parameters or the reporting limit for inorganic parameters. If one or more analytes exceed the RL, an additional blank will be analyzed. If analyte levels are still above the method detection limits, the system will be inspected for malfunctions and the source of contamination will be identified. Sample analysis will not resume until instrument and calibration blank analyte levels are below the RL. Organic samples analyzed between acceptable and unacceptable blanks will be evaluated to determine the need for reanalysis per the following guidelines:

If no target analytes are detected in the samples, reanalysis will not be required.

If sample target analyte levels are above the method detection limits, samples will be reanalyzed at analyst discretion. Reanalysis will be dependent upon the analyte levels and whether or not there is likelihood that analytes detected are a direct result of system contamination.

If the analytes present at unacceptable levels in the instrument blank are not of interest or concern in the associated samples, reanalysis will not be required. This is often a consideration for ICP analyses where analytes of concern may be only a subset of the possible analytes.

Methods for the analysis of inorganic analytes require that all samples associated with an out of control blank be re-analyzed.

Method Blanks

Prior to sample analysis, method blanks will be evaluated for the presence of target analytes. Ideally, no target analytes should be present in the method blank. If analytes are detected at or above the Reporting Limit, the method blank will be reanalyzed to verify that the contamination is not a result of instrument carryover or malfunction. If the presence of target analytes is confirmed, the concentrations must be below the RL for those analytes.

Several volatile and semi-volatile compounds and certain elements are considered to be common laboratory contaminants. Concentrations of these common laboratory contaminants may exceed the method detection limits, but may not be present at concentrations greater than five times the method reporting limits. Target analytes considered to be common laboratory contaminants are:

Volatile Organic Compounds

Methylene Chloride
Acetone
2-Butanone

Semi-volatile Compounds

Dimethylphthalate
Diethylphthalate
Di-n-butylphthalate
Butylbenzylphthalate
bis-(2-Ethylhexyl) phthalate
Di-n-octylphthalate

If target analyte concentrations in the method blank exceed the acceptable levels and instrument malfunction or contamination has been ruled out, the method blank and all associated samples will be re-prepared and reanalyzed. If there is insufficient sample volume remaining for reprocessing, the Project Manager will be notified. If it is necessary to report results associated with an unacceptable method blank, the results will be qualified to indicate possible laboratory contamination.

In the event that an analyte detected in the samples ≥ 20 times the method blank levels re-preparation and reanalysis is not required. It is assumed that any contamination in the method blank is insignificant and will not affect final quantified results.

Laboratory Control Samples

Prior to sample analysis, the laboratory control sample (LCS) will be evaluated to verify that recovery values for all spiked compounds are within the specified acceptance limits. If LCS recoveries are out of control, corrective action is required. Corrective actions may include anything from a written explanation in the case narrative up to re-preparation and reanalysis of the entire sample batch.

Internal Standards

For volatile and semi-volatile organic analyses, internal standard results will be evaluated after each analytical run to verify that the values are within acceptance limits. Internal standard values will be within -50% to +100% of the internal standard values in the continuing calibration. If any internal standard does not meet the criteria, the system will be evaluated to confirm that all instrumentation is operating properly. The sample will then be reanalyzed. If the reanalysis results do not meet acceptance criteria, it will be assumed that the sample matrix is affecting internal standard values. Further reanalysis will not be required.

Surrogate

Surrogate recovery values will be evaluated after each analytical run to verify that the values are within acceptance limits. If recovery values are outside acceptance limits, the system will be evaluated to confirm that all instrumentation is operating properly. Documentation and bench sheets will be reviewed to verify that the concentrations of surrogate spike solutions added are accurate. For extractable organic analysis, bench sheets will be reviewed to determine if any additional dilutions or concentrations were performed. Bench sheets will also be reviewed for any explanatory notes about the sample.

If no system documentation, solution preparation or spiking errors are identified, the following considerations will be made:

When a volatile organic surrogate recovery value is outside of acceptable limits, the sample will be reanalyzed. If the reanalysis results are within acceptance limits, it will be assumed that the initial analysis was in error. If the reanalysis results are not within acceptance limits, it will be assumed that sample matrix is affecting surrogate recovery. Further reanalysis will not be required.

For semi-volatile organic analysis, one acid and one base/neutral surrogate recovery may be outside acceptance limits with no corrective action required provided the recoveries are at least 10%. If more than one acid or base surrogate standard is outside acceptance limits, or if any surrogate recovery value is less than 10%, the sample will be re-extracted and reanalyzed. If the reanalysis results are not within acceptance limits, it will be assumed that sample matrix is affecting surrogate recovery assuming all other QC analyses are acceptable. Further reanalysis will not be required. *Matrix spikes will not be re-extracted for unacceptable surrogate recovery values.*

For other extractable organic analysis, if a surrogate recovery value is outside of acceptance limits, the data will be reviewed to determine if the unacceptable surrogate is a result of matrix effect. If matrix interference is determined, the sample will be re-extracted or if re-extraction is not deemed useful, fully documented in the analytical narrative associated with the analyses. If a surrogate recovery is too low, based on the opinion of the final QA Data Reviewer, the sample will be re-extracted and reanalyzed.

Matrix Spikes

Matrix spikes will be evaluated to verify that recovery values for all spiked compounds are within the specified acceptance limits. If unacceptable results are obtained, the system will be evaluated to confirm that all instrumentation is operating properly. Documentation and bench sheets will be reviewed to verify that the concentrations of spike solutions added are accurate. Sample preparation bench sheets will be reviewed to determine if any additional dilutions or concentrations were performed. Bench sheets will also be reviewed for any explanatory notes about the sample.

If no system, documentation, solution preparation, or spiking errors are identified, the following considerations will be made:

Organic Analyses:

If a matrix spike recovery value is outside the acceptance limits, but the LCS meets recovery acceptance criteria, re-extraction will not be required. It will be assumed that the unacceptable recovery value is a result of matrix effect.

If both LCS and matrix spike recovery values are outside the acceptance limits, the sample batch will be re-extracted and reanalyzed. This indicates the possibility of a systematic error that may affect the accuracy of final results.

Inorganic analyses:

Matrix spikes with unacceptable recovery values will be re-prepared and reanalyzed. If the reanalysis results are not within acceptance limits, it will be assumed that the sample matrix is affecting the recovery values. Further reanalysis will not be required.

A post-digestion spike analysis will be performed for all metals analyses processed following EPA-CLP guidelines.

Sample and Matrix Spike Replicates

Sample and matrix spike replicates will be evaluated to verify that percent differences between the replicates are within acceptable limits. Percent differences for metals and inorganic sample replicates will be within ±20%. When percent difference criteria are not met, the system will be evaluated to confirm that all instrumentation is operating properly. Documentation and bench sheets will be reviewed to verify that the concentrations of spike solutions added are accurate. Sample preparation bench sheets will be reviewed to determine if any additional dilutions or concentrations were performed. Bench sheets will also be reviewed for any explanatory notes about the sample.

If no system, documentation, solution preparation, or spiking errors are identified, the following considerations will be made:

If percent difference values between sample replicates for metals and inorganic analyses do not meet acceptance criteria the Project Manager in consultation with ARI's client will determine whether to re-analyze the samples or flag the analytical results. If the samples are reanalyzed and results are not within acceptance limits, it will be assumed that the sample is not homogeneous, causing the poor analytical precision. Further re-analyses will not be required.

Replicate sample analyses are not routinely performed for organic parameters.

If percent difference values between matrix spike replicates do not meet acceptance criteria, but spike recovery values are acceptable, no re-extraction or analysis will be required. It will be assumed that the sample is not homogeneous, causing the poor analytical precision.

If percent difference values between matrix spike replicates do not meet acceptance criteria and recovery values in one or both replicates are not acceptable, the sample and associated matrix spike replicates will be re-prepared and reanalyzed. If the reanalysis results are not within acceptance limits, it will be assumed that the

sample is not homogeneous, causing the poor analytical precision. Further re-analyses will not be required.

Samples

In addition to monitoring sample quality control indicators, ARI evaluates samples to determine the need for reanalysis. Conditions considered while evaluating samples are:

If a target analyte detected in a sample exceeds the upper limit of the instrument calibration range, the sample is diluted and reanalyzed. Dilution and reanalysis continues until the analyte concentration falls within the linear range of calibration. If the sample requires dilution to such a level that surrogates are no longer detectable and analytical accuracy is questionable, the sample will be re-prepared using a smaller sample aliquot.

Samples will be evaluated for matrix interference that may affect analyte detection and quantification. Appropriate cleanup procedures will be employed to remove interference. Samples will be diluted and reanalyzed as required to minimize background interference. If it is not possible to remove all interference, reported results will be qualified as necessary.

If low-level analytes detected in a sample are suspected to be a result of instrument carryover, the sample will be reanalyzed. If analyte levels remain approximately the same the initial results will be considered valid. If analytes are not detected during reanalysis, it will be assumed that the initial detection was due to carryover, and the initial results will not be reported.

If an instrument malfunction or procedural error occurs during analysis, all affected samples will be reanalyzed. If the malfunction appears to be an isolated incident, it will not be necessary to inspect the analytical system. If the malfunction appears to be an ongoing problem, the system will be inspected and necessary maintenance/corrective actions will be taken prior to resuming analysis.

Sample Storage Temperatures

Every sample storage unit's temperature will be evaluated at the beginning of each day. Temperatures will be between 2 and 6 °C for refrigerators and < -10 °C for freezers. If a temperature is outside the specified range, the unit's temperature will be adjusted to bring the temperature back within limits. The Temperature Log will be annotated to document the adjustment.

If adjustment does not bring the temperature within range, or if adjustment is not possible, the Laboratory Supervisor will be notified and will take corrective action. The Temperature Log will be annotated to document the action. If the temperature fluctuation is chronic or extreme, the

samples will be removed from the unit and placed in another storage unit until the malfunctioning unit is repaired or replaced.

Balance Calibrations

Balances are serviced once a year by a certified technician. The service includes preventative maintenance and calibration.

Balance accuracy will be verified prior to balance use. The recorded weight will be within the acceptance criteria specified on the Calibration Log. If the recorded weight is not within the acceptance limits, the QAPM will be notified. The Calibration Log will be annotated to document the action. The balance will not be used until it can be verified that acceptance criteria can be met.

Water Supply System

The water supply for the volatile organic and inorganic laboratories will be monitored daily for the presence of contaminants through the analysis of method and/or instrument blanks. Organic contaminants, especially chloroform, are early indicators of the need for preventative maintenance. If organic or other contaminants are detected, the system filters will be changed. After filters have been changed, an additional aliquot of water will be analyzed to confirm that contaminants are no longer present.

The water supply for the metals laboratory will be monitored daily. When the resistivity falls below 18 megaohm, system maintenance will be performed.

Section 13: LABORATORY EVALUATION AND AUDITS

Routine evaluations of the laboratory ensure that all necessary quality control activities have been implemented and are being effectively utilized. It is the responsibility of the QAPM to ensure that quality control activities are periodically evaluated for compliance. Findings from these evaluations allow the laboratory to address and modify any procedures that are not in accordance with the laboratory Quality Assurance Program or accreditation program requirements.

A number of tools are available for monitoring laboratory performance. ARI evaluates the quality of laboratory performance through the use of

Internal QA Audits
Technical System Audits
Data Quality Reviews
Audits by Outside Agencies (External Audits)
Performance Evaluation Analyses
Annual Management Review

Each audit provides an objective evaluation of laboratory performance. All internal audits and reviews are conducted according to specified guidelines. In addition, a collective review of audit findings provides an overall evaluation of the laboratory. Deficiencies noted during the course of an audit or performance evaluation will be addressed, a root cause analysis performed, and appropriate corrective actions will be taken. Follow-up audits will be conducted to verify that corrective actions have been satisfactorily implemented.

Internal QA Audits

The Quality Assurance Officer regularly evaluates quality control activities within the laboratory to verify accuracy and compliance. The QAPM or designee routinely audits the following activities:

Balance verification records
Sample storage cooler temperature records
Oven, incubator and water bath temperature records
Chain of Custody records

Standard preparation records
Documentation and Response to Client Complaints
Chain of Custody Procedures
Documentation of Computer and Software Revisions

Checklists are utilized to ensure consistent and complete audits. The checklists are included in SOP 1005S. Internal QA audit results will be summarized and reported to both staff and management. Corrective actions will be initiated as necessary. A schedule of internal QA audits is provided in Appendix L.

When an audit finding indicates possible errors or deficiencies in analytical data, ARI will correct the error and notify all affected clients within 2 working days.

Technical System Audits

An audit of technical systems within the laboratory will be conducted at least annually. The audit will focus on the quality control and data generation/collection systems. The QAPM will conduct the audit with assistance from section managers and data reviewers. This evaluation will address areas such as:

Calibration records
Maintenance records
Control charts
Computer vs. hard copy data
Adherence to SOPs and methods
Support system records (DI water, balances, pipettes, etc.)

In addition, audit results from the past year will be reviewed to verify that all necessary corrective actions have been addressed and implemented.

Data Quality Reviews

Reviews of final data packages by the QAPM or his/her designee. The Data quality review verifies that the final data deliverables meet project and quality systems specifications

Audits by Outside Agencies (External Audits)

As a requirement for many accreditation programs, on-site review of laboratory facilities and operations are conducted by clients or other outside agencies. The laboratory may be periodically audited by the following agencies:

State of Washington Department of Ecology
A United States Department of Defense Agency (US Army, US Navy or US Air Force)
State of Oregon Environmental Laboratory Accreditation Program (ORELAP) as an Accrediting Body for The NELAP Institute.

External audits are beneficial in that they provide an independent evaluation of the laboratory without internal influence or bias. The laboratory will be available for evaluation at the convenience of the auditing agency. Laboratory personnel will be available during the audit to address questions or provide information regarding laboratory procedures. All comments, deficiencies, and areas of potential improvement noted by the auditor will be reviewed, and appropriate corrective actions will be taken to resolve the noted issues. A listing of laboratory accreditations is included as Appendix M.

Performance Evaluations

Performance Evaluation (PE) sample analysis is a means of evaluating individual performance as well as the overall analytical system. In addition to the external audit, PE sample (PES) analysis is a requirement of many certification and accreditation programs. The laboratory routinely participates in the following performance evaluation programs:

Analytical Standards, Inc.(ASI) Performance Evaluation Studies
USEPA Water Pollution (WP) Performance Evaluation Studies (Commercial Supplier)
USEPA Water Supply (WS) Performance Evaluation Studies (Commercial Supplier)
USEPA Contract Laboratory Program Quarterly Performance Evaluations (as required)
AASHTO (for geotechnical samples)

A PES is a sample containing specific analytes in concentrations unknown to analysts. Comparison of the laboratory result to the "true" value determines the accuracy of the

reported result and indicates the laboratory's ability to perform a given analysis. These results are also used to verify individual analyst proficiency. The QAPM will periodically submit internal “blind” performance evaluation samples to the laboratory sections for analysis. Values obtained by the laboratory will be compared to expected or true values. Parameters with reported values outside of the specified acceptable ranges will be evaluated by the analytical staff to determine the source of error. All necessary corrective actions will then be documented and implemented.

Quality Assurance Reports to Management and Staff

In order to ensure that laboratory managers are kept apprised of quality related activities and laboratory performance, a “Quality Assurance Report to Management” the QAPM will be produced annually and distributed to ARI management. The report will, at a minimum include:

1. Information concerning current and ongoing internal and external audits
2. Status and results of current or ongoing internal or external proficiency analyses
3. Identification of Quality Control problems in the laboratory
4. Information on all ongoing Corrective Actions
5. Current status of external certifications
6. Current status of the Staff Training Program
7. Outline of new and/or future Quality Assurance Program initiatives

The QAPM is responsible for follow-up and resolution of any deficiencies discussed in the report. Unresolved issues will remain on subsequent reports until addressed. Information such as performance evaluation results and audit reports will be distributed to the laboratory staff.

The application of these combined activities provides comprehensive monitoring and assessment of laboratory performance, and ensures that all data produced by ARI will be of the highest possible quality.

Annual Management Review

In the last quarter of each year, executive management will perform a comprehensive review of ARI quality system and analytical procedures to assess their continued suitability and effectiveness. Management will consider the following during the review process:

Suitability of policies and procedures

Reports fro management and supervisory personnel

Results of internal audits

Corrective and preventative actions

Results of recent external quality systems audits

PT results

Changes in volume and type of analyzes performed

Client Feedback

Complaints

Other relevant factors such as quality control activities, available resources and analyst training

Section 14: APPENDICES

A. Laboratory Organization and Key Personnel Resumes
B. Training and Demonstration of Proficiency
C. Laboratory Facilities
D. Laboratory Instrumentation and Computers
E. Standard Operating Procedures
F. Sample Collection Containers, Preservation and Holding Times
G. Laboratory Workflow
H. Analytical Methods
I. Method Detection Limits and Reporting Limits
J. Quality Control Recovery Limits
K. Internal Audit Schedule
L. Laboratory Accreditations
M. Data Reporting Qualifiers
N. Standards for Personal Conduct
O. QA Policies
P. Modifications to ARI's LQAP

Appendix A

Laboratory Organization Chart
and
Key Personnel Resumes

KEY PERSONNEL RESUMES

Mark Weidner

Laboratory Director

Profile

Mr. Weidner co-founded Analytical Resources, Inc., along with Brian Bebee, Sue Dunnihoo and David Mitchell. Prior to his co-founding of ARI in 1985, Mr. Weidner was the Head Mass Spectroscopist at Michigan State University and an instructor at the Finnigan Institute. As Laboratory Director, Mr. Weidner is responsible for overall laboratory performance, as well as facility expansion and major purchasing. Mr. Weidner is intimately familiar with all operational and analytical aspects of ARI and initiated many of the procedures currently in use.

Education:

M.S., Medicinal Chemistry, Purdue University, W. Lafayette, IN (1978).

B.S., Biochemistry, Michigan State University, E. Lansing, MI (1975).

Experience:

Laboratory Director/Co-founder, Analytical Resources, Inc., Seattle, WA (1985 to present).

Senior Chemist, City of Seattle, Seattle, WA (1981 to 1985).

Instructor, Finnigan Institute, Cincinnati, OH (1979 to 1981).

Mass Spectroscopist, Michigan State University (1978 to 1979).

Brian Bebee

Laboratory Manager

Administrative Services Manager

Profile:

Mr. Bebee co-founded Analytical Resources, Inc., along with Mark Weidner, Sue Dunnihoo, and David Mitchell. Prior to his co-founding of ARI, Mr. Bebee had gained extensive GC/MS experience as a GC/MS Chemist at the Municipality of Metropolitan Seattle, (METRO). When he co-founded ARI in 1985, Mr. Bebee became the Organics Division Manager until 1993, when he assumed the position of Laboratory Manager. As Laboratory Manager, Mr. Bebee is responsible for the day to day flow of all laboratory operations, including personnel, instrument, and procedural concerns. He is also responsible for the direct supervision of the Volatile and Semivolatile Laboratories.

Education:

A.A., Oceanography, Marine Biology, Biology, Shoreline Community College (1973).

Experience:

Laboratory Manager, Analytical Resources, Inc., Seattle, WA (1987 to present).

Organics Division Manager/Co-founder, Analytical Resources, Inc., Seattle, WA (1985 to 1987).

GC/MS/DS Operator, Municipality of Metropolitan Seattle, Seattle, WA (1980 to 1985).

Senior Water Quality Technician, Municipality of Metropolitan Seattle (METRO), Seattle, WA (1976 to 1980).

Water Quality Technician, Municipality of Metropolitan Seattle (METRO), Seattle, WA (1973 to 1976)

David Mitchell

Quality Assurance Program Manager

Profile:

Mr. Mitchell co-founded Analytical Resources, Inc., along with Mark Weidner, Sue Dunnihoo, and Brian Bebee. Prior to his co-founding of ARI, Mr. Mitchell had gained extensive experience in the environmental chemistry field as Senior Chemist and Trace Organics Laboratory Supervisor at the Municipality of Metropolitan Seattle (METRO). His responsibilities include the management of ARI's Quality Assurance/Quality Control Program.

Education:

Graduate Work in Chemistry (Organic/Biological), University of Wyoming, Laramie, WY (1970 to 1974).

B.S., Chemistry, Upper Iowa College, Fayette, IA (1970).

Experience:

Quality Assurance Manager, Analytical Resources Inc., Seattle, WA (1998 to Present)

Client Services Manager, Analytical Resources Inc., Seattle WA (1987 to 1998)

Vice President/Co-founder of Analytical Resources, Inc., Seattle, WA (1985 to 1987).

Senior Chemist, METRO Trace Organics Laboratory, Seattle, WA (1979 to 1985).

Research Associate, Northwestern University Medical School (1974 to 1979).

Susan Dunnihoo

Director, Client Services

Profile:

Ms. Dunnihoo co-founded Analytical Resources, Inc., along with Mark Weidner, Brian Bebee, and David Mitchell. Prior to her co-founding of ARI, Ms. Dunnihoo had gained extensive experience in the environmental chemistry field through her work at Laucks Testing Laboratories, the City of Tacoma, and the Municipality of Metropolitan Seattle (METRO). As Director of Client Services, Ms. Dunnihoo is responsible for assisting project managers in responding to the needs of ARI clients, and for communicating to the laboratory the analytical capabilities that should be added to satisfy future client needs. Ms. Dunnihoo also acts as project manager for a number of projects.

Education

Graduate work in Chemical Oceanography, University of Washington (1976-1980)
ACS Certified BA, Chemistry, Augsburg College, Minneapolis, MN (1976)

Experience

Director, Client Services, Analytical Resources, Inc., Seattle, WA (2007-present)
Client Services Manager, Analytical Resources, Inc., Seattle, WA (1998-2007)
Computer Services Manager, Analytical Resources, Inc., Seattle, WA (1985 to 2000)
Corporate Secretary, Analytical Resources, Inc., Seattle, WA (1985 to present)
Chemist, Laucks Testing Laboratories, Seattle, WA (1983 to 1985)
Chemist, City of Tacoma, Plant II, Tacoma, WA (1982 to 1983)
GC/MS/DS Operator, METRO TPSS Lab, Seattle, WA (1980 to 1982)

Jay Kuhn

Inorganic Division Manager

Profile:

Mr. Kuhn oversees ARI's Inorganic Division, which includes the Metals Sample Preparation, Metals Analysis, and Conventional Wet Chemistry sections. He has extensive experience in the environmental chemistry field, with an emphasis in inorganic analyses. Mr. Kuhn is experienced with in-house and EPA standard methods and protocols, as well as the operation, maintenance, and repair of ICP-MS, ICAP, CVAA, and Graphite Furnace instruments.

Education

Graduate work in Environmental Chemistry, University of Washington, Seattle, WA.

B.S. Chemistry, University of California at Santa Barbara (1980)

Experience

Inorganic Division Manager, Analytical Resources, Inc., Seattle, WA (1992 to present)

Metals Division Manager, Analytical Resources, Inc., Seattle, WA (1990 to 1992)

Research Technologist III and Laboratory Manager, UW College of Forest Resources Chemical Analysis Cost Center (1985-1990)

Research Technologist, UW College of Forest Resources Chemical Analysis Cost Center (1981 to 1985)

Appendix B

Training

Qualification Requirements

In addition to on-the-job training, ARI recommends a specific level of education and experience for the following positions:

GC/MS Laboratory Supervisor

A Bachelor's degree in chemistry or scientific/engineering discipline, three years experience operating GC/MS systems and one year supervisory experience.

GC Laboratory Supervisor

A Bachelor's degree in chemistry or scientific/engineering discipline, three years experience operating GC systems and one year supervisory experience.

Sample Preparation Laboratory Supervisor

A Bachelor's degree in chemistry or scientific/engineering discipline, three years experience in organic sample preparation and one year supervisory experience.

Data Systems/LIMS Manager

A Bachelor's degree with four or more computer-related courses and three years experience in systems management or programming. A minimum of one year experience with software utilized for laboratory report generation is also recommended.

Programmer Analyst

A Bachelor's degree with four or more computer-related courses and two years experience in systems or application programming. A minimum of one year experience with software utilized for laboratory report generation is also recommended.

Quality Assurance Officer

A Bachelor's degree in chemistry or a scientific/engineering discipline and three years of laboratory experience, including one year of applied experience with quality assurance.

Project Manager

A Bachelor's degree in chemistry or a scientific/engineering discipline and three years of laboratory experience, including one year of applied experience with quality assurance.

GC/MS Chemist

A Bachelor's degree in chemistry or a scientific/engineering discipline and at least one year experience operating a GC/MS system. Three years of GC/MS operations and spectral interpretation experience may be substituted in lieu of educational requirements.

Mass Spectral Interpretation Specialist

A Bachelor's degree in chemistry or a scientific/engineering discipline and participation in training course(s) in mass spectral interpretation. Also, at least two years of experience in mass spectral interpretation is recommended.

Purge and Trap Expert

A Bachelor's degree in chemistry or a scientific/engineering discipline and one year experience operating a purge and trap type liquid concentrator interfaced to a GC/MS system.

GC Chemist

A Bachelor's degree in chemistry or a scientific/engineering discipline and at least one year experience operating a GC system. Three years of GC operations and maintenance experience may be substituted in lieu of educational requirements.

Pesticide Analysis Expert

A Bachelor's degree in chemistry or a scientific/engineering discipline and at least one year experience operating a GC system. Three years of GC operations and spectral interpretation experience may be substituted in lieu of educational requirements.

ICP Spectroscopist

A Bachelor's degree in chemistry or a scientific/engineering discipline and Four years of applied experience with ICP analysis of environmental samples. Four years of ICP experience may be substituted in lieu of educational requirements.

ICP Operator

A Bachelor's degree in chemistry or a scientific/engineering discipline and one year of experience operating and maintaining ICP instrumentation. Three years of ICP experience may be substituted in lieu of educational requirements.

Atomic Absorption (AA) Operator

A Bachelor's degree in chemistry or a scientific/engineering discipline and one year of experience operating and maintaining graphite furnace and cold vapor AA instrumentation. Three years of AA experience may be substituted in lieu of educational requirements.

Conventionals (Classical Chemistry) Analyst

A Bachelor's degree in chemistry of a scientific/engineering discipline and one year of experience with classical chemistry procedures. Three years of classical chemistry experience may be substituted in lieu of educational requirements.

Sample Preparation Expert

A high school diploma and one college level course in chemistry. One year of experience in sample preparation is also recommended.

Appendix C

Laboratory Facilities

ANALYTICAL RESOURCES INC. occupies a total of 23,500 square feet of floor space located at 4611 S. 134th Place in Tukwila, Washington. The laboratory facility, constructed between September 2001 and June 2002, includes:

- State-of-the-art heating, ventilation and air conditioning (HVAC) systems to assure a clean comfortable working environment while maintaining air flow balance designed to minimize the possibility of sample cross contamination between laboratory areas.
- A central service area provides space for three walk-in coolers (356 sq. ft. total), two walk-in freezers (760 cubic ft.), metals archive storage, and sample cooler storage. A 400 sq. ft. walk-in freezer covered by a mezzanine for storage was added in 2005.
- A data network linking all workstations to a centralized server room. All connections are made to managed switches and hubs and are protected by the latest firewall technology and uninterruptible power supplies.
- Distribution systems to deliver pressurized Air, Zero Grade Air, Argon, Helium, Hydrogen, Nitrogen and Argon/Hydrogen to the laboratory areas from a central location.
- A system to deliver ASTM Type 1 water directly to sinks in each laboratory area. Water is purified by filtration, ion exchange and reverse osmosis and continuously re-circulated through a filtration + ion exchange + UV radiation polishing loop that delivers water directly to the laboratories.
- An isolated and ventilated hazardous waste storage area.
- An electronic repair shop and storage room.
- Alarm monitored fire sprinkler and intrusion detection systems

The facilities are divided into five functionally-distinct sections as detailed below:

1) The Organics Division features three main laboratory areas as described below:
   - The Organics Extraction Laboratory (2400 sq. ft.) is utilized to isolate and concentrate organic compounds from various environmental sample matrices. The laboratory contains approximately 200 linear feet of bench space and nine fume hoods. It is equipped with two gel permeation chromatographs, an accelerated solvent extractor (ASE) and a gas chromatograph for extract screening purposes. The laboratory includes a separate area for extraction of aqueous samples, a glassware cleaning area and individual workstations for the laboratory supervisor and analyst.
   - The Semivolatile Organics Analysis Laboratory (3000 sq. ft) has 124 linear feet of instrument bench space plus personal workstations. The Laboratory is equipped with seven Gas Chromatographs (GCs) with six GC-MS instruments, one High Resolution GC/MS (HRGC-MS) and a fume hood for preparation of standard solutions and dilution of samples. Each gas chromatograph is individually vented to the outside for removal of heat and potentially contaminated GC exhaust gases.
   - The Volatile Organics Analysis (VOA) Laboratory (2500 sq. ft) houses seven GC-MS and two GC-PID instruments dedicated to volatile organics analysis. Each instrument is vented to the outside. The laboratory area includes two fume hoods, a sample/standards preparation area, a TCLP preparation/tumbler room and sample holding refrigerators. The HVAC system maintains a positive air pressure in the laboratory using filtered air from outside of the building. This eliminates the possibility of cross contamination of samples with solvents from other areas of the laboratory.

2) The Inorganic Division includes a Trace Metals Laboratory and the Conventional Analyses Laboratory:
   - Trace Metals Laboratory (3000 square feet)
     - The Metals Preparation Laboratory (1200 sq. ft) contains five fume hoods including two 8-foot polypropylene. An additional eight foot polypropylene laminar flow fume hood is housed in a separate class 1000 clean room. The lab is equipped with tumblers, hot-plates, digestion blocks, facilities for glassware cleaning, and a spectrophotometer for cold vapor analysis of mercury, a TCLP tumbler room, and storage areas.
     - The Metals Instrument Laboratory (1300 sq. ft) features two atomic absorption spectrometers for graphite furnace analyses, two inductively coupled argon plasma spectrometers (ICP) for simultaneous analysis of metals species, and an ICP-mass spectrometer for analysis of metals species at low detection levels.
     - A 500 sq. ft. Office provides desk area for Trace Metals laboratory personnel.
   - The Conventional Analyses (Wet Chemistry) Laboratory (2500 sq. ft.) contains approximately 200 linear feet of bench space, eight fume hoods and includes a separate microbiology room. Instruments in this lab include two Rapid-Flow Analyzers, two TOC analyzers, an ion chromatograph, two uv/visible spectrophotometers, and various other equipment necessary for the evaluation of inorganic parameters.

3) The Geotechnical Laboratory includes 2500 square feet of space with special areas and equipment for soil testing, treatability studies, and soil/sediment leaching studies. The Laboratory includes approximately 50 feet of linear bench space and 5 fume hoods.

4) The Sample Receiving Facility consists of an area to accept and log-in samples to ARI's Laboratory Information Management System (LIMS) and an area to prepare and ship sampling supplies.
   - The Sample Receiving Facility (1000 sq. ft.) is equipped with two fume hoods, and 70 feet of bench space. Four computer terminals are available to log samples into ARI's LIMS.
   - The Sampling Containers Facility (500 sq. ft.) is used to prepare sampling containers for shipment to ARI's client designated locations.

4) Administrative Areas (8600 sq. ft.) include:
   - The Quality Assurance Section
   - Executive Offices
   - Project Management Section
   - The Human Resources Section
   - The Computer Services Section
   - One Conference Room
   - A Lunch Room
   - Several Storage Areas

Appendix D

Laboratory Instrumentation and Computers

LABORATORY INSTRUMENTATION and COMPUTERS

Organic Extractions Laboratory Equipment

(MARS 1) CEM MARS™ (2008) – Microwave extraction apparatus.

(GPC 1) Gel Permeation Chromatograph (1985) – Fluid Metering Inc. pump and ISCO UA-5 UV detector equipped with a 16 position autosampler used for clean-up of samples prior to final analysis.

(GPC 2) Gel Permeation Chromatograph (2003) – Fluid Metering Inc. pump and ISCO UA-5 UV detector equipped with a 16 position autosampler used for clean-up of samples prior to final analysis.

Zymark Turbo-Vap LV (1999) - 24 place

Zymark Turbo-Vap LV (2002) - 24 place

Zymark Turbo-Vap LV (2007) - 24 place

Zymark Rapid Trace Solid Phase Extraction Workstations (2007) - 5 each

Horizon Technology – DryVap Concentrator System Model 5000 – 2 each

Dioxin Extractions Laboratory Equipment

(MARS 1) CEM MARS™ Express (2010) – Microwave extraction apparatus.

Zymark Turbo-Vap LV (2010) - 24 place

Rotovap R-205 with V-805 Vacuum Controller (2010) – 2 each

Glas-Col Combo Heating Mantle (2010) – 6 place – 3 each

Vacuum Manifold – 6Place (2010) – for SPE

Gas Chromatograph - High Resolution Mass Spectrometer (GC/HRMS)

(HR1) Waters Autospec Premier (2009) – A GC-HRMS system with Masslynx Version 4.1 data acquisition & quantitation software. System includes an Agilent 7890A GC and 7683B autosampler.

Gas Chromatograph - Mass Spectrometers (GC/MS)

(FINN5) Finnigan MAT Incos 50 (1989) - A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. System includes an HP 5890 GC, a Tekmar LSC 2000 Purge & Trap and a Dynatech PTA-30 autosampler for VOA analysis of either aqueous or solid samples.

(NT2) Hewlett Packard (1999) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. System includes Agilent 6890 GC, 5973 MSD, and 7683 autosampler.

(NT3) Hewlett Packard (1999) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. System includes an HP 6890 Plus GC, an HP 5973 MSD, an OI Analytical Eclipse 4660 and a Varian Archon autosampler for VOA analysis of aqueous or solid samples.

(NT4) Hewlett Packard (2001) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system includes HP 6890-Plus GC, 5973 MSD and 6890 autosampler

(NT5) Hewlett Packard (2002) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system is equipped with an HP 6890N GC, an HP 5973N MSD, a Tekmar LCS 2000 Purge and Trap and a Dynatech PTA 30 autosampler for VOA analysis of aqueous or solid samples.

(NT6) Hewlett Packard (2002) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system includes an HP 6890 Plus GC, an HP 5973 MSD and an HP 7683 autosampler.

(NT7) Hewlett Packard (2007) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system is equipped with an HP 6890N GC, an HP 5973N MSD, a Tekmar LCS 2000 Purge and Trap and a Dynatech PTA 30 autosampler for VOA analysis of aqueous or solid samples.

(NT8) Agilent (2008) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system is equipped with Agilent 6890N GC, 5975C MSD, and 7683 autosampler.

(NT9) Agilent (2008) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system is equipped with Agilent 6890 GC and 5973 MSD, a Tekmar LSC 2000 Purge and Trap and a Dynatech PTA-30 autosampler for VOA analysis of either aqueous or solid samples.

(NT10) Agilent (2008) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system is equipped with Aglient 6850GC,an Agilent 5975C inert MSD GC, an OI Analytical Eclipse 4660 and a Varian Archon autosampler for VOA analysis of aqueous samples.

(NT11) Hewlett Packard (2009) - A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system includes an Agilent 6890 N GC, an HP 5973 MSD and a Combi-pal SPME autosampler.

Gas Chromatographs

Hewlett Packard 5890 Series II (2003) – A GC system equipped with both FID and ECD detectors, capillary injectors, an autosampler and Chemstation. Used for screening samples before full extraction.

(ECD1) Hewlett Packard 5890 Series II (2004) - A GC system equipped with dual ECD detectors, an Agilent 6890 autosampler and HP Chem Station data system.

(ECD3) Hewlett Packard 5890 Series II (1991) – A GC system equipped with Dual ECD detectors, two Cool on column capillary injectors, an HP7673 autosampler and ChromPerfect data system.

(ECD4) Hewlett Packard 5890 Series II (1994) – A GC system equipped with dual ECD detectors, a split/splitless capillary injector, HP6890 autosampler and Chemstation data system.

(FID2) Hewlett Packard 5890 Series II (2004) – A GC system equipped with an FID detector, a capillary injector, an HP 7673A autosampler and HP Chem Station data system.

(FID3 A, B) Hewlett Packard 6890 (1996) – A GC system equipped with dual FID detectors, two capillary injectors, a dual tower HP 6890 autosampler, and HP Chem Station data system. A Restek GC Racer has been added to enhanced performance.

(FID4 A, B) Hewlett Packard 6890 (1996) – A GC system equipped with dual FID detectors, two capillary injectors, a dual tower HP 6890 autosampler, and HP Chem Station data system. A Restek GC Racer has been added to enhanced performance.

(PID1) Hewlett Packard 5890 Series II (2002) – A GC system equipped PID and FID detectors in series, an Dynatech PT30 autosampler and Tekmar LCS 2000 Sample Concentrator and Chemstation data system.

(PID2) Hewlett Packard 5890 Series II – (2005) –A GC system equipped with dual PID detectors, one in series with an FID, a Dynatech PT30 autosampler, a Tekmar 2000 sample concentrator and HP Chem Station data system.

(PID 3) Hewlett Packard 5890 Series II – (2006) –A GC system equipped with PID and FID detectors in series, a Dynatech PT30 WS autosampler, a Tekmar 2000 sample concentrator and HP Chem Station data system.

(ECD5) Hewlett Packard 6890 Plus Micro – (2002) – A GC system equipped with dual ECD detectors, an HP 7683 autosampler and an HP Chem Station data system.

(ECD6) Hewlett Packard 6890 Plus Micro – (2008) – A GC system equipped with dual ECD detectors, an Agilent 6890 autosampler and an HP Chem Station data system.

(FID5) Hewlett Packard 5890E Series II (2005) – A GC system equipped with dual FID detectors, an HP 7683 autosampler and HP Chem Station data acquisition system.

(FID6) Hewlett Packard 5890 Series II (2005) – A GC system equipped with an FID detector, an HP 7694 Headspace Sampler and HP Chem Station data acquisition system.

(FID7) Agilent 6850 (2008) – A GC system equipped with a single FID detectors, an Agilent 6850 autosampler and HP Chem Station data acquisition system.

(ECD7) Hewlett Packard 6890 Plus Micro – (2008) – A GC system equipped with dual ECD detectors, an Agilent 6890 autosampler, and HP Chem Station data system.

(FID8) Agilent 6890N (2008) – A GC system equipped with a dual FID detectors, an Agilent 7683B autosampler and HP Chem Station data acquisition system.

(FID9) Agilent 6850 (2009) – A GC system equipped with a single FID detector, an Agilent 6850 autosampler and HP Chem Station data acquisition system.

Inorganic Instrumentation

Perkin-Elmer SCIEX ELAN 6000 ICP-MS (1996) - A completely automated ICP-Mass Spectrometer with autosampler and multitasking software.

Perkin-Elmer NexIon 300 ICP-MS (2010) - A completely automated ICP-Mass Spectrometer with autosampler and multitasking software.

Perkin-Elmer Optima 7300DV ICP (2009) – Automated dual view simultaneous ICP with an Elemental Scientific SC-2 fast autosampler system

Perkin-Elmer Optima 4300 ICP (2001) - A completely automated dual view simultaneous ICP with auto-sampler and multitasking software.

Varian 300Z (1992) - A single channel atomic absorption graphite furnace instrument equipped with Zeeman background correction, and an auto-sampler

Varian 300Z (1991) - A single channel atomic absorption graphite furnace instrument with Zeeman background correction, equipped with an auto-sampler

CETAC M-6000A Mercury Analyzer (2000) – A fully automated high sensitivity cold vapor atomic absorption instrument dedicated to trace and ultratrace Mercury analysis. System is computer controlled with windows base software and an auto-sampler

Dionex Ion Chromatography DX 500 (1997) – A fully automated system with an auto-sampler for quantitative anion analyses. The system is computer controlled using Peaknet software.

Dionex Ion Chromatography 2100 (2009) – A fully automated system with an auto-sampler for quantitative anion analyses. The system is computer controlled using Chromeleon CHM-2 Version 7.0 software.

Thermo Genesys 10 (2003) - UV-VIS Spectrophotometer used for quantitative conventionals analysis.

Thermo Genesys 10 (2005) - UV-VIS Spectrophotometer used for quantitative conventionals analysis.

Lachat QuickChem 8000 Flow Injection Analyzer (2003) – Automated flow injection instrument dedicated to low level nutrient analysis

Lachat QuickChem 8500 Flow Injection Analyzer (2007) – Automated flow injection instrument dedicated to low level nutrient analysis

Dohrmann Apollo 9000 (2001) - Total Organic Carbon (TOC) Analyzer. Includes an autosampler for water analysis and a boat sampler for solids analysis.

Dohrmann Apollo 9000 (2009) - Total Organic Carbon (TOC) Analyzer. Includes an autosampler for water analysis and a boat sampler for solids analysis.

Kontes Midi-Vap Cyanide Distillation Systems (3 each)(1995-2008) – Each of the systems is capable of simultaneously distilling up to 10 samples for cyanide analysis using small sample aliquots.

Centrifuge (1987) - Beckman Model GP with swinging bucket rotor and inserts for 250 ml bottles and scintillation vials

Aim 500 Block Digestion System (2006) with Controller

Environmental Express Hot Block digestion blocks (10 ea) (1999-2008) for digestion of samples prior to trace metals analysis.

Hach COD Digestion Blocks (2)

Hach Ratio Nephelometer

Incubators: Lab-Line Ambi Hi-Lo Chamber and **Thermolyne 41900.**

GeoTech Laboratory Equipment

Trautwein Sigma 1 (2008) – Triaxial loading system

Sedigraph III Model 5120 (2007) – Automatic particle size analyzer

Beckman Coulter LS 13320 (2008) – Laser diffraction particle size analyzer with microliquid and universal liquid modules

Trautwein Soil Equipment – 12 position flexible wall permeability station

Soil Test Load Frame – with 500, 2,000 and 10,000 pound load cells for QU, UU, and CU triaxial tests, with pore pressure.

Soil Consolidation Apparatus – 16 tsf

Biosciences BI-1000 – 8 position electrolytic respirometer

Microtox – photo-luminescence toxicity test instrument

Beckman JP-21 – refrigerated centrifuge with 6 x 500 ml fixed angle head

IEC DRP-6000 – refrigerated centrifuge with a 4 x 1,000 ml swinging bucket head

Plas-Labs Anaerobic Test Chambers – 3 each

U.S. Army Corps of Engineers – column settling; column and batch leaching apparatus

Network Servers

ARI's central laboratory computer is a Dell PC Server, PowerEdge 2300/450, running Microsoft Windows NT 4.0 SP6. This system is home to ARI's Laboratory Information Management System (LIMS) database developed by Northwest Analytical of Portland, OR. The LIMS receives electronic data from all lab sections and produces hardcopy and electronic deliverables. In addition, the LIMS stores sample demographic data while providing a common tracking mechanism for all laboratory information.

The LIMS is connected to two sub-networks. Most data, with the notable exception of Conventionals and Geotech, is transferred electronically as text files from other data systems to the LIMS. This key process enhances data integrity by reducing manual entry and manipulation of instrument output.

The metals section uses an Intel PC Server with the Windows 2000 Server operating system. This system runs as a file server for dBASE IV and MS Access 2000 database applications. Once data is collected by the metals instrument computers, dBASE is used to aggregate and process the results and transfer it to the LIMS. The MS Access software has been customized by ARI's metals data supervisor to generate metals CLP forms and other internal reports. This server also provides additional services such as DHCP, WSUS, and the corporate vacation calendar.

The organics section uses an HP-UX Server with the HP-UX 10.20 operating system. This system runs Target 3.4 data analysis software. All GC/MS and other GC instruments are networked to this system. In addition to providing one common platform for organics data processing, the Target software produces CLP forms for organics data packages.

The conventional analysis laboratory uses individual PC Workstations with MS Excel for data reduction. Filled spreadsheets are saved to Server3. Data is manually copied from the MS Excel spreadsheet into the LIMS systems using LIMS worklists specific to a test method.

Server2 is the primary internal/external interface and provides email, NTP, web (internet and intranet), DHCP, proxy, document (Geotech), CVS, database, and authentication services. Access to Server2 is limited to authorized users and only IT personal have access to the shell.

Server3, running Windows 2000 Advanced Server, is the primary document server for ARI and is used to warehouse all scanned (pdf) data packages. The hardware for Server3 consists of a generic box with a 2.4 MHz Intel Pentium 4 processor. Packages saved to this server are indexed using the CI service of Windows and are available for searching via the ARI intranet.

All servers are secured in a locked room where only management and IT staff have access. Some users have external access to the network but this is limited to current employees and only through an end-to-end encrypted VPN (OpenVPN).

Note: Extensive in-house replacement parts are available for lab instruments and computers, including spare circuit boards. A majority of all service maintenance is performed by ARI employees.

Appendix E

ARI Active Standard Operating Procedures (SOP)

A list of ARI's current Standard Operating Procedures (SOPs) is available on ARI's web site at:

http://www.arilabs.com/portal/downloads/ARI-SOPs.zip

SOPs are updated periodically. Assure that you have ARI's current SOPs by downloading the files at the time of use.

Appendix F

Sample Containers, Preservation and Holding Times

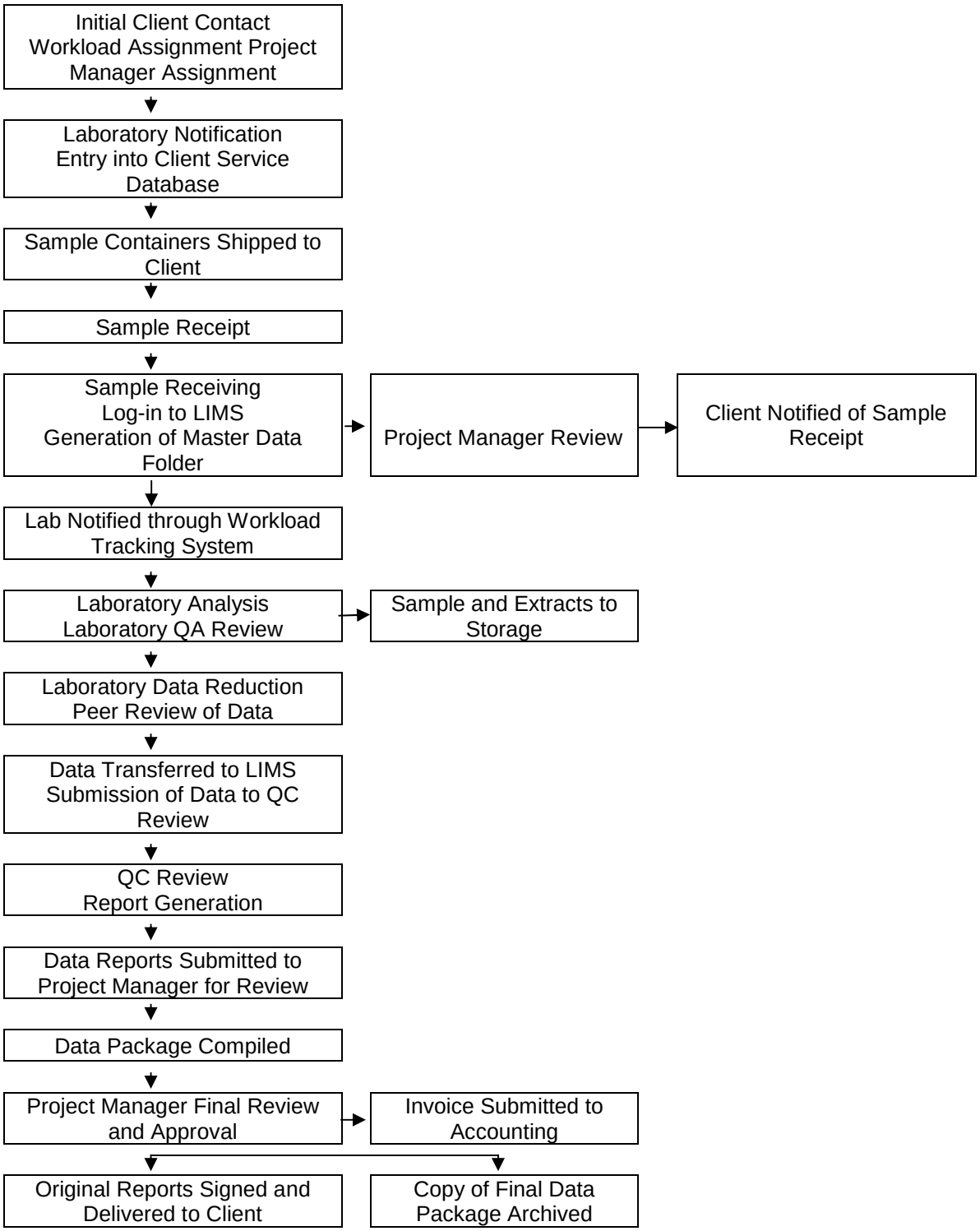
A summary of sample containers, preservatives and holding times is available on ARI's web site at:

http://www.arilabs.com/portal/downloads/

The summary is updated periodically. Assure that you have ARI's current document by downloading the files at the time of use.

Appendix G

Laboratory Workflow


Initial Client Contact
Workload Assignment Project Manager Assignment
Laboratory Notification
Entry into Client Service Database
Sample Containers Shipped to Client
Sample Receipt
Sample Receiving
Log-in to LIMS
Generation of Master Data Folder
Project Manager Review
Client Notified of Sample Receipt
Lab Notified through Workload Tracking System
Laboratory Analysis
Laboratory QA Review
Sample and Extracts to Storage
Laboratory Data Reduction
Peer Review of Data
Data Transferred to LIMS
Submission of Data to QC Review
QC Review
Report Generation
Data Reports Submitted to Project Manager for Review
Data Package Compiled
Project Manager Final Review and Approval
Invoice Submitted to Accounting
Original Reports Signed and Delivered to Client
Copy of Final Data Package Archived

Appendix H

Analytical Methods

ORGANIC ANALYSES

Parameter	Methods	Technique
Volatiles (GC/MS)	524.2/624/8260B	GC/MS
	Low Level Vinyl Chloride & 1,1 – Dichloroethene	GC-MS-SIM
Volatiles (GC)		
Volatile Aromatics	602/8021B	GC/PID
Semivolatiles (GC/MS)		
Semivolatile Organics	625/8270D	GC/MS
Polynuclear Aromatic Hydrocarbons (PNA/PAH)	625/8270D	GC/MS (SIM)
Isotope Dilution Semivolatiles	1625	GC/MS
Butyl Tin Species	Krone (1988)	GC/MS-SIM
Pesticides/GC Analyses		
Chlorinated Pesticides	608/8081A	GC/ECD
Aroclors/PCBs	608/8082	GC/ECD
PCB Congeners	ARI Method	GC/ECD
Phenols	604/8041	GC/FID
Chlorinated Phenols	8041 (mod)	GC/ECD
Pentachlorophenol	8151A (mod)	GC/ECD
Organophosphorous Pesticides	614/8141A	GC/NPD
Polynuclear Aromatic Hydrocarbons (PNA/PAH)	610/8100	GC/FID
Chlorinated Hydrocarbons	612/8121	GC/ECD
Herbicides	615/8151A	GC/ECD
Glycols	ARI Method(SOP 426S R2)	GC/FID
Hydrocarbon ID	NWTPH-HCID	GC/FID
Gasoline Range Hydrocarbons	(N)WTPH-G/AK101/WI-GRO	GC/FID
Diesel Range Hydrocarbons	(NWTPH-D/AK102/WI-DRO)	GC/FID
Extractable Petroleum Hydrocarbons	ARI Method	GC/FID
Volatile Petroleum Hydrocarbons	ARI Method	GC/PID
Organic Sample Preparation and Clean Up		
TCLP / SPLP Extraction		1311 / 1312
Sonication		3550B
Soxhlet		3540C
Accelerated Solvent Extraction (ASE)		3545B
Separatory Funnel		3510C
Continuous Liquid-Liquid		3520C
Alumina Clean-up		3610B

Florisil Clean-up	3620B
Gel Permeation (GPC)	3640A
Silica Gel	3630C
Sulfur Clean-up	3660B
Sulfuric Acid Clean-up	3665A

INORGANIC ANALYSES

Parameter	Methods	Technique
Wet Chemistry		
Acidity	2310/305.1	Titrimetric
Alkalinity	2320/310.1	Titrimetric
Ammonia	4500NH_3H/350.1	AutomatedPhenate/ISE
Biological Oxygen Demand-BOD		
Carbonaceous – BOD	5210.B/405.1	5-day Winkler Titration
Bromide	4500Br.B	Phenol Red Colorimetric
Anions	300.0	Ion Chromatography
Cation Exchange Capacity	9080	Neutral Ammonium Acetate
Chemical Oxygen Demand	5220.D/410.4	Closed Reflux, Colorimetric
Chromium Hexavalent (Cr6+)	3500Cr-D/7196A	Diphenylcarbazide
Chloride	4500CI.E/325.2	Automated Ferricyanide
Chlorophyll a	10200.H	Spectrophotometric
Coliform, Total / Fecal	9222.B/D	Membrane Filtration
Color	2120.B/110.2	Visual Comparison
Conductivity	2510/120.1	Electrometric
Corrosivity (CaCO3 Saturation)	2330	Calc. (pH, Alk, TDS, Ca)
Cyanide, Total	4500CN.C/335.2/9010	PBA, Colorometric
Cyanide, Amenable	4500CN.G/335.1	Alkaline Chlorination
Cyanide, WAD	4500CN.I	Weak Acid Distillation
Dissolved Oxygen	4500-O.C/360.2	Winkler Titration
Fats/Oils/Grease	5520.B/413.1/9070A	Gravimetric
Fluoride	4500F.C/340.2	Ion Specific Electrode
	300.0	Ion Chromatography
Formaldehyde	ASTM D-19 P216	Colorimetric
Hardness, Calculation	2340.B/6010B	Ca, Mg Calculation
Heterotrophic Plate Count	9215.D	Membrane Filtration
Iron (II) ferrous	3500Fe.D	Phenanthrolene
Nitrate + Nitrite	4500NO_3F/353.2	Automated Cd Reduction
Nitrate	4500NO_3F/353.2	Calculated
	300.0	Ion Chromatography
Nitrite	4500NO_3.F/353.2mod	Automated Colorimetric
	300.0	Ion Chromatography
Oil & Grease, Solids	5520.D/907	Gravimetric
Oil & Grease, Polar/Non Polar	5520.F	Gravimetric
PH	150.1	Electrometric
Phenols	5530.D/420.1/9065	4-AAP w/ Distillation
Phosphorous, Total	4500P.B/365.2	Colorimetric w/ digestion

Phosphorous, Ortho (SRP)	4500P.B/365.2	Colorimetric
	300.0	Ion Chromatography
Salinity	2520	Conductimetric
Silicate	4500Si.E/370.1	Heteropoly Blue
Total Kjeldahl Nitrogen (TKN)	4500N.org/351.4	Block Digest/ISE
Total Solids	2540.B/160.3	Gravimetric, 104^{o}C
Total Suspended Solids (TSS)	2540.D.160.2	Gravimetric, 104^{o}C
Total Dissolved Solids (TDS)	2540.C/160.1	Gravimetric, 180^{o}C
Total Volatile Solids (TVS)	2540.E/160.4	Gravimetric, 550^{o}C
Settleable Solids	2540.F	Volumetric
Streptococcus, Fecal	9230.C	Membrane Filtration
Sulfide	4500S^{2}.E/376.1/9034	Iodometric
Sulfide, Low Level	4500S^{2}.D/376.2	Methylene Blue
Sulfide, Acid Volatile	4500S^{2}.D/376.2	Methylene Blue
Sulfate	4500SO_4^{2}.F/375.2/9036	Auto. Methylthymol Blue
	300.0	Ion Chromatography
Sulfite	4500SO_3^{2}.B.377.1	Iodometric
Total Organic Carbon (TOC)	5310.B415.1/PSEP	Combustion NDIR
Turbidity	2130.B/180.1	Nephelometric
Total Lipids in Tissue	Bligh & Dyer (mod)	Gravimetric

Trace Metals Analyses

Inductively Coupled Plasma (ICP):

Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sn, Sr, Th, Ti, Tl, V, (Li, Th, U, W - special request only)	Zn200.7 / 6010B	ICP

Graphite Furnace (GFAA):

Ag, As, Cd, Sb, Pb, Se, Tl	200 Series / 7000 Series	GFAA

Cold Vapor (CVAA):

Hg	7470A/7471A	CVAA

Inductively Coupled Plasma/Mass Spectroscopy (ICP-MS):

Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Th, Tl, U, V, Zn	200.8/ 6020 Mod.	ICP/MS

Trace Metals Sample Preparation

Toxicity Characteristic Leaching Procedure	1311
Synthetic Precipitation Leaching Procedure	1312
Digestion for Total Recoverable or Dissolved Metals	3005A
Digestion of Aqueous Samples for Total Metals by ICP	3010A
Digestion of Aqueous Samples for Total Metals by GFAA	3020A
Digestion of Sediment, Sludge and Soil	3050B

Appendix I

Method Detection Limits and Reporting Limits

Summaries of method specific MDL studies and reporting limits are available on ARI's web site at:

http://www.arilabs.com/portal/downloads/ARI-MDLs.zip

MDL's and reporting are updated periodically. Assure that you have ARI's current detection limit data by downloading the files at the time of use.

Appendix J

Quality Control Recovery Limits

Method specific control limits are available on ARI's web site at:

http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use.

Appendix K

Internal Audit Schedule

Schedule of Laboratory Quality Assurance Audits

Process To Be Audited	Frequency
Verify Effectiveness of Corrective Actions	Monthly
Verify Refrigerator and Freezer Temperature Logs	Monthly*
Verify Oven and Incubator Temperature Logs	Monthly*
Verify That Balance Records Are Complete	Quarterly*
Verify That Standard Records are Complete	Monthly#
Verify That Logbooks Are Reviewed	Monthly#
Verify That SOPs Are Current and Available in Labs	Monthly#
Review Chain of Custody Documentation	Monthly#
Audit Internal Technical Systems	Annually
Post-Completion Project Review	Monthly**

* all sections will be audited

one section will be audited each month

** frequency may be contract specific i.e. 10% of NFESC projects must be audited

Appendix L

Laboratory Accreditations

Laboratory Accreditations

Analytical Resources Inc. is currently certified to perform environmental analysis by the National Environmental Laboratory Accreditation Program (NELAP), the State of Washington Department of Ecology and the State of Alaska Department of Environmental Conservation. ARI is approved to perform analyzes for the US Navy and the US Army Corps of Engineers following the Department of Defense Quality Systems Manual (DoD-QSM)

ARI's laboratory QA/QC Program has been audited and approved by The Boeing Company and Battelle Pacific Northwest Laboratories.

ARI analyzes drinking water, waste water and solid matrix performance testing (PT) samples semiannually.

List of Accreditations

1) National Environmental Laboratory Accreditation Conference (NELAC) – Accrediting authority is Oregon Environmental Laboratory Accreditation Program (ORELAP).
2) State of Washington, Department of Ecology - Environmental Laboratory Accreditation Program
3) The Alaska State Department of Environmental Conservation - Laboratory Approval Program
4) United States Army Corps of Engineers (USACE)
5) United States Naval Facilities Engineering Service Center (NFESC) (formerly known as NEESA)

Continuing Contracts Resulting from On-Site Laboratory Audits

1) The Boeing Company Corporate Environmental Affairs Division
2) The City of Seattle
3) The Port of Seattle

Appendix M

Data Reporting Qualifiers

Data Reporting Qualifiers

Effective 7/10/2009

Inorganic Data

U Indicates that the target analyte was not detected at the reported concentration

* Duplicate RPD is not within established control limits

B Reported value is less than the CRDL but ≥ the Reporting Limit

N Matrix Spike recovery not within established control limits

NA Not Applicable, analyte not spiked

H The natural concentration of the spiked element is so much greater than the concentration spiked that an accurate determination of spike recovery is not possible

L Analyte concentration is ≤5 times the Reporting Limit and the replicate control limit defaults to ±1 RL instead of the normal 20% RPD

Organic Data

U Indicates that the target analyte was not detected at the reported concentration

* Flagged value is not within established control limits

B Analyte detected in an associated Method Blank at a concentration greater than one-half of ARI's Reporting Limit or 5% of the regulatory limit or 5% of the analyte concentration in the sample.

J Estimated concentration when the value is less than ARI's established reporting limits

D The spiked compound was not detected due to sample extract dilution

E Estimated concentration calculated for an analyte response above the valid instrument calibration range. A dilution is required to obtain an accurate quantification of the analyte.

Q Indicates a detected analyte with an initial or continuing calibration that does not meet established acceptance criteria (<20%RSD, <20%Drift or minimum RRF).

S Indicates an analyte response that has saturated the detector. The calculated concentration is not valid; a dilution is required to obtain valid quantification of the analyte

NA The flagged analyte was not analyzed for

NR Spiked compound recovery is not reported due to chromatographic interference

NS The flagged analyte was not spiked into the sample

M Estimated value for an analyte detected and confirmed by an analyst but with low spectral match parameters. This flag is used only for GC-MS analyses

M2 The sample contains PCB congeners that do not match any standard Aroclor pattern. The PCBs are identified and quantified as the Aroclor whose pattern most closely matches that of the sample. The reported value is an estimate.

N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification"

Y The analyte is not detected at or above the reported concentration. The reporting limit is raised due to chromatographic interference. The Y flag is equivalent to the U flag with a raised reporting limit.

EMPC Estimated Maximum Possible Concentration (EMPC) defined in EPA Statement of Work DLM02.2 as a value "calculated for 2,3,7,8-substituted isomers for which the quantitation and /or confirmation ion(s) has signal to noise in excess of 2.5, but does not meet identification criteria" **(Dioxin/Furan analysis only)**

C The analyte was positively identified on only one of two chromatographic columns. Chromatographic interference prevented a positive identification on the second column

P The analyte was detected on both chromatographic columns but the quantified values differ by ≥40% RPD with no obvious chromatographic interference

X Analyte signal includes interference from polychlorinated diphenyl ethers. **(Dioxin/Furan analysis only)**

Z Analyte signal includes interference from the sample matrix or perfluorokerosene ions. **(Dioxin/Furan analysis only)**

Geotechnical Data

A The total of all fines fractions. This flag is used to report total fines when only sieve analysis is requested and balances total grain size with sample weight.

F Samples were frozen prior to particle size determination

SM Sample matrix was not appropriate for the requested analysis. This normally refers to samples contaminated with an organic product that interferes with the sieving process and/or moisture content, porosity and saturation calculations

SS Sample did not contain the proportion of “fines” required to perform the pipette portion of the grain size analysis

W Weight of sample in some pipette aliquots was below the level required for accurate weighting

Appendix N

Standards for Personal Conduct

Standards of Conduct

Since effective working relationships depend upon each of us, ARI expects certain minimum standards of personal conduct.

This list highlights general Company expectations and standards and does not include all possible offenses or types of conduct which may result in discipline or discharge. Management reserves the absolute right to determine the appropriate degree of discipline, including discharge, warranted in individual cases.

Employees engaged in the following activities, or similar activities deemed equally serious, will normally be terminated:

theft or embezzlement
disclosure of trade secrets or industrial espionage;
willful violation of safety or security regulations;
conviction of a felony;
working for a competitor or establishing a competing business.

In addition, dismissal may result from other serious offenses such as:

being intoxicated, under the influence or in possession of illegal drugs on the job;
falsification of records;
abuse, destruction, waste or unauthorized use of equipment, facilities or materials;
gambling on the premises;
chronic tardiness or absenteeism;
insubordination;
unwillingness to perform the job;
unauthorized requisition of materials from vendors.

There may be no alcoholic beverages on the Company premises, other than at times designated as Company functions. At such times, non-alcoholic beverages will be provided as well.

Personal and corporate honesty and integrity have built the character of ARI. This good character is fundamental to our well-being, future growth and progress. It is vitally important that we avoid both the fact and the appearance of conflicts of personal interest with that of the firm, its clients, and any other professional contacts.

This policy requires that ARI employees have no relationships or engage in any activities that might impair their independence of judgment. Employees must not accept gifts, benefits, or hospitality that might tend to influence them in the performance of their duties. It is expected that there will be no employment by any competing company, nor any employment by any outside interest or engagement in outside activity which might impair an employee's ability to render the full-time service to the company that employment involves.

If any possible conflict of interest situation arises, the individual concerned must make prior disclosure of the facts so that action may be taken to determine whether a problem exists and,

Standards of Personnel Conduct – continued

if so, how best to eliminate it. Likewise, any financial interest in an organization doing business with ARI or which competes with us should be revealed to Company management. (Excluded from this requirement is ownership of securities traded in major stock exchanges or other recognized trading markets.)

Our standards are those generally expected of employees in any well-regarded, ethical business organization.

ARI further expects that each employee will:

Be dressed and groomed appropriately for a business office. Employees in the laboratory areas are expected to dress in compliance with established safety procedures. Specific standards will be discussed with each employee during Health and Safety orientation. Your supervisor and the Administrative Services Manager always are available to answer questions.

Maintain the confidential nature of Company information. Removal of Company documents, records, stored materials, computer printouts, or any similar information, or copies of such material or information from the office without specific permission is prohibited. Likewise, revealing confidential information to an unauthorized person or using such information in an unauthorized way is prohibited. If there could be any possible question about the applicability of this requirement to a given circumstance, ask your supervisor.

Use Company computer capabilities and facilities only for authorized business at authorized times and locations; observe strictly all computer security measures and precautions; enter, alter or delete no computer instructions or stored material apart from that required by faithful performance of assigned duties; remove, copy, use or permit to be used no computer software developed for, purchased by, or otherwise used by ARI except as required by faithful performance of assigned duties.

Conduct business dealings with clients and members of the public in a courteous manner.

Appendix O

Quality Assurance Policies

QUALITY ASSURANCE POLICY

POLICY NUMBER: 1

SUBJECT: CORRECTIONS TO DATA/BENCHSHEETS

DATE: 8/2/96

Manual corrections made on any raw data, bench sheet, logbook or document used during sample processing will be made in the following manner:

1. Draw a single line through the information to be deleted or corrected. The original information must remain readable.

2. Enter any new information, preferably above the original information.

3. Initial and date the correction.

QUALITY ASSURANCE POLICY

POLICY NUMBER: 2

SUBJECT: LINING OUT UNUSED BENCHSHEET PORTIONS

DATE: 8/2/96

All unused portions of logbook pages and benchsheets will be lined through so that information cannot be added at a later date. This will be completed in the following manner:

1. Line out unused portions of a logbook page or benchsheet by drawing a single line or "Z" through the unused portions.

2. Initial and date the page beside the lineout.

3. Do not line out a page or section until it is certain that no additional information will be added to the unused portions.

QUALITY ASSURANCE POLICY

POLICY NUMBER: 3

SUBJECT: STOP WORK ORDERS

DATE: 8/28/96

It is the responsibility of all staff members to address situations that may require the issuance of a "stop work order". Potential and actual "stop work orders" will be handled as follows:

1. If an analyst or technician observes a situation which will or may have a negative impact on data quality, that person will notify her/his section supervisor immediately.

2. The section supervisor will assess the situation. If it appears that a "stop work order" may be required, the section supervisor will notify the appropriate manager (inorganic or organic).

3. The supervisor and manager will then decide if a "stop work order" should be issued. The manager will make a final decision on whether or not to issue a "stop work order". The incident will be reported to the Quality Assurance Program Manager using a Corrective Action Request form.

4. If a "stop work order" is issued, the manager will inform the Project Managers and the QA section. The section supervisor will notify section staff of the order.

5. The laboratory manager involved will oversee the development and implementation of a Corrective Action Plan (CAP). Upon completion of the CAP the "stop work order" may be rescinded.

6. Prior to rescinding a "stop work order", verification must be made that control has been regained and that work may begin. Only the inorganic or organic manager may rescind a "stop work order".

7. When the "stop work order" is rescinded, the Project Managers, analytical staff and QA section will be notified. The QA section will require documentation verifying that the procedure is back in control.

QUALITY ASSURANCE POLICY

POLICY NUMBER: **4**

SUBJECT: **SOP Review**

DATE: **9/3/96**

All Standard Operating Procedure (SOP) documents will be reviewed and updated at least annually by qualified staff members. Laboratory management will review and approve all modifications to the SOPs.

QUALITY ASSURANCE POLICY

POLICY NUMBER: 5

SUBJECT: Reporting Dilutions

DATE: 9/11/96

Dilution factors will be recorded as whole numbers followed by "X" (i.e., 5X, 10X, etc.). This reporting convention will be used on run logs, bench sheets, raw data and final reports for all diluted samples, extracts or digestates or standards.

QUALITY ASSURANCE POLICY

POLICY NUMBER: 6

SUBJECT: Formatting for SOPs – Computer Related

DATE: 1/31/00

Conventions for formatting computer-related instructions in SOPs

Commands should be indented and formatted as **`bold courier`** and one or two font sizes smaller:

```
USE PARAMS ORDER PARAMS
BROW
```

Many systems and languages are *case-sensitive*, and case should match the syntax and/or stylistic standards of the language.

If only one command, like ***SET CENTURY ON***, is needed, it can be included in the rest of the text, so long as it is also italicized.

If the user must substitute a particular value in place of a general descriptor, italicize the descriptor, make it lowercase, and *do not make it bold*:

```
USE PARAMS ORDER PARAMS
COPY TO TEMPARM FOR JOB = 'job' .AND. SAMPLE = 'sample'
```

In general, keywords, variable names, formatting codes, and descriptors should be in *courier* and *italicized*.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**7**
SUBJECT:	**Manual Adjustment of Data**
DATE of IMPLEMENTATION:	**1/1/01**

Modern chromatographic instruments include computer software to identify a detector response as a chromatographic peak, characterize that peak and determine the relative height or area of the signal. The software utilizes parameters (threshold, slope, etc) that are adjusted by the instrument operator to optimize the results.

A single set of operator controlled settings that determine peak characteristics for an entire data file is defined as an "automated procedure". An automated procedure often characterizes chromatographic peaks incorrectly. ARI requires that trained analysts identify and resolve these errors using an alternate automated procedure or a "manual adjustment" of the data. Manual adjustment is defined as the process used by an analyst to adjust an individual peak or a subset of data in a chromatographic file.

1. The settings for a routine automated procedure normally used to process chromatographic data must be described in the method Standard Operating Procedure (SOP).

2. Trained analysts may substitute one automated procedure for another in order to optimize peak characteristics. The use of an alternate automated procedure must be permanently documented using either a software generated log file or analyst notes.

3. Manual adjustment of chromatographic peak characteristics will be used to correct the results of an automated procedure that, in a trained analyst's opinion, are clearly incorrect and will result in erroneous peak identification, integration or quantification.

4. Manual adjustment will be implemented in a reasonable and consistent manner. Guidelines for performing manual adjustment will be documented in method SOPs.

5. All manually adjusted data will be clearly identified for approval in the data review process. A permanent record of all manual adjustments will be maintained in both electronic and hardcopy versions of the raw data.

6. Manual adjustment of chromatographic files will not be used to falsify data for any purpose. Falsification of data through the use of manual peak adjustment is unethical, unlawful and will result in termination of the offending analyst.

Approval:

_____

Quality Assurance Program Manager Date

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**8**
SUBJECT:	**Performance Evaluation Samples**
IMPLEMENTATION DATE:	**1/1/01**

Performance Evaluation Samples (PES) will be analyzed on a periodic basis to monitor laboratory performance and/or meet the requirements of an external accreditation program. PES samples contain target analytes in concentrations unknown to laboratory personnel. PES may be submitted by a third party or prepared internally under the direction of ARI's QA personnel.

PES will be submitted blind to the laboratory whenever possible.

PES will be logged-in, prepared, analyzed and reported as a routine sample without special consideration.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**9**
SUBJECT:	**Modifications to Analytical Methods Procedures or Reports**
DATE of IMPLEMENTATION:	**8/24/05**

This Policy defines the processes used to initiate and validate modifications to analytical processes, QA/QC protocol, data processing programs and algorithms, data reporting formats or other changes to analytical procedures or SOPs at Analytical Resources Inc. (ARI). The procedures outlined will also be used to validate project specific changes to analytical protocol and new analytical methods.

Changes to analytical procedures must be approved by ARI's Management (Managers and/or Supervisors) and be well documented using the following procedure:

1. Modification may be requested by any staff member. The modification must be requested using ARI's Corrective Actions Tracking System. Corrective Action requests for changes to analytical protocol or reports will assigned to the appropriate manager or supervisor by the initiator. As an alternative the request may be assigned to the QA Section. The Corrective Actions assignee may approve the project or re-assign the request for approval to a third party. The QA Section will monitor the progress of all requests.

2. The requestor must detail and justify the proposed modifications or additions when initiating a Corrective Action issue. Modifications must be approved by ARI management prior to any work performed to establish the modification.

3. The following must be in place before final approval and/or implementation of the proposed modification.

A. A new or revised SOP as appropriate including the modification or new protocol.
B. An Initial Demonstration of Proficiency as defined in ARI SOP 1018S for new or modified analytical procedures.
C. An MDL study following the procedure in ARI SOP 1018S for new or modified analytical procedure.
D. When appropriate, successful analysis of a blind Performance Evaluation Sample using new or modified procedures or data processing protocol.
E. Documentation that new or modified software provides the desired result.

4. ARI staff must have sufficient training to implement the procedural changes.

5. Notification of the modifications must be distributed to all affected personnel including appropriate client personnel.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**10**
SUBJECT:	**Reporting of Target and Spiked Analytes For Dual Column GC Analyses**
DATE of IMPLEMENTATION:	**8/24/05**

Analytical Resources Inc. uses single injection, dual column gas chromatographs to simultaneously identify and confirm the presence of target or spiked analytes in some GC analyses. Only one quantitative value is reported for each target or spiked analyte. ARI's policy for deciding which value to report is outlined as follows:

1. ARI considers each column equally valid for compound identification and quantification. Both GC columns must be compliant with all quality assurance parameters outlined in ARI's SOPs and LQAP. Both GC columns must produce valid initial and continuing calibrations using the same calibration model.

2. The analytical value reported will be determined by comparison of the quantitative results of confirmed analytes as follows.

a. The relative percent difference (RPD) between the results on the two columns (R_1 & R_2) is calculated using the formula:

$$RPD = \frac{|R_1 - R_2|}{\left(\frac{R_1 + R_2}{2}\right)} \times 100$$

b. If the RPD is less than 40% the greater of the two values is reported for both target analytes and spiked compounds. When required by specific QA protocol, by contract or client request the lower value will be reported for target analytes.

c. If the RPD is greater than 40%, ARI's analyst must examine the chromatogram for anomalies (overlapping peaks, incorrect integration, negative peaks) and either correct the anomalies (i.e. perform manual integrations) or report the most appropriate target analyte value. The higher value will be reported for spiked analytes. ARI's analyst must provide a written evaluation of all analyses where an RPD exceeds 40% and this information must be passed on to ARI's client or the data user.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**11**
SUBJECT:	**Calculation of Analytical Uncertainty**
DATE of IMPLEMENTATION:	**8/31/06**

Analytical Resources Inc. will use the procedure[1] proposed by Thomas Georgian, PhD to estimate analytical uncertainty. Dr. Georgian's proposes using the formulae below to calculate uncertainty:

For biased corrected analytical results:

100 (c/R)(1± L / R)
Where:
c = Measured concentration of the analyte
R = Average LCS spike recovery
L = ½ the warning or control range

And for unbiased results i.e. R = 100

c (± L / 100)

Example:

For a 10 ppb analytical result when the mean LCS recovery is 50% and the control limits are 20% to 80% an interval for the analytical results is calculated as follows:

100 (10 ppb / 50)(1±30 / 50) = 20 ± 12 ppb

[1] Estimation of Laboratory Analytical Uncertainty Using Laboratory Control Samples, Thomas Georgian, Ph.D., *Environmental Testing & Analysis*, November/December 2000.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**12**
SUBJECT:	**Rounding of Numbers and Reporting Limits**
DATE of IMPLEMENTATION:	**8/24/05**

I. ARI reports analytical results in concentration units as follows:

A. Values expressed as a concentration (mg/L, µg/Kg etc.)

1. Values less than or equal 10 are reported using 2 significant figures.
2. Values greater than 10 are reported using 2 or 3 significant figures.

B. Values expressed as percent (control limits, RSD etc.) are reported using the appropriate whole number. Examples: 6.38 rounds to 6, 9.95 rounds to 10, 99.93 rounds to 100, 145.48 rounds to 145.

II. ARI rounds numbers to the appropriate level of precision using the following rules:

A. If the figure following those to be retained is greater than or equal to 5, the absolute value of the result is to be rounded up: otherwise, the absolute value of the result is rounded down. Examples: -0.4365 rounds to -0.437 and 2.3564 rounds to -2.356; 11.443 is rounded down to 11.44 and 11.455 is rounded up to 11.46.

B. When a series of multiple operations is performed (add, subtract, divide, multiply), all significant figures are carried through the calculations and the final result is rounded to the appropriate number of significant figures.

III. ARI compares concentration values to reporting limits prior to rounding final concentration values. Example: with an RL of 0.50, 0.499 is undetected at 0.50 (0.50U) and 0.504 is detected at 0.50.

III. ARI will round quality control results prior to determining if the value is in control. Example: for spike recovery limits of ± 10% (90 – 110%), a recovery of 110.47is in control at 110% and a calculated recovery of 110.50 is out of control at 111%.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**12**
SUBJECT:	**Use of "J" Flag when Reporting Analytical Data**
DATE of IMPLEMENTATION:	**3/1/09**

1. ARI uses a "J" flag to indicate that a quantitative result chemical analysis is an estimated value. In general, "J" flags note positively identified compounds that are not in an instrument's verified calibrated range.
2. A "J" indicates quantitative values with a high degree of uncertainty. Data users must consider the greater uncertainty when using "J" flagged quantitative values.
3. ARI will not use "J" flags when reporting the results of metals analyses. Instrumental analysis of metals is subject to inter-element interference, non-specific absorption and sample-to-sample carryover that make quantification of elements below the reporting limit difficult. MDL studies performed on clean sample matrices are not subject to these interferences.
4. ARI will not report analytes below the RL ("J" flag is not used) for any single column GC analysis. (HCID, TPH-D, BTEX, TPH-G, RSK-175, Direct Aqueous Injection)
5. ARI uses "J" flags when reporting results of GC-MS (VOA and SVOA) and dual column GC analyses using the following criteria:
   A. All analyses must meet ARI established QA criteria for calibration and spike recovery.
   B. Analytes must meet method specific identification criteria (i.e. spectral match, retention time and/or relative retention time).
   C. The analyte concentration must exceed the greater of either the MDL or ½ the reporting limit before a "J" flag is applied.
   D. An analyte in a method blank will be "J" flagged only when any associated sample contains the same analyte.
   E. The application of a "J" flag is discretionary, depending on the professional judgment of ARI's data reviewers. GC-MS parameters such as ion ratios, spectral match, background contamination and instrument noise are weighted when considering the application of "J" flags.
6. Some typical circumstances that may warrant the use of a "J" flag:
   A. A compound identified at a concentration between the MDL or ½ RL and ARI's reporting limit (normally the low concentration used to calibrate the instrument).
   B. The quantified values in a dual column GC analysis differ by > 40% with obvious interference on one column. ARI may report the value with the lowest concentration or the least interference.
   C. The analyte is present at low concentration due to extract dilution and identified in a previous analysis of less dilute extract.
   D. Analytes < the RL and reported in previous analyses from the same sampling site.
   E. An analyte is < the RL in a sample and greater than the RL a duplicate or replicate analysis. This often applies to Matrix Spike and Laboratory Control Samples and their duplicates.

Appendix P

Modifications to ARI's LQAP

Modifications to ARI's LQAP

New Revision	Date	Modifications
		1. Updated Appendix D – Instrument/Equipment List 2. Specified length of data archive in Section 5.5
12-010	1/4/08	1. Edit Sections 4.4.1, 4.4.2, 4.4.3.2, 5.5, 6.3 (subcontracting), 8.3, 9.1 (MDLs) and 13 for Navy CAP. 2. Transferred Containers, Preservative & HT Table from Appendix F to Web
12-009	7/21/07	1. Updated SOP list in Appendix E 2. Updated Instrument List in Appendix D 3. Updated Accreditations Appendix L 4. Removed SOP table to web-site
12-008	12/20/06	1. Added Methane, Ethane & Ethene Info to Appendix F Table 2. Updated SOP Table in Appendix E 3. Modified Internal Audit Schedule 4. Archived SOP 355S and removed it from list in Appendix E 5. Updated Instrument / Equipment List in Appendix D
12-007	4/11/06	1. Removed Appendix J – Tuning Criteria are in the SOP 2. Changed BOD RL from 1 to 2 ppm 3. Integrated all SVOA Soil/Sediment MDLs into One Table 4. Added SIM Analysis to Soil/Sediment SVOA MDL Table 5. Added SIM Analysis to Water SVOA MDL Table 6. Updated MDL for SVOA in Water 7. Updated MDLV for Pesticides in Soil (25g to 5mL) 8. Updated MDLV for Pesticides in Soil (12g to 4mL) 9. Updated MDLV for PCB in Water (500 to 1mL) 10. Updated MDLV for PCB in Water (500 to 5mL) 11. Updated MDLV for Chlorinated Phenols in Water (500 to 50mL) 12. Removed Appendix I – MDL & RL Summaries 13. Updated MDL for SIM-PNA 14. Updated MDLV for SIM-PNA 15. Removed Appendix K – Control Limits
12-006	1/16/06	1. Updated MDL for TBT in Pore Water 2. Updated MDL and MDLV for Toxaphene in Soil/Sediment 3. Updated MDLV for VOA 8260B 20 mL Purge 4. Added IDL, MDL & RL for Low RL Mercury 5. Updated all Metals MDL Verifications 6. Updated MDLV for Water VOA using 5 mL purge 7. Updated MDLV for PCB in Soil with Soxhlet Extraction 8. Updated MDLV for SVOA (8270D) Analysis of Water using SepFunnel 9. Updated MDL for GC-MS-SIM Analysis of Skydrol & BHT in Water 10. Updated MDL for Chlorophenols (8041) in Soil 11. Modified RL for Chlorophenols in Soil & Tissue 12. Added Headspace GC (FID5) to Instrument List 13. Updated Footnotes on Glycols RL Table 14. Modified RL for 1,4-Dioxane in Water Method 8270D 15. Updated MDL for Analysis of Soil for VOA 16. Updated MDL for Analysis of Soil for JP-8 17. Updated MDL for Analysis of Sediment for TBT 18. Updated MDLV for Analysis of TBT in Water and Tissue 19. Added MDL for Analysis of PCB in Tissue with 4 ppb RL 20. Updated MDLV for PCB Analysis of Soil (Soxhlet) and Tissue (4 ppb) 21. Updated MDLV for Manchester Analysis of PCB in Water 22. Updated MDLV for Analysis of Gasoline in Soil and Water 23. Updated MDLV for Analysis of BTEX in Soil and Water 23. Updated MDLV for Analysis of Motor Oil in Soil and Water

		24. Updated MDLV for Analysis of VOA-SIM in Water 25. Updated MDLV for Analysis of VOA (20 mL) in Water 26. Updated MDL Table for Conventionals 27. Updated MDLV for Pesticides in Water (500 to .5 mL) 28. Updated MDLV for PCB Analysis of Soil 29. Updated MDLV for Chlorophenols (8041) in Soil 30. Updated MDLV for JP4 in Water and Soil 31. Updated MDLV for JP8 in Soil 32. Updated MDLV for VOA (8260B) in Water 5 mL & 20 mL Purge Volumes 33. Updated MDL for PCB in Soil – Standard Analysis & Medium Level 34. Updated MDL for Pesticides in Water – Standard Analysis 35. Updated MDL for SVOA in Water – Liq-Liq Extraction 36. Updated MDLV for Chlorophenols in Water
12-005	10/24/05	1. Added MDL for Chlorinated Phenol Analysis of Tissue (Method 8041) 2. Modified QA Policy 10 3. Established Implementation Date for QA Policies 09 & 10 4. Updated MDLV for TBT in Water 5. Corrected MDL Value for bis-(2-Ethylhexyl)-phthalate in SVOA Tissue 6. Updated MDL for Pesticides in Soil 7. Modified Title Format of Selected MDL Tables 8. References to 8270 or 8270C changed to 8270D 9. Deleted MDL Tables for SVOA Analyses of Tissue 10. Updated MDLs for SIM-PNA in Water (SepFunnel) and Soil 11. Updated MDLV for Metals 12. Updated MDLV for Manchester Pesticides 13. Updated MDLV for TPH-D In Soil 14. Updated MDLV for SIM-PNA in Water with Liq-Liq Extraction 15. Updated MDLV for JP-4 in Soil 16. Updated MDLV for VOA Water 5 mL Purge 17. Corrected MTCA RL for Methoxyclor & Manchester RL for all Pesticides 18. Updated MDL for Manchester Beta-BHC to reflect latest MDLV 19. Corrected Tissue Pesticide RLs 20. Updated MDLV for LVI-SIM-PNA in Water with Liq-Liq Extraction 21. Updated MDL for VOA-SIM Analysis of Aqueous Samples 22. Updated MDLV for PCB in Water (500 to 5 mL) 23. Updated MDLV for Diesel in Water (NWTPH-D & AK102) 24. Updated MDLV for Chlorophenols in Aqueous Samples 25. Updated MDLV for Chlorophenols in Tissue Samples 26. Removed & Archived Modifications to LQAP for 2002 & 2003 27. Updated MDL for Skydrol/BHT Analysis in Water Using 8270-SIM 28. Removed Direct Aqueous Injection MDLs RL Table. 29. Updated SOP Table (Appendix E)
12-004	8/19/05	1. Added “A” Flag for GeoTech to Appendix N. 2. Updated MDL for JP-4 in Soil 3. Updated MDL for Pesticides in Tissue 4. Updated MDLV for JP-4 in Soil 5. Updated MDLV for Pesticides in Soil 6. Updated MDLV for Pesticides in Water 7. Updated MDLV for PCB in Soil (25g to 1 mL) 8. Updated MDLV for PCB in Water (500 to 5 mL) 9. Updated MDLV for TPH-D in Water 10. Updated MDLV for PNA-SIM in Water (Liq-Liq Extraction) 11. Updated MDLV for VOA in Water (5 mL 8260B) 12. Updated MDLV for VOA in Water (20 mL 8260B) 13. Updated MDL for PSDDA SVOA in Sediment 14. Updated Appendix E – SOP List 15. Corrected MDL for Pesticides in Soil Information (IA-80 not GU-32)

		16. Corrected Reporting Limits for TBT in Water, Sediment & Tissue 17. Added Control Limits for 1,4-Dioxane to SVOA List 18. Added low level RLs for BTEX Compounds 19. Updated MDLV for TBT in Pore Water 20. Updated MDLV for BTEX Water & Soil 21. Updated MDLV for TPH-G in Water & Soil 22. Updated Appendix E SOP Table 23. Updated MDLV for Motor Oil in Soil Using ASE 24. Updated MDLV for Motor Oil in Soil Using MicroTip 25. Updated MDLV for Motor Oil in Water Using SepFunnel 26. Updated MDLV for JP-4 in Water Using SepFunnel
12-003	7/15/05	1. Added MDLV for 5 mL VOA Analysis of Water – Method 8260B 2. Updated MDL for MTCA PCB in Water Samples 3. Added MDL for Soxhlet Extraction of PCBs 4. Removed Aroclor 1242 from MDL Table 5. Control Limits for HEM Changed to Equal Those in SOP 648S 6. Updated MDL for PSDDA PCB Analysis. 7. Added MDL for TBT in Tissue 8. Updated MDL for 20 mL 8260B 9. Updated MDLV for SIM-VOA 10. Updated MDL for Pesticides in Soil 11. Updated MDLV for TPH-D in Soil 12. Added MDLV for PSEP Level Pesticides in Sediment 13. Updated (added missing compounds) PSDDA SVOA MDLs 14. Updated & Corrected Appendix F (Containers & Preservatives) 15. Added “A” Flag for GeoTech to Appendix N.
12-002	6/9/05	1. Updated Motor Oil MDL (NWTPH-Dext & AK103) for Soil 2. Documented MDLV for Gasoline in Soil (Methods NWTPH-G & AK101) 3. Corrected units for DRO & RRO MDL for water from mg/kg to mg/L 4. Added MDL for JP-4 in Water using Sep Funnel Extraction 5. Updated MDL for Sediment Analysis (Krone) of TBT using Sonication 6. Updated MDL for SVOA Water SepFunnel 7. Noted that BTEX –SIM MDL in Table was Medium Level Extraction 8. Added MDL Verification Information for ICP Metals 9. Updated MDL for TBT in Water and Pore Water – SepFunnel 10.Updated MDLV for TPH-D Water – SepFunnel 11. Added EPH and VPH RL Tables 12. Added MDLV for JP-4 Analysis of Water – Sep Funnel 13. Added MDLV for BTEX analysis of Soil 14. Added MDLV for SVOA Water - SepFunnel 15. Added MDLV for TBT Sediment 16. Updated MDL for PSEP Pesticides in Sediment/Soil 17. Updated MDL for Chlorinated Phenols in Water 18. Updated MDL for Pesticides in Water – SepFunnel 19. Added MDLV for 524.5 20. Added MDLV for Metals 21. Updated MDL for Manchester Pesticides 22. Added Appendices to the Table of Contents 23. Added MDL for PCB Analysis of Tissue
12-001	4/5/05	1. List of SOPs (Appendix E) Modified & Updated as Appropriate 2. MDL Verification for DRO in Soil Added 3. MDL Verification for PCB Water Standard Analysis (HO-24) Added 4. AK-101 Removed from BTEX MDL Table for Water 5. Metals IDLs & MDLs Updated 6. BTEX MDL for Analysis of Water and Soil Updated 7. RL for 1,4-Dioxane in SVOA Analysis of Water Changed from 1.0 to 5.0 8. Control Limits for BTEX and Gasoline updated

		9. MDL for Gasoline in Soil Updated 10.MDL for Diesel and Motor Oil in Soil Updated. 11. Split TPH-G Table into Aqueous and Soil Table & added MDLV for Water 12. Entered updated MDLs for SIM-LVI-PNA 13. Changed RL for 20 mL 1,2-Dibromo-3-Chloropropane from 2 to 0.5 ppb 14. Updated MDLs for 524.2 15. Updated Conventionals MDLs 16. Updated MDLs for 5 mL VOA analysis of Water Samples (8260B) 17. Modified MDL Table for TPH-D Analysis of Water 18. Updated TPH-D and TPH-Dext MDL for Water Analyses. 19. Removed EPH and VPH MDLs from the LQAP
11-028	12/31/04	1. Modified definition of "Y" flag in Appendix N 2. Updated MDL for TPH-D Soil 3. Updated Appendix M - Laboratory Certification and Accreditation
11-027	12/15/04	1. Updated SOP List in Appendix E. 2. Added AK-101 to BTEX/GRO Control Limit Table. 3. Lowered RL for Benzene in MDL Summary for Method 8021B 4. Added Additional Surrogates to VOA-SIM BTEX Control Limit Table 5. Corrected BTEX MDLs for 8260-SIM to Reflect Sample Conc. Not On-Column values 6. Updated SOP Table in Appendix E 7. Modified VOA 5 mL Water RLs - Acrylonitrile & 1,2,3-Trichloropropane 8. Modified VOA mL Soil RL – 4-Methyl-2-Pentanone 9. Corrected MDL Value for Methoxychlor in PSDDA Sediment Analysis. 10.Modified definition of "Y" Flag in Appendix N 11.Updated MDL for BTEX Water PID-2 12.Updated MDL for Pesticides MTCA Analysis of Water 13.Updated MDL for PSDDA SVOA Analysis 14.Updated MDL for VOA Soil 15.Updated MDL for SVOA, Water, Liq-Liq 16.Updated MDL for Various PCB (1660) Analyses 17.Updated MDL for TPH-G – Water & Soil 18.Updated MDL for SVOA Soil Micro Sonication 19.Added MDL for Manchester Aroclor 1254 20.Modified Control Limits for EPH Analyses 21.Deleted MDL Table for SVOA, Soil, MacroTIp Extraction 22.Deleted MDL for Soil Skydrol/BHT, GC-MS-SIM 23.Updated Instrumentation Listing (Appendix D)
11-026	11/02/04	1. Updated Control Limits for SIM-PNA 2. Added Control Limit Table for Full Scan PNA Analysis (Method 8270D) 3. Updated SIM-PNA Water MDL for NT-1 4. Updated Appendix E – SOPs 5. Modified PCB MDL Table –Remove Manchester & Combine PSEP/Low Level Sediment MDLs 6. Updated MDL for VOA SIM Water NT3 7. Updated MDL Table for SIM Skydrol/BHT in Water 8. Updated SOP Table in Appendix E.
11-025	9/16/04	1. Added new Appendix N listing Data Qualifiers & changed designations for Appendices N, O & P to O,P & Q respectively 2. Updated MDL Table for PCB Analyses. 3. Combined MDL tables for SVOA Water & Deleted Sep Funnel Table 4. Updated PCB & TPH-D MDL Tables 5. Updated Equipment List (Appendix D) & added GeoTech Equipment 6. Revised MDL Table for FID Analysis of Polar SVOA (EPA Method 8015) 7. Updated MDLs for Pesticide analysis of soil. 8. Sediment Pesticide MDLs added to Soil Table, Sediment Table Deleted 9. Control Limit for MS Recovery of Pyrene in Sediment Corrected

		10.Updated Cyclohexanone MDL (Finn 1, 20 mL purge) 11.Updated SIM-PNA Soil MDL for NT-1 12. Edited MDL Tables for SVOA for consistency and accuracy 13. Modified EPH Reporting Limits 14. Revised formatting on most MDL tables. 15. Corrected dates for VOA Control Limit data 16. Deleted analytes except cyclohexanone from VOA MDL Table for Project Specific Analytes. 17. Added BTEX in Soil to VOA-SIM MDL Table 18. Added Manchester MDL to PCB Table 19. Updated Skydrol/BHT Control Limits
11-024	7/19/04	1. Revised and Updated MDL Tables for TPH Analyses of Soil/Sediment. 2. Revised and Updated MDL Tables for PCB Analyses. Combined All PCB MDL into One Table. 3. Deleted all other MDL tables 4. Updated MDL for VOA analysis of Soil using ARI's In-house Method. 5. Added 1-Methylnaphthalene to SIM-PNA MDL Tables for Water & Soil 6. Updated Appendix D (Lab Equipment) and added GeoTech Section 7. Combined Water & Soil SIM-PNA MDL Tables into One Table 8. Deleted Water-SF & Soil SIM-PNA MDL Tables 9. Updated MDLs for Pesticide – Manchester Extraction 10. Revised VOA Water Control Limits Table 11. Updated MDLs for VOA analysis of Water-8260B-5mL purge
11-023	7/6/04	1. Corrected Conventionals MDL/RL Table 2. Corrected Control Limit for TPH-D MS Recovery in Water Samples. 3. Updated MDLs for NWTPH-D Soil ASE & MicroTip. 4. Removed HPLC MDL Table for analysis of PNA. 5. Removed MDL Table for HCID 6. Removed FID-3B from TPH MDL Tables 7. Updated MDLs & Modified Table for SVOA-PSEP analysis of Sediments 8. Revised Section 11 9. Updated MDL for VOA (524.2) analysis of Water 10. Removed MDLs for VOA-SIM analysis of Soil 11. Updated MDL Table for VOA-Water 20 mL 12. Updated MDL Table for VOA-Water 5 mL
11-022	5/17/04	1. Corrected Extract Final Volume in MDL table for Sediment PCB 2. Deleted FINN 8 from all MDL Tables 3. Corrected RL for Hg in Water.
11-021	5/07/04	1. Implemented default control limits for EPA Method 524.2 2. Decreased RL for Aroclor 1221 to level of other Aroclors 3. Eliminated Control Limits for VOA using ARI SOP 804S. 4 Updated VOA 8260B full scan control limits for water & sediment/soil 5. Updated 10 mL purge VOA-SIM control limits for water 6. Changed effective date for VOA-SIM BTEX control limits 7. Updated 8270-SIM-PNA control limits for water & sediment/soil 8. Updated BTS control limits for water & soil.
11-020	4/26/04	1. Updated MDL (PID1 & 2) for BTEX in water 2. Updated MDL (PID 1) for gasoline in water 3. Deleted MDL Table for ASE extraction of chlorinated pesticides 4. Updated MDL for VOA water 5 mL purge 8260B on NT3 5. Updated MDL for pesticide in water separatory funnel on ECD3 6. Added MDL Table for VPH in water and soil 7. Deleted Control Limit Table for HPLC PNA 8. Updated PCB control limits 9. Updated Herbicide control limits 10. RL for Sulfate to 2.0 & 20.0 ppm for water & solids respectively 11. Updated TPH-D Control Limits

		12. Updated Chlorinated Phenols Control Limits 13. Updated BTEX & TPH-G Control Limits 14. Corrected Pesticide MTCA MDL Table 15. Corrected RL for GC-ECD analyses of HCBD & HCB
11-019	3/11/04	1. Revised holding time for Total Solids in soil & sediment from 7 days to 14 days. 2. Updated MDLs for SVOA water L/L NT4 & NT 6. 3. Updated Metals IDLs and MDLs 4. Added QA Policy 9 – Modifications to method, protocol or reports 5. Updated Conventionals MDLs 6. Added QA Policy 10 – Reporting of dual column GC analytes
11-018	1/21/04	1. Revised Control Limits for GC-MS analysis of SVOA 2. Revised Control Limits for Chlorinated pesticides 3. Updated Appendix E – Table of SOPs 4. Updated and Revised Appendix F – Sample Containers, Preservation and Holding Times 5. Modified Sign-of Sheet to include only QA manager
11-017	1/4/04	1. Minor revisions to Section 13 2. Revisions to subcontracting language in Section 6.3

APPENDIX C

Health and Safety Plan

HEALTH AND SAFETY PLAN

Data Gaps Investigation

8801 East Marginal Way South

Seattle, Washington

Prepared by:

AMEC Earth & Environmental, Inc.
11810 North Creek Parkway North
Bothell, Washington 98011

July 29, 2011

Project No. 9-915-14995-L

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APPENDICES

HEALTH AND SAFETY PLAN
8801 East Marginal Way South
Seattle, Washington

Project Name: PACCAR Inc
Project Location: 8801 East Marginal Way South, Seattle, Washington (8801 site)
Project Number: 9-915-14995-L

THIS SITE SPECIFIC HEALTH AND SAFETY PLAN APPLIES TO AMEC PERSONNEL AND SUBCONTRACTORS

SAFETY PERSONNEL CONTACT INFORMATION

Health and Safety Coordinator:	Michael Smith, CIH	425-368-1000
Project Manager:	Meg Strong	425-368-1000
Site Safety Coordinators:	Anastasia Speransky	206-342-1760
	Joseph Petrick	425-368-1000
Client Contact:	Vicki ZumBrunnen	425-468-7055

EMERGENCY CONTACTS

Hospital/Emergency Room: **Harborview Medical Center**
325 9th Avenue, Seattle, WA 98104-2420
206-731-3000

Map showing shortest route to Hospital is attached to this document

Fire:	911
Police:	911
Poison Control Center:	1-800-222-1222
AMEC Emergency Telephone:	425-368-1000
Department of Ecology Spill Response:	425-649-7098
Emergency Natural Gas: Puget Sound Energy	425-454-6363
Electric Utility: Puget Sound Energy	425-454-6363
Emergency Water Shut-Off: Seattle Public Utilities	206-386-1800
Washington State Patrol:	911

IAAI Site Representative Bobbie Egan 206-465-9385

PACCAR Inc
Client Contact Vicki ZumBrunnen - PACCAR) 425-468-7055

AMEC Earth and Environmental, Inc.

Health and Safety Coordinator:	Michael Smith, CIH	425-443-4306 (cell)
		425-368-1000 (office)
Project Manager:	Meg Strong	425-864-2096 (cell)
		425-368-1000 (office)

If an emergency occurs, the Site Safety Coordinator (SSC) will shut down field operations and notify the appropriate emergency personnel and the Project Manager. The Project Manager will inform the Client immediately and other personnel, as needed.

Additionally, the SSC, Project Manager, and Health and Safety Coordinator (HSC) are to be notified immediately if worker exposure, accidents, or site conditions not anticipated in this document are encountered. In the case of hazard (for example, chemical) exposure, the hospital and any emergency response personnel shall be notified that the patient's clothing may be contaminated. Consultant will have ready additional copies of the appropriate Material Safety Data Sheets to be handed to emergency aid personnel.

ACTION LEVELS

Upgrade personal protective equipment (PPE) Level to Level “C”: ***5*** ppm (Benzene short term exposure limit [STEL]) or greater measured by a direct reading photoionizaton detector (PID).
Stop all work and exit work area: ***100*** ppm or greater measured by PID

1.0 GENERAL INFORMATION

AMEC Earth & Environmental, Inc., (AMEC) produced this site-specific health and safety plan as the controlling health and safety document for all environmental investigation work conducted at the site. If other contractors have a separate health and safety plan, the SSC must review and approve a copy of that plan before the contractors may enter the 8801 site.

1.1 PROJECT DESCRIPTION

AMEC’s proposed data gaps investigation includes sampling and analysis of soil, groundwater, and surface materials at the 8801 site. The scope of work is as follows:

- Advance four soil borings (DG11-1 through DG11-3 and DG11-8) to 15 feet below ground surface (bgs).

- Advance six soil borings (DG11-4 through DG11-7, DG11-9 and DG11-10) to 5 feet bgs.
- Advance seven soil borings to depths ranging from 20 to 25 feet bgs and complete these soil borings as monitoring wells MW-43A through MW-49A.
- Collect and analyze soil samples from the borings for the specific chemicals being investigated in each area, including chemicals to be analyzed with lower detection limits than in previous investigations.
- Collect and analyze groundwater samples from the seven newly installed monitoring wells for the area-specific chemicals to determine if chemicals are leaching to groundwater.
- Collect groundwater samples from the seven newly installed wells and existing on-site monitoring wells to evaluate the distribution of volatile organic compounds (VOCs) and low-level vinyl chloride in groundwater across the 8801 site.
- Collect groundwater samples from two monitoring wells to determine if polychlorinated biphenyls (PCBs) are present in the groundwater.
- Collect bulk samples of paint, mastic, and joint compounds to determine if surface materials are the source of tributyl tins (TBTs) and PCBs in stormwater solids.

AMEC personnel will collect soil and groundwater samples in accordance with the sampling and analysis plan (SAP). Samples will be placed into appropriate containers, labeled, and submitted under chain-of-custody to a state-certified testing laboratory.

1.2 SITE HISTORY

The site occupies approximately 25 acres on the east bank of the LDW at the street address 8801 East Marginal Way South, Tukwila, Washington (Figure 1). During the early 20th Century, the site was developed and occupied by various companies, including a subsidiary of General Motors Corporation, Boeing, and Monsanto, before being purchased by PACCAR in 1946. From 1946 to 2002, Kenworth Motor Truck Company, a subsidiary of PACCAR, occupied the 8801 site and manufactured heavy trucks there. The factory was decommissioned in 2002 (Kennedy/Jenks June 2003).

In October, 2000, before the decommissioning, PACCAR entered into the Voluntary Cleanup Program (VCP) with Ecology. The program involved removing USTs and associated contaminated soil impacted by petroleum hydrocarbons and conducting two major site investigations to characterize soil, groundwater, seeps, and stormwater at the site. In October, 2004, PACCAR sold the property to Merrill Creek Holdings, LLC who then leased the property to Insurance Auto Auctions Incorporated (IAAI).

The 8801 site is surrounded primarily by industrial properties, including Boeing to the north, the former Monsanto property to the south, East Marginal Way and Boeing Field to the east, and the LDW (classified as a Superfund site for sediments) to the west.

1.3 SITE SAFETY PERSONNEL

As the HSC, Mr. Michael Smith, CIH, coordinates health and safety planning for AMEC projects. The primarily duties of the HSC are coordination with the Project Manager and SSC for preparation of site health and safety plans, assessment of chemical hazards, and selection of safety/monitoring equipment necessary for each project.

Ms. Meg Strong, the Project Manager, has overall responsibility for project operations, including providing a safe work environment. This involves hazard assessment, coordinating preparation of a site health and safety plan, and providing necessary resources for implementation of the site health and safety plan.

Ms. Anastasia Speransky and Mr. Joseph Petrick (or another AMEC representative directed by the Project Manager), the SSCs, have the responsibility of implementing the site health and safety plan while at the site. The SSCs were involved with the HSC and the Project Manager in preparation of the site health and safety plan. If the plan is not being implemented or if unanticipated situations arise, the SSCs may stop all work and direct all personnel to leave the site. The SSCs will have charge of all instruments and see to their proper use and function.

2.0 EMERGENCY PROCEDURES

In all emergencies, staff will document action taken and notify the HSC, Project Manager, SSC, and Client Contact of the emergency and of actions taken.

2.1 HAZARD EXPOSURES

Absorption (skin): Remove contaminated clothing immediately. Wash with soap and water.

Inhalation: Remove to fresh air. Where necessary, call emergency medical help (ambulance, hospital, and police) and follow medical emergency help procedures.

Eye contact: Flush with eyewash or water for at least 15 minutes. Follow emergency medical help procedures, if indicated. Contaminants may be absorbed through the eyes.

Ingestion: Identify material ingested. Obtain medical help if indicated.

Injuries: Administer first aid if necessary. Follow emergency medical procedures below, if necessary. Medical emergencies take precedence over decontamination.

2.2 HAZARD COMMUNICATION

All workers will be informed of the hazards of chemicals that may be encountered at the 8801 site. These chemical compounds are listed in Section 2.8 of this document.

2.3 EMERGENCY MEDICAL HELP PROCEDURES

Call hospital **(Harborview Medical Center).** See map attached to plan (Section 4.0).

Hospital Address: **325 9th Avenue**
Seattle, WA 98104-2420
206-731-3000

If the injury is life-threatening, follow steps 1 through 8 below. If the injury is not life threatening, perform necessary first aid and consider the need for decontamination before transport. The SSC shall have up-to-date first aid and CPR training.

1. Perform first aid necessary to determine victim(s) medical status.
2. Call emergency transport.
3. Give specific directions to location of emergency.
4. Give phone number from which you are calling.
5. Tell emergency services what happened. Inform emergency personnel that victim(s) may be wearing contaminated clothing.
6. Inform emergency services how many need help.
7. Inform emergency services what is being done for the victim(s).
8. Stay on phone until told to hang-up.
9. Transport the victim(s) to hospital, if possible.

2.4 FIRE/EXPLOSION

Use hand extinguisher if appropriate and as safety permits. Call fire department, if appropriate. Evacuate to upwind location if fire cannot be controlled with a fire extinguisher.

2.5 ACCIDENTAL SPILL/RELEASE

1. Pick up, isolate, or contain spill.
2. Evacuate area, if necessary.
3. Contact emergency agencies, if necessary.

2.6 UNANTICIPATED CONDITIONS

1. Suspend all non-emergency activities.
2. Notify HSC and Project Manager immediately. Do not restart planned operations in the area until authorized by the HSC, Project Manager, and Client.
3. If visual or olfactory evidence indicates unanticipated additional soil contaminants, the HSC, Project Manager, and SSC will reevaluate site conditions, required protective equipment level, and action levels. Client approval will be required before restarting planned operations.

2.7 HAZARD ASSESSMENT

Based on the history of the site and activities to be performed, AMEC anticipates encountering the following types of hazards:

1. Chemical
2. Physical
3. Construction
4. Utilities

AMEC's preliminary assessment is the proper PPE for the site is Level “D” protection, with the capability to upgrade to Level “C” protection when conditions warrant.

2.8 CHEMICAL

Chemical hazards that could be encountered through inhalation, ingestion, or absorption include gasoline; benzene, toluene, ethylbenzene, and xylenes (BTEX);, solvents; VOCs; semivolatile organic compounds (SVOCs); and metals. Applicable time-weighted averages (TWAs) / permissible exposure limits (PELs) / threshold limit values (TLVs) for these chemical hazards are listed in Table 1 below, as well as the limits at which the chemicals are immediately dangerous to life and health (IDLH). The nature of this project precludes continuous exposure to any potential contaminant.

CHEMICAL	PEL/TLV	IDLH	WARNING PROPERTY	EXPOSURE ROUTE	ACUTE HEALTH EFFECTS	CHRONIC HEALTH EFFECTS
Total Petroleum Hydrocarbon Constituents and Volatile and Semivolatile Organic Compounds						
Gasoline	300 ppm	Not Established	Distinct Odor at 0.25 ppm	Inhalation, dermal, ingestion	Intoxication, headaches, blurred vision, dizziness, and nausea	Eye, nose, and throat irritation; dizziness; anesthesia; intoxication; possible kidney damage
Benzene	1 ppm (8-hour TWA) 5 ppm (15-min STEL)	500 ppm	Aromatic Odor	Inhalation, dermal, ingestion	Eye, nose, skin, and upper respiratory irritation; headache; dizziness; nausea	Leukemia, anemia, chromosomal aberrations
Benzo(*ghi*)perylene	Not established	Not Established	Aromatic	Inhalation, dermal, eyes	Skin irritation after contact	Skin irritation, skin cancer, affection of kidney tissue, feeling of weakness
Ethylbenzene	100 ppm (8-hour TWA)	800 ppm	Aromatic	Inhalation, ingestion, dermal	Eye and mucous membrane irritation, respiratory irritation, dermatitis	Liver and kidney damage, central nervous system effects
Diesel	100 mg/m^3 (8-hour TWA) (15 ppm)	Not Established	Distinct characteristic petroleum odor at 2.7 ppm	Inhalation, dermal, ingestion	Eye, nose, skin, and upper respiratory irritation; digestive tract irritation; headache; dizziness; nausea	Possible skin cancer hazard, possible kidney damage.
Bis(2-ethylhexyl)phthalate	5 mg/m^3 (8-hour TWA)	5000 ppm	Slight odor	Dermal, inhalation, ingestion	Eye and skin irritant	Possible carcinogen
1,1-dichloroethylene	5 ppm (8-hour TWA)	3000 ppm	Characteristic odor	Inhalation, ingestion	Eye, skin, and respiratory tract irritant	Skin dermatitis, possible effects on kidneys and liver
cis-1,2-Dichloroethylene	200 ppm (8-hour TWA)	1000 ppm	Pleasant odor	Inhalation, dermal, eyes, ingestion	Respiratory irritation, nausea, vomiting, drowsiness	No information given on significant long term exposure effects
Tetrachloroethylene	25 ppm	150 ppm	Ether or	Inhalation,	Headache; drowsiness;	Possible damage to

CHEMICAL	PEL/TLV	IDLH	WARNING PROPERTY	EXPOSURE ROUTE	ACUTE HEALTH EFFECTS	CHRONIC HEALTH EFFECTS
	(8-hour TWA)		chloroform odor	eyes, dermal, ingestion	dizziness; irritation of respiratory tract, skin, and eyes. Ingestion may cause gastrointestinal irritation.	kidneys, liver, lungs, blood, or central nervous system.
Toluene	200 ppm (8-hour TWA)	500 ppm	Aromatic	Inhalation, dermal, ingestion	Fatigue, weakness, dizziness, headaches	Liver and kidney damage, central nervous system effects, skin damage
Trichloroethylene	10 ppm (8-hour TWA)	1000 ppm	Chloroform-like odor	Inhalation, dermal, ingestion, eyes	Eye, skin, and respiratory tract irritant: headaches, dizziness, abdominal pain, dry skin.	May cause liver, kidney, central nervous system, and peripheral nervous system effects. Suspected carcinogen.
Vinyl Chloride	1 ppm (8-hour TWA)	Not Established	Pleasant, sweet odor	Inhalation, ingestion	Central nervous system effects: dizziness, drowsiness, loss of coordination	Liver cancer, asphyxiation
Xylenes (all isomers)	100 ppm (8-hour TWA)	900 ppm	Aromatic	Inhalation, ingestion, dermal	Eye, nose, skin, and upper respiratory irritation; dizziness, drowsiness; nausea	Liver and kidney damage, central nervous system effects
Acetone	1000 ppm (8-hour TWA)	2500 ppm (10% lower explosive limit [LEL])	Mint-like odor	Inhalation, ingestion, dermal, eye contact	Irritation of eyes, nose, and throat; headache; dizziness; central nervous system depression; dermatitis	Eyes, skin, respiratory system, central nervous system
Other Potential Site Contaminants						
Dichloroethane (DCA)	400 mg/m^3	3000 ppm	Chloroform-like odor	Inhalation, ingestion, dermal, eye contact	Skin irritation; central nervous system depression; liver, kidney, and lung damage	Central nervous system [potential occupational carcinogen]
Dichloroethene (DCE)	790 mg/m^3	1000 ppm	Chloroform-like odor	Inhalation, dermal, ingestion,	Irritation of eyes, skin, and throat; dizziness; headache; nausea;	Eyes, skin, respiratory system, central nervous system, liver, kidneys,

CHEMICAL	PEL/TLV	IDLH	WARNING PROPERTY	EXPOSURE ROUTE	ACUTE HEALTH EFFECTS	CHRONIC HEALTH EFFECTS
				eye contact	dyspnea (breathing difficulty); liver and kidney disturbance; pneumonitis	[potential occupational carcinogen]
Arsenic	0.010 mg/m^3 (8-hour TWA)	5 mg/m^3	Poor	Inhalation, absorption, dermal, ingestion	Eye, nose, and skin irritation; GI disturbances; hyper-pigmentation of skin	Liver and kidneys, skin, lungs, lymphatic system
Barium	0.5 mg/m^3 (8-hour TWA)	50 mg/m^3	Poor	Inhalation, ingestion, dermal	Eye, nose, and skin irritation; GI disturbances; reduced pulse; muscle spasms	Eyes, skin, respiratory system, hearing, central nervous system
Cadmium	0.005 mg/m^3 (8-hour TWA)	9 mg/m^3	Poor	Inhalation, absorption, dermal, ingestion	Eye, nose, and skin irritation; dizziness; nausea; convulsions	Eyes, skin, respiratory system, central nervous system, cardiovascular system
Chromium	0.5 mg/m^3 (8-hour TWA)	250 mg/m^3	Poor	Inhalation, absorption, dermal, ingestion	Eyes, respiratory, and skin irritation; nausea; blurred vision; GI disturbances	Respiratory system, central nervous system, peripheral nervous system
Copper	1.0 mg/m^3 (8-hour TWA) Cu dusts and mists 0.1 mg/m^3 (8-hour TWA) Cu fume	100 mg/m^3	Poor	Inhalation, dermal, eye contact	Irritation of eyes and upper respiratory system; metal fume fever: chills, muscle ache, nausea, fever, dry throat, cough, lassitude (weakness, exhaustion); metallic or sweet taste; discoloration of skin and hair	Eyes, skin, respiratory system (increased risk with Wilson's disease)
Lead	0.050 mg/m^3 (8-hour TWA)	100 mg/m^3	Poor	Inhalation, ingestion, dermal	Eyes, nose, and skin irritation; abdominal pain	Eyes, GI tract, central nervous system, blood, kidneys
Nickel	Ni elemental 1.5 mg/m^3 (8-hour	10 mg/m^3	Poor	Inhalation, ingestion, dermal	Skin and eye irritation, skin and lung sensitization	Toxic to skin. May be toxic to kidneys, liver, and upper respiratory tract. Can

CHEMICAL	PEL/TLV	IDLH	WARNING PROPERTY	EXPOSURE ROUTE	ACUTE HEALTH EFFECTS	CHRONIC HEALTH EFFECTS
	TWA); soluble inorganic compounds 0.1 mg/m^3; Insoluble inorganic compounds 0.2 mg/m^3					cause dermatitis and pneumoconiosis. Insoluble nickel compounds can cause lung cancer. Soluble nickel compounds can cause nasal cancer.
Mercury	0.050 mg/m^3 (8-hour TWA)	10 mg/m^3	Poor	Inhalation, absorption, ingestion, dermal	Eyes and skin irritation, cough, GI disturbances	Eyes, skin, respiratory system, central nervous system, kidneys
Silver	0.01 mg/m^3 (8-hour TWA)	10 mg/m^3	Poor	Inhalation, ingestion, dermal	Eyes, nose, and skin irritation; GI disturbances	Nasal septum, skin, eyes
Selenium	0.2 mg/m^3 (8-hour TWA)	1 mg/m^3	Poor	Inhalation, ingestion, dermal	Eyes, nose, and skin irritation; sore throat; chills; difficulty breathing	Eyes, skin, respiratory system, liver, kidney, blood, spleen
Zinc	2 mg/m^3 (8-hour TWA	500 mg/ m^3	Poor	Inhalation, ingestion, dermal, eye contact	Eyes, nose, and skin irritation;, GI disturbance	Respiratory disorders, possible damage to pancreas
Polycyclic aromatic hydrocarbons (PAHs) as creosote or coal tar	0.2 mg/m^3 (8-hour TWA) as benzene-soluble fraction	80 mg/m^3	Poor	Inhalation, dermal, eye contact	Dermatitis, bronchitis	Respiratory system, skin, bladder, kidneys, [potential occupational carcinogen]
Polychlorinated Biphenyl (PCB) 42% Chlorine	1 mg/m^3 (8-hour TWA)	5 mg/m^3	Mild hydrocarbon odor	Inhalation, ingestion, dermal, eye contact	Eye irritation, chloracne	Skin, eyes, liver, reproductive system, [potential occupational carcinogen]

2.9 PHYSICAL

The physical hazards that may be encountered during site activities include noise, manual lifting, working near drilling equipment, weather related hazards (heat stress, wind), rough terrain, and explosion hazards. Hard-hats, safety glasses, hearing protection, and steel-toed boots will be required for all personnel working near heavy equipment. The SSC will monitor workers for weather related hazards such as heat stress and will implement a work/rest schedule, if warranted.

Using safe work practices at all times will mitigate identified hazards. The SSC has total responsibility for ensuring that all AMEC personnel on site perform work tasks in a safe and sensible manner.

AMEC personnel will oversee and ensure that all subcontractors and equipment operators are responsible for the safe operation of heavy equipment. The excavation company subcontractor will be responsible for ensuring that equipment operators are trained and qualified to operate all equipment. AMEC and the subcontractor will inspect all equipment to assure that it is in good working order, including, but not limited to, hydraulic hoses, belts, cables, chain links, and hoist hooks. All equipment will be turned off, locked up, or otherwise secured at the close of each work period to prevent unauthorized use.

If at any time the SSC determines that safe work practices are not followed, the tasks will be suspended and corrective actions will be taken.

Because of the potential explosion hazard presented during subsurface exploration of sites, **SMOKING WILL NOT BE ALLOWED ANYWHERE IN OR AROUND THE WORK ZONE.**

2.10 CONSTRUCTION

Construction hazards will be mitigated by performing all work in general accordance with the state safety standards for construction work (Washington Administrative Code [WAC] 296-155).

2.11 UTILITIES

Before any excavation, the contractor will conduct a utility locate. The contractor shall make reasonable inquiry of appropriate sources, including PACCAR, regarding the location of underground utilities in the area of any work to be performed, and shall be responsible for any loss or damage to such utilities and installations caused by contractor's failure to make reasonable inquiry or use reasonable care in performing the work.

If there are overhead power lines in the vicinity of the site, they must be carefully avoided. A good rule of thumb is for all masts, buckets of backhoes/trackhoes, and front-end loaders to remain at least 10 feet away from lines carrying up to 125,000 volts, 15 feet from lines carrying up to 250,000 volts,

and 20 feet from lines carrying over 250,000 volts. If line voltage is not clearly marked, maintain a 20-foot distance from lines.

Soil excavations will be advanced no closer than 5 feet from any located underground utilities. In case of damage to an underground utility, exit the work area/site safely and close it to the public, if necessary, before contacting the appropriate utility agency for repair/closure of the utility line.

2.12 ACCIDENT/EMERGENCY ACTION PLAN

In the event of an accident or emergency, document action taken on the Injury/Accident Form (Appendix A) and notify the HSC, Project Manager, SSC, and Client of occurrence or near-occurrence of an emergency and actions taken. Notify appropriate personnel in the event of an accident. If the accident is serious, call 911 immediately.

2.13 PERSONAL PROTECTION LEVEL

The SSC is responsible for ensuring the health, safety, and efficiency of the project team. The level of personal protection necessary for the health and safety of the project team will be determined by the SSC based on the above action plan and any overt signs of hazards to life and health.

Any team member can seek to upgrade the level of protection established by the SSC. This will be accomplished through consultation with the AMEC SSC, and an agreement will be reached before the team member enters the work area. **UNDER NO CIRCUMSTANCES** will AMEC team members downgrade the level of personal protection selected by the SSC. The level of protection selected for this site is modified Level "D" with the capability of upgrading to Level "C." Neither of these levels of protection is adequate for confined space entry. **UNDER NO CIRCUMSTANCES** shall any AMEC team members enter a confined space, unless a confined space entry permit is authorized by a "competent person."

2.13.1 Modified Level D Personal Protective Equipment

Modified Level "D" consists of steel-toed, chemical resistant rubber boots, inner gloves of PVC or latex, outer gloves of nitrile or equivalent, hard hat, safety glasses, and Tyvek® coveralls.

WEARING TYVEK WILL BE DISCRETIONARY BASED ON CIRCUMSTANCES AND SSC'S DIRECTION

2.13.2 Level C Personal Protective Equipment

Level "C" consists of Level "D" plus a full-face air-purifying respirator equipped with organic vapor and high efficiency particulate cartridges.

3.0 SITE CONTROL

3.1 EXCLUSION ZONE

In the event that an exclusion zone is required (for example, a spill), a hot line will be established 15 feet from the area. This line should be marked with tape where practicable. The area within the hot line is considered the Exclusion Zone.

3.2 CONTAMINATION REDUCTION ZONE

If the SSC determines that site conditions warrant a Contamination Reduction Zone (CRZ), this zone will be established adjacent to the exclusion zone. A corridor will be established for personnel decontamination stations where PPE will be doffed. All disposable PPE will be placed in plastic bags. Other PPE, such as respirators, rubber boots, and hardhats, will be cleaned with an appropriate cleaning solution (such as Alconox with water). Separate corridors within the CRZ will be established for decontamination of portable field equipment and excavation equipment.

3.3 SUPPORT ZONE

A support zone will be established for personnel not directly involved in the excavation and sampling operation. This zone will be established adjacent to the CRZ, with line of site to all Exclusion Zone activities.

3.4 EXPOSURE MONITORING PLAN

Exposure monitoring will be conducted with a direct reading instrument (photoionization detector). Additional personal monitoring may be conducted at the discretion of the SSC.

3.5 EQUIPMENT LIST SUMMARY

Following is a list of equipment to be used at the site:

Activity	Equipment to be Used
Exposure Monitoring	Photoionization detector
Sampling: Water	Water level meter
	Peristaltic pump
	Equipment decontamination materials
Sampling: Soil	Photoionization detector

3.6 SITE SECURITY

Unauthorized persons shall not be allowed in the work zone at any time. Unauthorized persons are those without appropriate training, without proof of medical surveillance, or with no business on the site.

3.7 TRAINING

Certificates of completion of a 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training course will be maintained at AMEC's Bothell office, included in Appendix F, and available to regulatory personnel upon request. All personnel shall carry current 40-hour HAZWOPER training cards while working on site. The SSC shall be first aid and CPR trained.

3.8 MEDICAL SURVEILLANCE

Evidence of a current physical examination in the form of a letter from an examining physician will be maintained at AMEC's Bothell office and will be available to regulatory personnel upon request.

3.9 DESCRIPTION OF FORMS

3.9.1 Tailgate Safety Meeting Form

The content of this plan will be discussed in detail at the beginning of each new site activity with all site personnel during an initial safety meeting held at the site. At the start of each day, a tailgate safety meeting will be conducted to review the tasks planned for the day and any special procedures that may be employed. The SSC shall document attendance at all of these meetings and record the important subjects discussed at each meeting (Appendix B).

3.9.2 Acknowledgement Form

All site personnel will be expected to sign an acknowledgement form indicating that they have read and understand the Health and Safety Plan (Appendix C).

3.9.3 Site Visitor Log

Only authorized persons are allowed onsite. All visitors that have been authorized by the Project Manager or the SSC are to log in and out using the Site Visitor Log (Appendix D).

4.0 DRIVING DIRECTIONS TO HARBORVIEW MEDICAL CENTER

Starting from: A 8801 East Marginal Way South, Seattle, WA

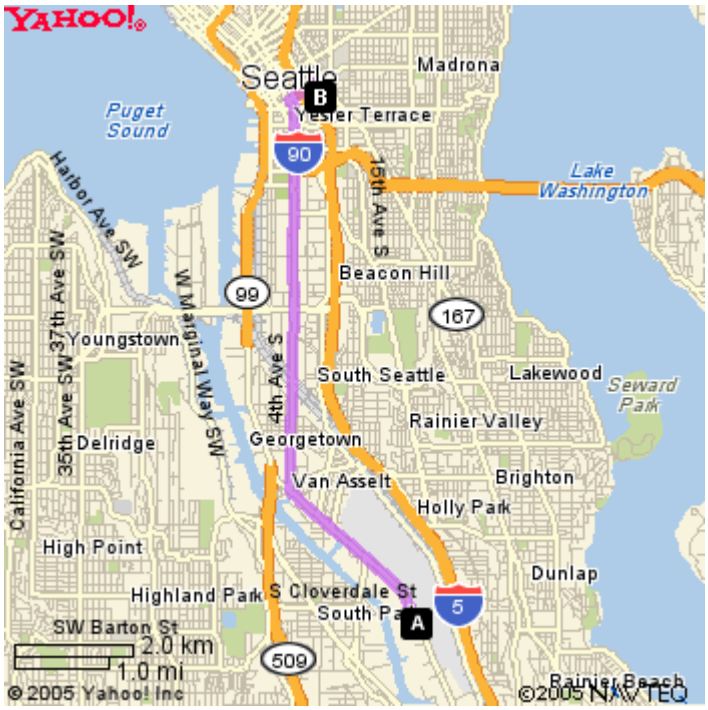
Arriving at: B Harborview Medical Center
325 9th Avenue, Seattle, WA 98104-2420 (206) 731-3000

Distance: 6.5 miles **Approximate Travel Time:** 14 mins

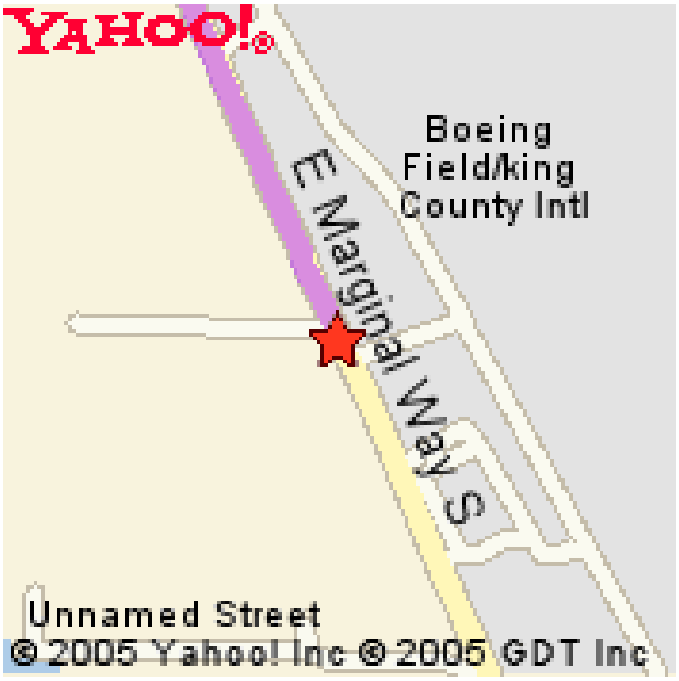
Your Directions

1. Start at **8801 EAST MARGINAL WAY SOUTH** - go **1.9** mi
2. Turn R on **4TH AVENUE** - go **4.2** mi
3. Turn R on **JAMES STREET** - go **0.3** mi
4. Turn R on **9TH AVENUE** - go **0.2** mi
5. Arrive at **HARBORVIEW MEDICAL CENTER,** on the R

Map Overview



Start Point: 8801 East Marginal Way South, Seattle, WA



End Point: 925 9th Avenue, Seattle, WA 98104-2420

APPENDIX C.1

Injury/Accident Form

INJURY/ACCIDENT FORM

Date of Report: _____ Report Completed by: _____

Date of Injury/Incident: _____

Description of the Injury/Incident: (time, location, event, description of injuries): _____

_____

_____

_____

_____

Name of Injured Person: _____ Employer: _____

Name of First Aid Provider(s): _____

Social Security Number: _____

Bloodborne Pathogen Exposure Incident Evaluation: _____

1. Was the First Aid Responder exposed to blood or other potentially infectious materials?
   - ☐ Exposure Occurred (see question 2)
   - ☐ No Exposure

2. Exposure occurred by contact with the following (check all that apply):
   - ☐ Eye
   - ☐ Mouth
   - ☐ Other Mucous Membrane
   - ☐ Broken Skin (cuts, abrasions)
   - ☐ Needle stick
   - ☐ Human Bite

Exposure Control Precautions Taken (check all that apply):
- ☐ None (contact SHE Coordinator or Corporate SHE Director)
- ☐ Glove
- ☐ Face Mask
- ☐ One-way CPR Valve
- ☐ Eye Protection
- ☐ Immediate Personal Hygiene
- ☐ Previous HBV Immunization
- ☐ Recommended for HBV Immunization
- ☐ Other _____

Please attach this completed form with the Supervisor's Report of Injury or Illness, and the Accident/First Aid Incident Summary Log, and forward to Human Resources, your SHE Coordinator, and the Corporate SHE Director.

Additional Information

NOTE: The information requested below is important for complete documentation of a reported occupational injury or illness.

ACCIDENT/INCIDENT INFORMATION		
To whom was the injury reported?	Injured worker's shift times: START ____ AM ____ PM | END ____ AM ____ PM	
Is the accident/incident questionable to the supervisor? ☐ YES ☐ NO	Were there any signs of the involvement of drugs or alcohol? ☐ YES ☐ NO ☐ Unknown	
Was the employee permanently disabled as a result of the accident/incident?	If accident resulted in a fatality, date of death: ☐ NA Date:	
Last date worked and time employee left work:	First day missed:	Number of days employee is expected to miss (if applicable):
Has the employee returned to work? ☐ YES, date: ☐ NO, expected return date:		
ACCIDENT INVESTIGATION INFORMATION		
Was any safety equipment provided? If yes, was it used?		
Was a third party responsible for the accident/incident? If yes, list name, address, and phone number:		
MEDICAL CARE PROVIDER INFORMATION		
Was first aid administered on-site? ☐ YES, describe: ☐ NO		
Name of clinic and/or doctor employee saw (include address, city, state, zip code, and phone number):		
If applicable, name of hospital employee was taken to (include address, city, state, zip code, and phone number):		
Was the employee admitted to the hospital? ☐ YES, date: ☐ NO		
Was the employee treated as an outpatient, receive emergency treatment, or ambulance service?		
Supervisor's Name: *(please print)*	Supervisor's Signature:	Date:

APPENDIX C.2

Exposure Monitoring Form

EMPLOYEE EXPOSURE RECORD

Complete the following after completing this phase of work. Return this page to the AMEC Health and Safety Coordinator.

Project Name:_____
Project Number:_____
Project Location:_____
Dates This Phase of Work Conducted:_____

Hazardous Substances Present on-site and highest concentrations present in water and soil, if available:

Employee Name	Total Hours on-site	Hazardous Substances Present in Work Area	Contact with Soil and or water?

APPENDIX C.3

Tailgate Safety Meeting Form

TAILGATE SAFETY MEETING FORM

Check One:

☐ Initial Kickoff Safety Meeting ☐ Regular/Daily Tailgate Safety Meeting ☐ Unscheduled Tailgate Safety Meeting

Date: _____ Site: _____

Field Manager: _____ Site Health and Safety Coordinator: _____
(Print) *(Print)*

Order of Business

Topics Discussed (check all that apply):

- ☐ Site History/Site Layout
- ☐ Scope of Work
- ☐ Personnel Responsibilities
- ☐ Medical Surveillance Requirements
- ☐ Training Requirements
- ☐ Safe Work Practices
- ☐ Logs, Reports, Recordkeeping
- ☐ Sanitation and Illumination
- ☐ Air Surveillance Type and Frequency
- ☐ Monitoring Instruments and Personal Monitoring
- ☐ Action Levels
- ☐ Accident Reporting Procedures
- ☐ Site Control (visitor access, buddy system, work zones, security, communications)
- ☐ Discussion of previous "near misses" including work crew suggestions to correct work practices to avoid similar occurrences
- ☐ Engineering Controls
- ☐ PPE Required/PPE Used
- ☐ Define PPE Levels, Donning, Doffing Procedures
- ☐ Physical Hazards and Controls (e.g., overhead utility lines)
- ☐ Decontamination Procedures for Personnel and Equipment
- ☐ General Emergency Procedures (e.g., locations of air horns and what 1 or 2 blasts indicate)
- ☐ Site/Regional Emergency Procedures (e.g., earthquake response, typhoon response, etc.)
- ☐ Medical Emergency Response Procedures (e.g., exposure control precautions, location of first aid kit, etc.)
- ☐ Hazardous Materials Spill Procedures
- ☐ Applicable SOPs (e.g., Hearing Conservation Program, Safe Driving, etc.)
- ☐ Injury/Illness Reporting Procedures
- ☐ Route to Hospital and Medical Care Provider Visit Guidelines
- ☐ Hazard Analysis of Work Tasks (chemical, physical, biological and energy health hazards and effects)

Safety suggestions by site workers: _____

_____

_____

Action taken on previous suggestions: _____

_____

_____

Injuries/accidents/personnel changes since previous meeting: _____

_____

_____

TAILGATE SAFETY MEETING REPORT *(continued)*

Observations of unsafe work practices/conditions that have developed since previous meeting:

Location of (or changes in the locations of) evacuation routes/safe refuge areas:

Additional comments:

Attendee signatures below indicate acknowledgment of the information and willingness to abide by the procedures discussed during this safety meeting.

	Name *(print)*	Company Signature

Meeting conducted by: Title:
(Print)

Signature: Time:

APPENDIX C.4

Acknowledgement Form

ACKNOWLEDGEMENT FORM

I have read; I understand; and I will abide by the rules established in the Health and Safety Plan.

SIGNATURE DATE

SEPARATE SAFETY PLAN(S)

APPENDIX C.5

Site Visitor Log

SITE VISITOR LOG

Date	Name	Company	Signature	Time In	Time Out

APPENDIX C.6

Hazwoper Certificates for Site Workers

THE NATIONAL ENVIRONMENTAL TRAINERS

Anastasia Speransky

has satisfactorily passed an exam and completed an 8-hour annual refresher training course entitled

Hazardous Waste Operations and Emergency Response

meeting the requirements identified in Title 29 CFR 1910.120.

This course has been awarded 1.34 Industrial Hygiene CM Points by the American Board of Industrial Hygiene-Approval Number 13334. This course is also eligible for .66 Continuance of Certification (COC) points from the Board of Certified Safety Professionals

NATIONAL ENVIRONMENTAL TRAINERS, Inc.

July 10, 2010

Course Number 1001, Awarded 8 PDH's
Florida Board of Professional Engineers
CEU Provider Number 0004284

www.nationalenvironmentaltrainers.com

Signature of Instructor

Clay A. Bednarz, MS, RPIH

Compliance Solutions

"Today's Training... Tomorrow's Solution"

3980 Quebec St, 2nd Floor Denver, CO 80207-1633 800-711-2706

Student Affiliation:

AMEC Earth & Environmental

200901828

Certificate of Completion

This is to certify that

Joseph Petrick

has been tested and successfully meets the training requirements for

8-Hour HAZWOPER Refresher

29 CFR 1910.120(e)

Presented

Friday, April 15, 2011

Compliance Solutions Occupational Trainers, Inc.

Certificate Number: 754817505

Neval Gupta

Vice President

Jeffrey Kline

President/CEO