REDACTED VERSION

Facility Investigation Workplan

Cedar Chemical Corporation Facility
Helena - West Helena, Arkansas

Prepared for:

Exxon Mobil Corporation and Helena Chemical Company

January 2008

Project No. 13636

Geomatrix

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GEOLOGY REGISTRATION STATE OF ARKANSAS

Geomatrix Consultants, Inc., has submitted an application for a temporary permit to practice geology in the state of Arkansas. According to A.C.A. 17-32-302(B)(i-ii), we may practice until the Arkansas Board or Registration has had an opportunity to review and make a decision on our application. If you have any questions regarding this clause or our application, please contact Ms. Connie Raper, Business Controller with the Board of Registration for Professional Geologist in Arkansas. She may be reached by calling 501.683.0150 or by email at connie.raper@arkansas.gov.

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Prepared for:

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Prepared by:

Geomatrix Consultants, Inc.
5725 Highway. 290 West, Suite 200B
Austin, Texas 78735

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FIELD INVESTIGATION WORKPLAN
CEDAR CHEMICAL COMPANY, HELENA -WEST HELENA, ARKANSAS

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FIELD INVESTIGATION WORKPLAN
CEDAR CHEMICAL COMPANY, HELENA -WEST HELENA, ARKANSAS

1.0 INTRODUCTION

On March 22, 2007, the Arkansas Department of Environmental Quality (ADEQ) issued a Consent Administrative Order (CAO) to Ansul Incorporated, formerly known as Wormald US, Inc., Helena Chemical Company, and Exxon Mobil Chemical Co., a division of Exxon Mobil Corporation, pursuant to the authority of the Arkansas Remedial Action Trust Fund Act ("RATFA"). The subject of the CAO is Cedar Chemical Corporation ("the Facility") located in Helena-West Helena, Phillips County, Arkansas. Pursuant to Paragraph V. 20 of the CAO, ADEQ, Helena Chemical Company, and Exxon Mobil Chemical Co. entered into a separate agreement which provides that further site investigation should be performed.

On November 16, 2007, a Current Conditions Report (CCR) was submitted to ADEQ on behalf of Exxon Mobil Chemical Co. and Helena Chemical Company, which comprise the current membership of the Cedar Chemical Corporation Site Joint Defense Group ("the Group"). An electronic copy of this CCR has been provided for reference with this FI Workplan. This CCR was prepared to compile existing and available information concerning the Facility, its setting, and known impacts to environmental media. Although extensive investigative work has previously been performed at the site, and the overall character and extent of environmental impact is generally understood, the CCR concluded that the on-site and off-site extents of impact to soil and groundwater have not been completely delineated, on-site source areas have not been fully characterized, and that additional information is needed to support effective remedy selection. Geomatrix Consultants, Inc., (Geomatrix) has prepared this FI Workplan to address the supplemental data needs.

In summary the data needs, and the work planned to address these, are as follows:

- Perched Zone Hydrogeology – extent and thickness, seasonal variability, groundwater flow velocity, and hydraulic conductivity. Address through:
  - Monitoring well installation in the perched zone using hollow-stem auger drilling methods, water level measurements, and aquifer testing.
- Alluvial Aquifer Hydrogeology –groundwater flow velocity, hydraulic conductivity, presence of highly transmissive natural features, and basic geochemical properties of the alluvial aquifer. Address through:
  - Cone penetrometer testing (CPT), monitoring well installation using sonic drilling methods, water level measurements, and aquifer testing.

- Chemical Impact to Perched Zone and Alluvial Aquifer Groundwater – further assessment of the source, character, and extent of chemical impact in the two groundwater zones. Address through:

  - Groundwater sampling and analysis of new and existing wells for constituents of concern (COCs).

- Waste Disposal Areas – further delineation of the extent of waste remaining on site that may be behaving as a source of groundwater contamination and of current concentrations in soil and groundwater adjacent to waste disposal areas. Address through:

  - Soil borings advanced using direct-push technology (DPT), soil sampling, field screening and analysis for COCs.

- Exposure Pathways – potential for the current or future groundwater use within and near to COC groundwater plumes. Address through:

  - Confirmation of residential and agricultural well survey, update the understanding of land use in site vicinity.

These activities are described in greater detail in Section 3 of this FI Workplan. Various figures showing the locations of soil borings to evaluate the contaminants at the former dinoseb disposal ponds, process area, the drum vault, and wells for the perched zone extent investigation are included in this workplan.

2.0 SITE DESCRIPTION

A full site description was presented in the November 2007 CCR. A brief summary of this information is provided below.

2.1 SITE LOCATION AND SETTING

The former Cedar Chemical Corporation (CCC) Helena-West Helena Plant is located just to the south of the city of Helena-West Helena, in Phillips County, Arkansas. The Facility consists of approximately 48 acres located within the Helena-West Helena Industrial Park, approximately 1.25 miles southwest of the intersection of U.S. Highway 49 and State Highway 242. A site location map is included as Figure 1.

The former operational portion of the property is divided into two major areas: (1) the manufacturing area, to the north of Industrial Park Road, and (2) the wastewater treatment system area, to the south of Industrial Park Road. Of the 48 acres, approximately 40 acres comprise the former manufacturing area of the facility, and are fenced. The remaining 8 acres contain the wastewater treatment ponds.

2.2 PHYSIOGRAPHY AND TOPOGRAPHY

The topography of the terrain at the site and surrounding area is relatively flat, with some areas sloping gently toward the southeast. The Facility is located on a gentle drainage divide; to the north and west, regional surface water flow is generally southwest, connecting through a series of ditches, creeks, and bayous to the White River approximately 50 miles to the southwest. To the south and east, regional surface water flow is generally toward the Mississippi River.

2.3 GEOLOGY AND HYDROGEOLOGY

The shallow geology of the Site comprises approximately 150 feet of alluvium overlying a thick sequence of clays (the Jackson Group). The clays of the Jackson Group are approximately 250 feet thick in this area, and comprise a regional confining layer over the Sparta Sand aquifer.

Geologic cross sections were developed for the Site; their locations are shown in Figure 2, and the cross sections are shown in Figures 3 and 4. A 1993 Facility Investigation identified five stratigraphic units within the Quarternary alluvium and underlying clay at the site (EnSafe, 1996(a)).

1. Unit 1 extends from ground surface to approximately 32 feet below ground surface (bgs) and consists of silts, clays and sands. Unit 1 includes a perched groundwater-bearing zone referred to as the perched zone.

2. Unit 2 extends from approximately 32 to 47 feet bgs, and consists of clays and silts. Unit 2 is referred to as the semi-confining unit.

3. Unit 3 extends from 47 to 116 feet bgs, and consists of a sand and gravel sequence that coarsens with depth and clay stringers. Unit 3 corresponds to the upper portion of the alluvial aquifer.

4. Unit 4 extends from 116 to 131 feet bgs, and consists of clay. Unit 4 is the middle section of the alluvial aquifer.

5. Unit 5 extends from 131 to 152 feet bgs, and consists of sand and gravel. Unit 5 is the lower section of the alluvial aquifer, and overlies the regional confining layer (Jackson Clay).

Two groundwater regimes exist at the site: a discontinuous perched zone in the Unit 1 silt and clay surficial sediments (ground surface to 32 feet bgs) and the alluvial aquifer. The alluvial aquifer, as discussed above, consists of an upper unit (Unit 3 from the discussion above) at approximately 47 to 116 feet bgs, and a lower unit (Unit 5) at approximately 131 to 152 feet bgs. The two are separated by a silty clay stratum (Unit 4). Locally, the alluvial aquifer appears to be confined by the upper 40 feet of silt and clays (Units 1 and 2). The alluvial aquifer overlies the Jackson Group stratum of clay and lignite materials at approximately 150 feet bgs.

2.4 SITE HISTORY

Prior to 1970, the land where the site now exists was used for agriculture purposes (EnSafe, 1996). The plant was constructed in the early 1970s, and operated by a number of parties until its closure under bankruptcy in 2002. ADEQ assumed control of the site on October 12, 2002.

During its operational life, the Facility manufactured various agricultural chemicals, including insecticides, herbicides, polymers, and organic intermediates. Plant processes were batch operations, with seasonal production fluctuations and the frequent introduction of new products. The plant also produced a variety of chemicals on a toll manufacturing basis for a number of customers.

Several previous investigations of the Site were completed between 1985 and 2002. These investigations are documented in previous reports and outlined in detail in the CCR (Geomatrix, 2007).

3.0 FIELD INVESTIGATION APPROACH

The following sections describe the investigation procedures that will be followed by field personnel during the implementation of the FI Workplan. Sampling and investigation procedures will follow currently accepted industry-standard practices and applicable regulatory guidance; selected specific procedures are described in detail below or in the Quality Assurance Project Plan (QAPP) located in Appendix A. The QAPP provides detailed information on the project description, project organization and responsibility, data quality assurance objectives, field sampling plans, sample custody procedures, field equipment calibration procedures, analytical procedures, and data validation and reporting. All Geomatrix field activities will also be performed pursuant to the Project Health and Safety Plan, included as Appendix B of this FI Work Plan.

3.1 PERCHED ZONE WELL INSTALLATION

Figure 5 shows the estimated extent of the perched zone based on historical data. Additional wells will be installed in the perched zone at the locations shown in Figure 5 to further delineate the extent and continuity of this zone. Additional locations may be added, at the discretion of the Geomatrix Project Manager, based on initial drilling results. Initial drilling results (for example, a dry well) may also suggest that a proposed well location is not suitable to address the investigation objectives. In this event, field personnel may elect not to install a well at a location shown on Figure 5, with the approval of the Geomatrix Project Manager, in consultation with the ADEQ Project Manager.

A typical well construction diagram for the perched zone wells is included as Figure 6. Although final drilling and construction details may be modified to account for observed conditions in the field, the anticipated general approach is as follows:

- Rotosonic drilling techniques will be used for drilling and well installation. This method generates a relatively continuous soil core as the drive casing is advanced.
- The soil core will be field screened and logged by an on-site field geologist. Screening will consist of chemical odors, or organic vapors. This will also include a headspace check using a field organic vapor meter. At least one sample from each 10-foot interval will undergo a headspace examination.
- If gross contamination, such as non-aqueous phase 1iquid (NAPL) or waste is encountered, a sample of this material will be retained for off-site analysis. Otherwise, soil samples from these borings will not be retained.

- The well will be constructed within the rotasonic drive casing. The filter pack and bentonite seal will be surface poured into the casing in increments, as the casing is gradually withdrawn. The depth to these materials will be regularly sounded with a weighted measuring tape as the casing is withdrawn.

- The base of the screen will be placed at approximately the upper surface of the Unit 2 clay confining layer. This is anticipated to be at a depth of approximately 30 to 35 feet below ground surface (bgs).

- After the bentonite seal has hydrated, the remaining annular space will be sealed with a cement-bentonite grout mix. Unless the annulus is dry, the grout will be placed through a tremie pipe; the discharge of this tremie pipe will be placed approximately two feet above the top of the bentonite seal. Grout returns will be observed, and the density of these returns must be within 10 percent of the original grout density before grouting is terminated. A sample of grout will be retained for each well.

Any boring not used for well installation will be sealed using bentonite chips or a bentonite-cement grout. Bentonite chips will only be used to seal the portion of borings within the saturated zone, or to top off the upper few feet of a grouted boring.

3.2 ALLUVIAL AQUIFER INVESTIGATION

Additional wells will be installed in order to complete the delineation of chemical impact in the alluvial aquifer, and to further characterize the hydraulic and geochemical nature of that aquifer. The locations and anticipated depths of alluvial aquifer wells will be based on the results of the CPT investigation and the January 2008 groundwater sampling event described in Sections 3.3 and 3.7, respectively. of this FI Work Plan. Proposed locations will be submitted to ADEQ after data acquisition from these two tasks has been completed. Typical well construction details for alluvial aquifer wells are shown in Figure 7. The general well installation procedures will follow those outlined in Section 3.1.

3.3 CONE PENETROMETER TESTING (CPT)

A CPT investigation will be performed to identify transmissive zones that may act as preferential migration pathways in the alluvial aquifer, and to improve the geologic characterization of this aquifer. The locations of the CPT borings are presented on Figure 8. The CPT methods are described below:

- At each location, a CPT rig will be used to advance a borehole to approximately 5 feet below the base of the alluvial aquifer at an approximate depth of 152 feet bgs, or refusal, whichever is shallower. As it is advanced, the CPT will generate a

continuous record of cone tip resistance and friction sleeve resistance. These will be correlated to known soil types, to generate a lithologic boring log.

- After reaching the total depth of the boring, the CPT probe will be removed and the boring will be sealed with bentonite-cement or bentonite grout.

Additional CPT borings may be added, at the discretion of the Geomatrix Project Manager, based on the findings from the CPT and other drilling work described in this FI Work Plan. At least two of the alluvial aquifer borings described in Section 3.2 of this FI Work Plan will be co-located with CPT borings, to allow confirmation of the lithologic interpretation generated from the CPT borings.

3.4 DIRECT PUSH BORINGS

Soil borings will be advanced using direct push technology (DPT) at background locations and in the areas of the former dinoseb disposal ponds, the drum vault, and the process areas, in order to:

- Identify and characterize possible waste or waste constituent migration from the drum vault.
- Locate the former dinoseb disposal ponds.
- Characterize soil impact at the various process area locations.
- Improve the characterization of background levels of metals, pesticides, and herbicides in surface and subsurface soils.

The boring locations are presented on Figure 9 for the drum vault and former dinoseb disposal ponds, Figure 10 for the process areas, and Figure 11 for the background locations. The DPT methodology is described below.

- DPT borings will be advanced to a depth of:
  - approximately 10 feet bgs in the area of the former dinoseb disposal ponds.
  - the shallower of 30 feet bgs or refusal at the periphery of the drum vault and at the process areas.
  - approximately 15 feet at the background sample locations.

- Each core will be logged and field screened in the field by the on-site field geologist as described in Section 3.1.

- At the former dinoseb disposal ponds, one soil sample per boring from a nominal depth of 3 to 5 feet will be retained and analyzed for pesticides and herbicides.

- In the area of the drum vault, at least one sample per boring from a nominal depth range of 0 to 5 feet below the vault's base, as observed from the evaluation described in Section 3.5 will be retained for off-site analysis. If that evaluation does not provide an accurate measure of the vault's depth, Geomatrix may excavate in selected locations around the vault's perimeter to determine that depth.Additional samples may be retained if waste materials or other evidence of gross contamination is observed.

- At the process areas, at least one sample per boring will be retained for off-site analysis, from a nominal depth range of 0 to 5 feet. Additional samples may be retained from other depths based on field observations.

- At background locations, one sample of surface (0 to 5 ft bgs) and subsurface (below 5 ft bgs) soils will be retained for analysis for pesticides/herbicides and metals.

- All DPT borings will be sealed using bentonite-cement or bentonite grout.

Additional borings may be advanced at each location at the discretion of the Geomatrix Project Manager, based on the results of this initial drilling. Also, since background boring locations are off site, their performance and schedule will be subject to access negotiation with the respective property owners.

3.5 DRUM VAULT INSPECTION

Geomatrix will identify and collect available information regarding the history of the construction and contents of the drum vault from historical sources and ADEQ files. Thereafter, Geomatrix will conduct an initial field evaluation ofthe conditions of drums within the vault, and the floor, walls, and backfill material of the vault itself. Geomatrix anticipates this initial field evaluation will include the following:

- Nominal 1-inch diameter borings will be drilled though the concrete warehouse floor which forms the roof of vault. One boring will be drilled in each quadrant of the vault. Borings will be drilled with the addition of water to the boring, to maintain wet conditions and prevent possible sparking.

- When the borings have penetrated into the vault, drilling will be terminated, and any residual water will be removed.

- The atmosphere of the vault will be tested for explosive conditions and organic vapors at each boring location. The borings will also allow the measurement of the approximate concrete thickness.

- If measured conditions indicate the presence of a significant hazard (i.e., toxic or explosive conditions), the borings will be sealed and an alternate plan of evaluation will be developed to address these conditions.

- If no such hazard is observed, concrete will be saw-cut at each boring location, to remove a concrete slab at least approximately 4 feet square.

- After slab removal, conditions within the vault will be visually inspected at each location, including drum construction, packing, and condition. If practicable, one or more drums may be opened or removed, and the contents inspected and sampled.

- At least one sample of the backfill material will be collected for off-site analysis at each entry location. The specific location, depth, and method of collection of these samples will be based on observed field conditions.

To the extent practicable, the condition of the floor and walls of the vault will be visually inspected at each location. Field personnel will photograph the entry and evaluation process at each location. At the conclusion of the visual inspection, the openings in the vault will be covered and temporarily sealed, pending decisions on the ultimate fate of the vault and contents. This approach may be modified or supplemented in advance of field mobilization as additional information on the vault is acquired. Any proposed modifications or additions will be provided in writing to ADEQ for approval prior to performance of the work.

3.6 SOIL SAMPLING

The anticipated soil sampling program is described for each drilling method in the preceding sections. Soil samples retained for off-site analysis will be managed as described in the QAPP provided in Appendix A.

3.7 GROUNDWATER SAMPLING

As discussed with ADEQ on December 4, 2007, Geomatrix and ADEQ personnel are currently performing a baseline groundwater sampling event of existing on-site wells. This event is anticipated to be completed by January 18, 2008, and will be performed pursuant to a Sampling and Analysis Plan submitted to the ADEQ in December 2007. During the sampling event an

assessment of the construction of selected wells using a downhole camera will be performed for which no construction details (particularly the screened interval) are available.

The data from this event will be used to update Geomatrix's understanding of groundwater conditions, and to guide the placement of new monitoring wells in the alluvial aquifer. Upon completion of the January 2008 baseline groundwater sampling event and evaluation of the data, a Supplemental FI Workplan will be submitted to ADEQ, identifying additional monitoring well locations.

Groundwater will also be sampled at new and existing wells upon completion of the FI well installation program.

As discussed in the QAPP, the preferred method for purging and sampling will be the low-flow (a.k.a., micopurge) approach. The methods for well measurements, purging, and sampling are discussed in the QAPP.

3.8 SAMPLE ANALYSIS

Samples of environmental media, including soils and groundwater, will be analyzed by an off-site laboratory certified by the State of Arkansas. The analytical methods are described in the QAPP included as Appendix A. Table 1 of the QAPP provides a Target Analyte List of individual compounds to be analyzed under each parameter group (i.e., metals, volatile organic compounds). Table 1 of this FI Workplan more specifically provides areas of investigation, media to be collected and constituents to be analyzed.

Table 1
Areas of Investigation, Media and Sample Collection Detail

	Media	Constituents to be Analyzed	
Perched Zone Well Installation	Soil	VOCs, SVOCs, Metals, Herbicides, Pesticides	if retained
	Groundwater	VOCs, SVOCs, Metals, Herbicides, Pesticides	
Alluvial Aquifer Investigation	Soil	VOCs, SVOCs, Metals, Herbicides, Pesticides	if retained
	Groundwater	VOCs, SVOCs, Metals, Herbicides, Pesticides	
Cone Penetrometer Testing (CPT)	None	None	
Direct Push Borings			
Dinoseb Disposal Ponds	Soil	Pesticides and Herbicides	
Drum Vault	Soil	VOCs, SVOCs, Metals, Herbicides, Pesticides	
Process Area	Soil	VOCs, SVOCs, Metals, Herbicides, Pesticides	
Background Locations	Soil	Pesticides and Herbicides, Metals	
Drum vault--drum contents & backfill	Solids	To be determined	

3.9 LAND USE AND SUPPLY WELL SURVEY

The CCR presented information on a previous water well survey conducted in 1995 by EnSafe. Several of the residences are located within a one-mile radius of the site, primarily along Phillips County Road 300. This survey identified nineteen residences downgradient or cross-gradient from the Site with wells that formerly supplied residences with domestic water. All of the residences, however, had reportedly been connected to the city water system for over 10 years at the time of the survey.

In order to update the well survey, Geomatrix will identify all residences and businesses within one mile downgradient (southeast) of the site. A request for information on well status will be mailed to each identified residence or business. If a well is present, Geomatrix will request permission from the property owner to inspect and possibly sample the well. All information will be recorded in the field log book.

In addition, a current aerial photograph will be flown, encompassing the well survey discussed above, and the surrounding area to a distance of at least 0.5 miles upgradient and to either side of the site cross gradient and one mile downgradient (all distances from the site boundary) of the site. A windshield survey will be performed to update a land use description for all properties within this area.

3.10 WELL ABANDONMENT

If monitoring wells are identified that are not suitable for future use, Geomatrix will propose their abandonment to ADEQ. The basis for this recommendation could be any of the following:

- Well location or depth is not likely to yield useful data.
- Well construction or condition does not meet current industry standards, and could behave as a pathway for contaminant migration into the subsurface or between water-bearing zones.
- Well construction cannot be verified.

Wells subject to this recommendation will not be sampled.

If the ADEQ concurs that any well should be abandoned, Geomatrix will perform this as follows:

- For wells that are completed within a single water-bearing zone, and for which reliable construction information is available, the well will be filled to the surface with bentonite

or bentonite-cement grout, and the surface completion and upper five feet of well casing will be removed.

- For wells that may span more than one water-bearing zone, or for which reliable construction information is not available, the well will be overdrilled with hollow-stem augers or rotasonic methods to at least the depth of the deepest water-bearing zone. The well materials will be removed from the boring, and the boring will be sealed with bentonite, or with bentonite-cement or cement grout.

3.11 HISTORICAL DATA VALIDATION

During previous investigations at the site, acetone and methylene chloride were detected in on-site soil. It is not known to what extent these constituents are actually present in soil as opposed to being a sampling or laboratory artifact. Historical data including field and laboratory methods will be reviewed and validated to assess the quality of these acetone and methylene chloride detections. Data validation will include:

- Review of the distribution of these compounds in soil samples.
- Review of laboratory and field quality control (QC) data (e.g., the presence of these compounds in blanks) and
- If available, review of facility laboratory records to determine if the laboratory operating before the facility shutdown handled or used these compounds.

3.12 AQUIFER TESTING

Aquifer testing will be performed on selected new and existing wells in both the perched and alluvial aquifers. After the installation of new wells, development, and sampling, five wells in each aquifer will be selected for step-drawdown or slug testing. Test locations will be selected by the Geomatrix Project Manager after the completion of the well installation activities. The objective of aquifer testing is to evaluate the flow regimes of both aquifers, including an evaluation of aquifer properties such as transmissivity (T), hydraulic conductivity (K), and radius of influence. Depending on the well recovery observed during the January 2008 groundwater sampling event, either a step-drawdown pumping test (if wells recover quickly) or a slug test will be performed. Aquifer test data will be analyzed by use of the mathematical methods Theis (1935), Cooper-Jacob (1946), and Bouwer & Rice (1976).

Each test method is described below.

3.12.1 Step-Drawdown Testing

The pumping phase of the step-drawdown test will consist of:

1. Initial measurements of water level in the pumping and observation wells.
2. Pumping the well at least five different rates (steps) specified by the responsible professional with an approximate duration of one hour per step. If practicable, the well will be allowed to recover to near-static conditions between steps.
3. Periodically measuring the water levels in the pumped well and observation wells, if available during each step;
4. Measuring the instantaneous and cumulative discharge from the pumped well using a flow meter or other appropriate means.

The maximum water-level drawdown will be approximately 50 percent of the available drawdown. A relatively constant pumping rate will be maintained during each step. The rate will be checked periodically and adjusted, if necessary. The accuracy of the flow meter also may be verified periodically by comparing the flow rate obtained by timing a revolution of the sweep needle on the flow meter with the flow rate obtained by timing the filling of a container of known volume.

The recovery phase of the step-drawdown test will begin immediately after the pump is shut off, at the completion of the final step of the pumping phase. Recovery water-level measurements will be made periodically in the pumped well and observation wells. Water level measurements will conclude when one of the following is satisfied:

- 95 percent of the induced drawdown has recovered; or
- The water level in the pumped well has changed less than 0.05 foot for at least 2 hours.

3.12.2 Slug Testing

This procedure describes the performance of slug tests for evaluating the hydraulic characteristics of the aquifer. The following procedures will be used to perform the slug test.

- The static water level will be measured in the test well. This information will input into the data logger along with the well identification, date and other information as required.

- A pressure transducer and cable will be lowered into the well to a depth of at least 10 feet below the water surface. If water levels in the well prohibit this depth of submergence, the transducer will be placed at the bottom of the well.
- The slug dimension will be measured and its volume calculated. The slug will then be placed into the well and the water level will be allowed to return to its static level.
- The slug will simultaneously be withdrawn and the data logger will be activated. Slug withdrawl will be rapid, with the slug emerging completely within 2 to 4 seconds of the test start.
- The test will be continued until the water level recovers to about 70 percent of the initial level.

3.13 WELL SURVEYING

A licensed surveyor in the State of Arkansas will be retained to survey the top of casing, location and ground and elevation of each new and existing well in the monitoring network in order to obtain current coordinates that will be used to develop accurate water level measurements relative to mean sea level.

3.14 INVESTIGATION-DERIVED WASTE (IDW) MANAGEMENT

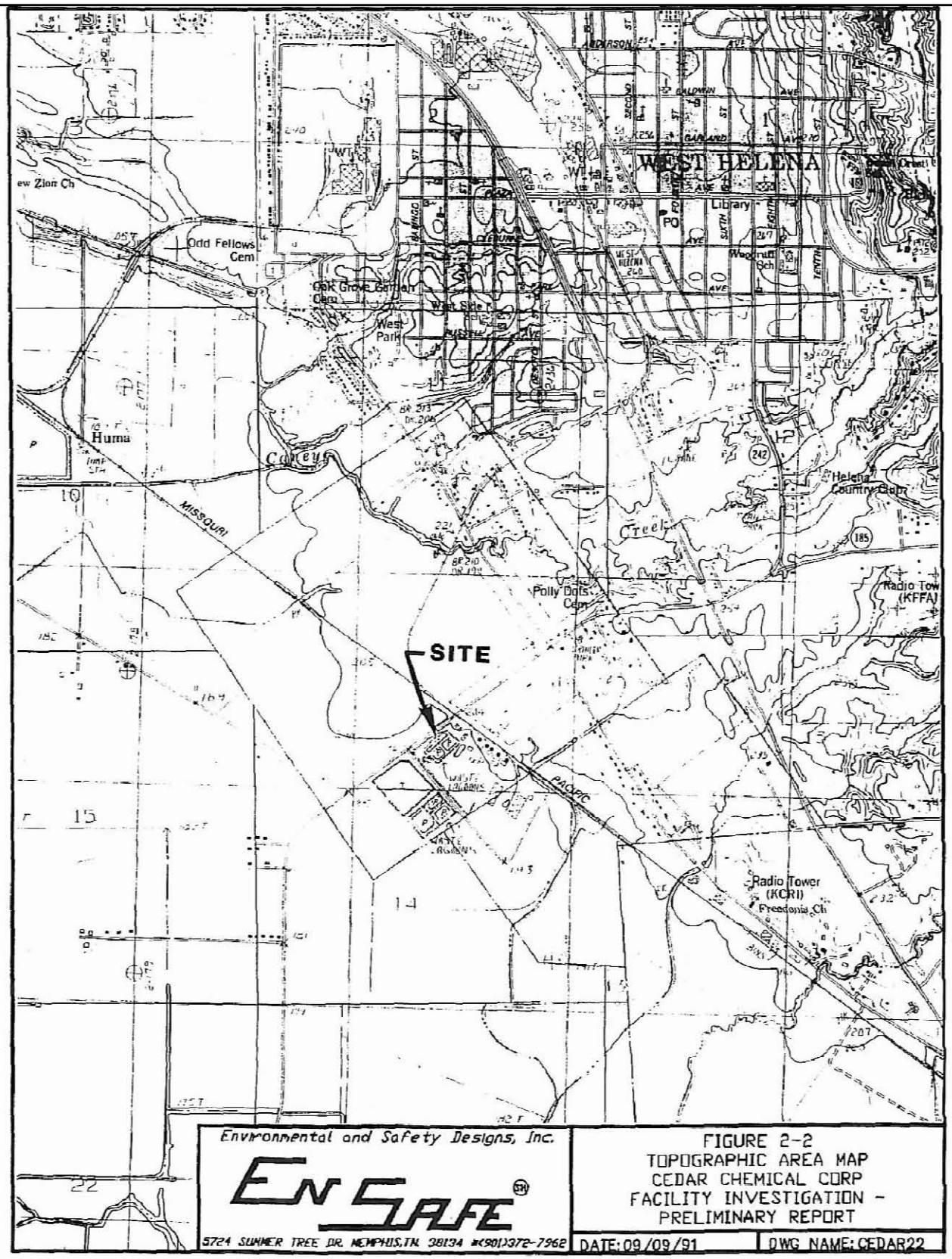
Soil cuttings generated during the investigation will be placed into a roll-off box pending characterization and water generated will be placed into storage tanks pending characterization as hazardous vs. non-hazardous. Non-hazardous soil will be disposed of at an appropriate landfill. Non hazardous water will be placed into the on-site wastewater treatment ponds, with ADEQ's approval. All hazardous waste will be managed and disposed according to applicable state and federal requirements.

4.0 FIELD INVESTIGATION SCHEDULE

The anticipated schedule for the project is provided below. Note that this assumes a nominal six-week ADEQ review time for this FI Workplan, and a nominal four-week review time following submittal of any supplemental workplan documents, with no substantial changes resulting from those reviews (i.e., comments can be addressed through correspondence or minor revisions). These dates are approximate and are subject to change based on field and weather conditions, acquisition of off-site access, and the actual duration of field activities. The following milestones are anticipated:

- Submittal of FI Work Plan to ADEQ and the completion of the baseline initial groundwater sampling event – January 18, 2008.
- ADEQ approval of FI Work Plan – within six weeks following the FI Work Plan submittal – February 29, 2008.
- Mobilization to the site to begin the field investigation – approximately two weeks following receipt of ADEQ approval of the FI Work Plan – March 17, 2008.
- Submittal of Supplemental FI Work Plan to ADEQ, with proposed alluvial aquifer well locations – approximately four weeks after field mobilization – April 11, 2008.
- ADEQ approval of Supplemental FI Work Plan – May 9, 2008.
- Completion of planned field investigation activities. Assume 12 weeks after approval of the Supplemental FI Workplan – August 1, 2008.
- Submittal of FI Investigation Report to ADEQ approximately 90 days after the completion of the field activities – October 30, 2008.

As noted above, these durations and dates are approximate. This performance schedule will be periodically updated as Facility Investigation activities proceed.



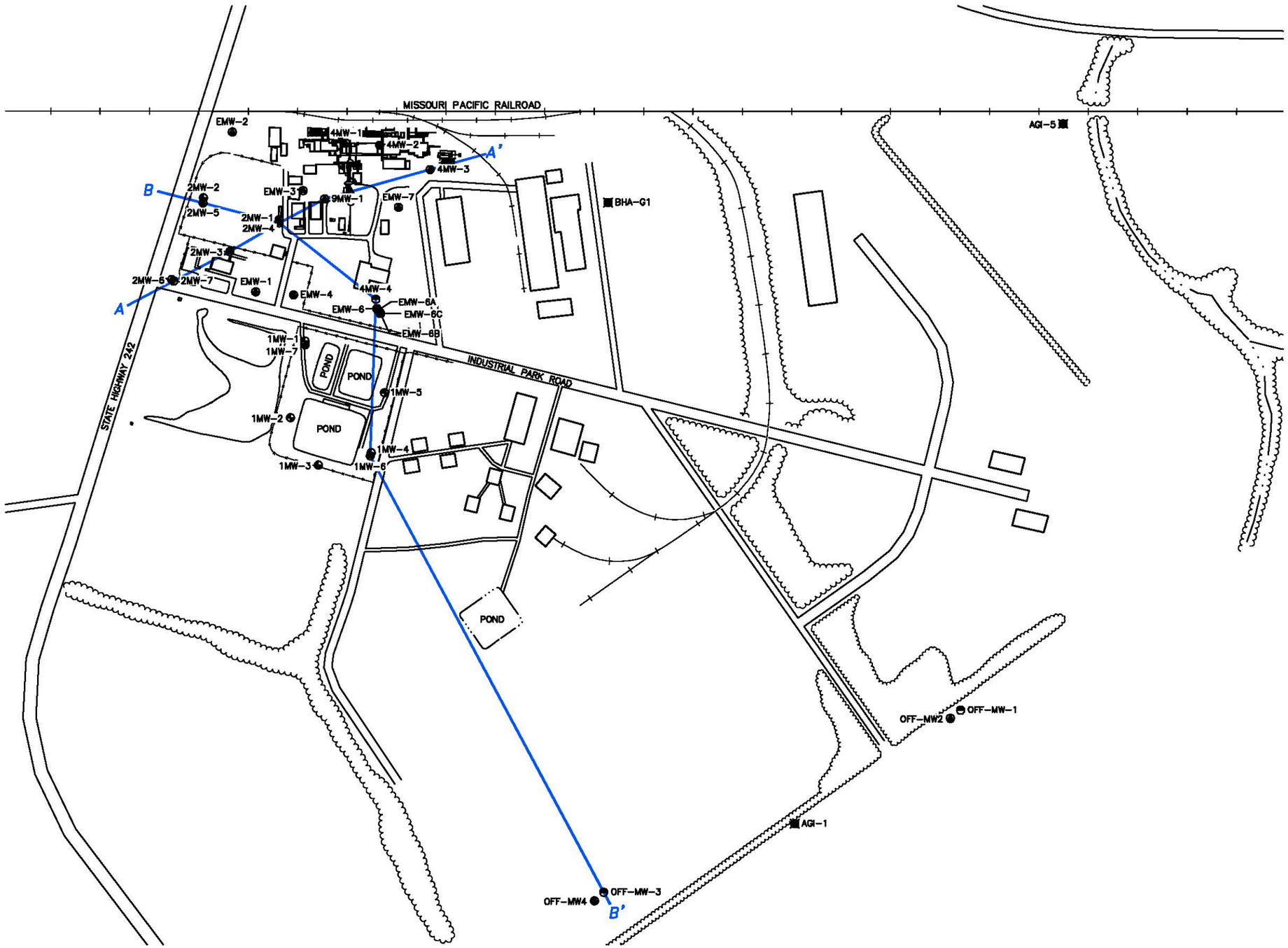
SOURCE: EnSafe, Phase II Investigation Report, 1995

SITE LOCATION MAP

Cedar Chemical
Helena-West Helena, Arkansas

Geomatrix | Project 13636 | Figure 1

I:\13636 - Arkansas Helena-West Helena\2007 CCR\FINAL FIGURES\ FIG 1 Site Location Map\FIG 1.dwg



EXPLANATION

- WATER OR DRAINAGE
- ROAD
- RAILROAD
- BUILDING
- FENCE
- DEEP MONITORING WELL (LOWER ALLUVIUM)
- SHALLOW MONITORING WELL (UPPER ALLUVIUM)
- PERCHED ZONE MONITORING WELL
- AGRICULTURAL IRRIGATION WELL
- A — A' LINE OF CROSS SECTION

0 500
APPROXIMATE SCALE IN FEET

FINAL

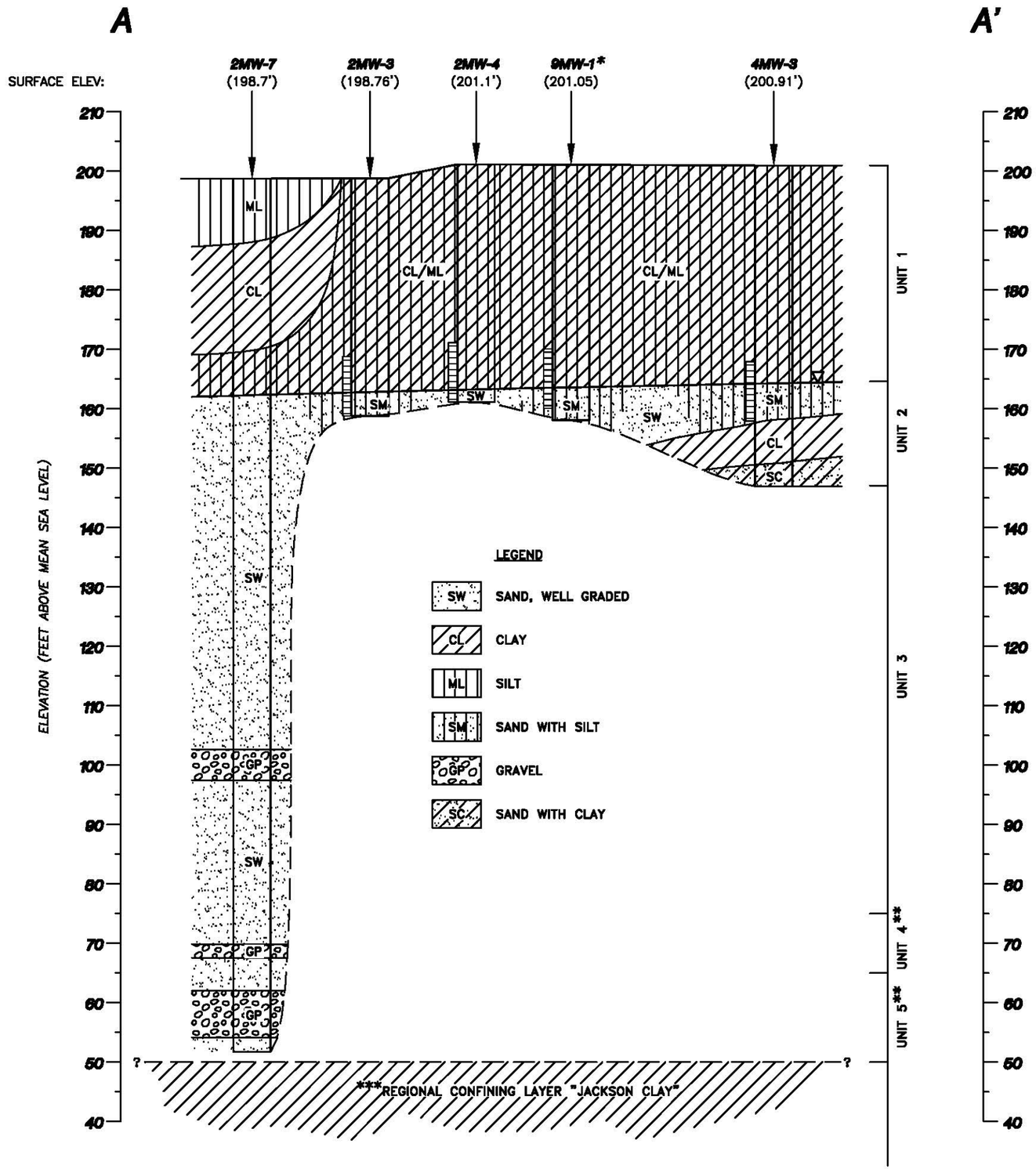
BASE MAP MODIFIED FROM:
EnSafe, 1996-Phase III FI, 2001 Groundwater Monitoring Report, Drawings C2162GWS and C2162VC7

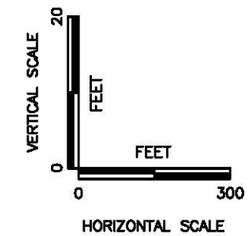
LINES OF CROSS SECTION MAP

Cedar Chemical
Helena-West Helena, Arkansas

By: HCS	Date: 1/15/08	Project No. 13636
Geomatrix		Figure 2

1/16/08 X-SECT.dwg





LEGEND

2MW-4	MONITORING WELL
‡	SCREENED INTERVALS FOR LOCATIONS HAVING INSTALLED WELLS
▽	RELATIVE GROUNDWATER ELEVATION
*	SURFACE ELEVATION AT THIS POINT INTERPRETED FROM TOPOGRAPHIC MAP
**	UNIT NOT OBSERVED IN LITHOLOGIC SAMPLES BUT WAS IDENTIFIED IN GEOPHYSICAL LOGGING

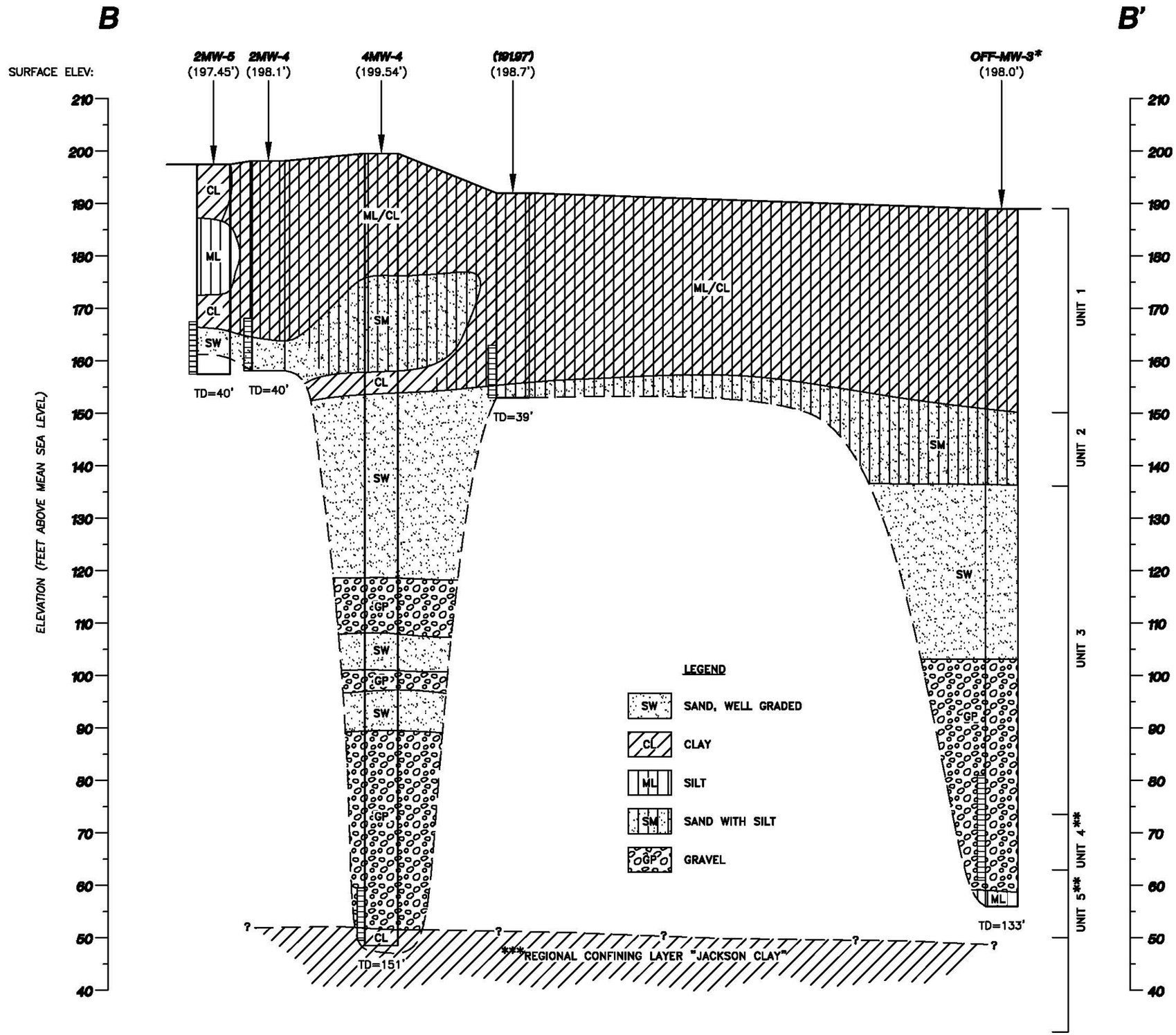
FINAL

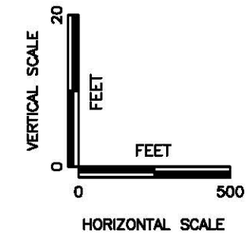
CROSS SECTION A-A'

Cedar Chemical
Helena-West Helena, Arkansas

By: HCS	Date: 1/15/08	Project No. 13636
Geomatrix		Figure 3

1/16/08 X-SECT.dwg





LEGEND

2MW-4	MONITORING WELL
	SCREENED INTERVALS FOR LOCATIONS HAVING INSTALLED WELLS
▽	RELATIVE GROUNDWATER ELEVATION
*	SURFACE ELEVATION AT THIS POINT INTERPRETED FROM TOPOGRAPHIC MAP
**	UNIT NOT OBSERVED IN LITHOLOGIC SAMPLES BUT WAS IDENTIFIED IN GEOPHYSICAL LOGGING

FINAL

CROSS SECTION B-B'

Cedar Chemical
Helena-West Helena, Arkansas

By: HCS	Date: 1/15/08	Project No. 13636
Geomatrix		Figure 4

1/16/08 X-SECT.dwg

EXPLANATION

APPROXIMATE PERCHED ZONE EXTENT

PERCHED ZONE MONITORING WELL

PROPOSED PERCHED ZONE MONITORING WELL LOCATION

NOTE:
ALL PROPOSED WELL AND BORING LOCATIONS ARE APPROXIMATE, AND MAY BE ADJUSTED BASED ON UTILITIES, FIELD ACCESS, AND OTHER CONDITIONS.

FINAL

0 500
APPROXIMATE SCALE IN FEET

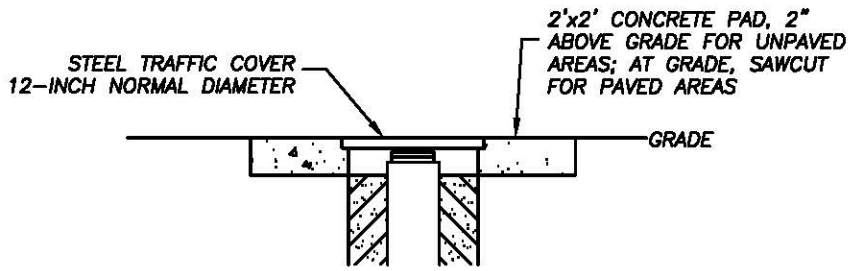
BASE MAP MODIFIED FROM:
EnSafe, 1996-Phase III FI, 2001 Groundwater Monitoring Report, Drawings C2162GWS and C2162VC7

PERCHED ZONE WELL LOCATIONS

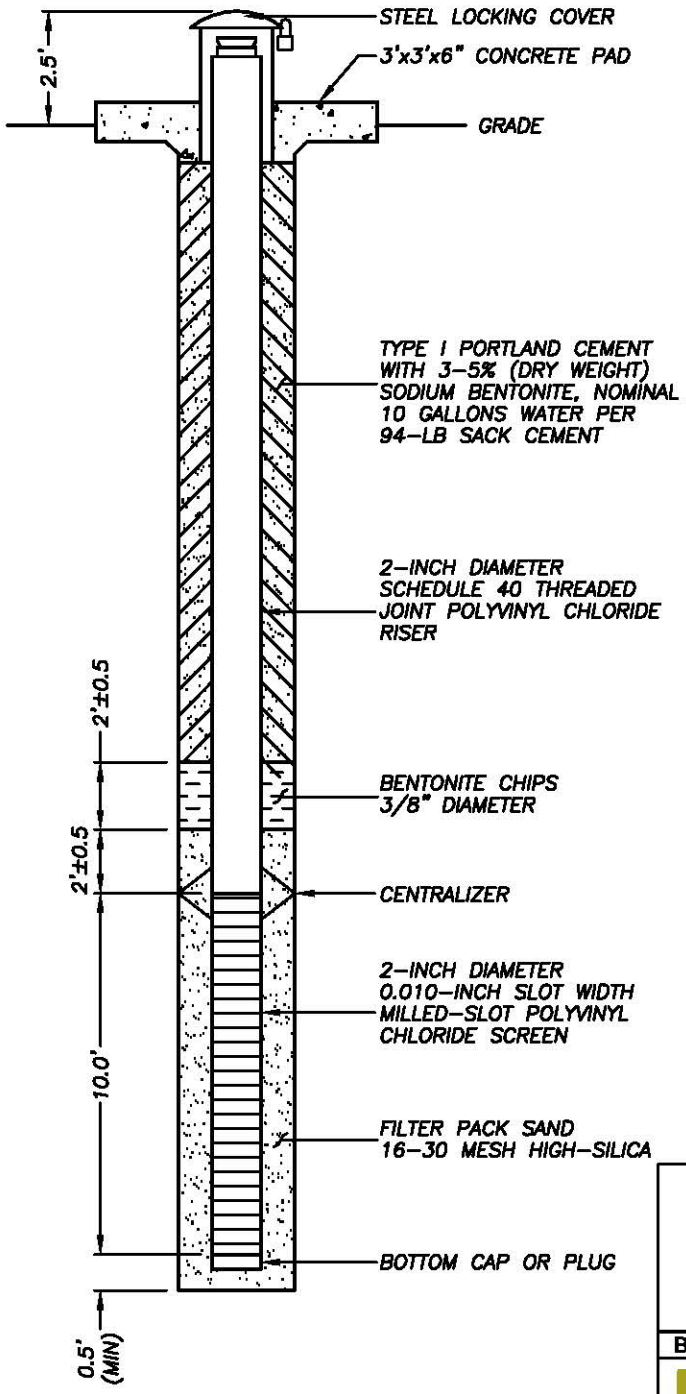
Cedar Chemical
Helena-West Helena, Arkansas

By: HCS	Date: 1/15/08	Project No. 13636
Geomatrix		Figure 5

1/16/08 PERCHED-01.dwg



ALTERNATE SURFACE COMPLETION



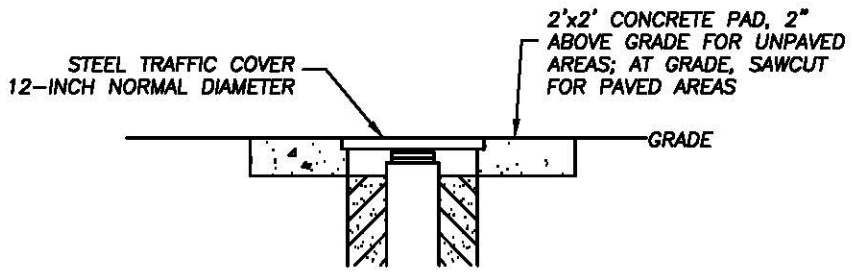
TYPICAL PERCHED ZONE MONITORING WELL CONSTRUCTION

Cedar Chemical

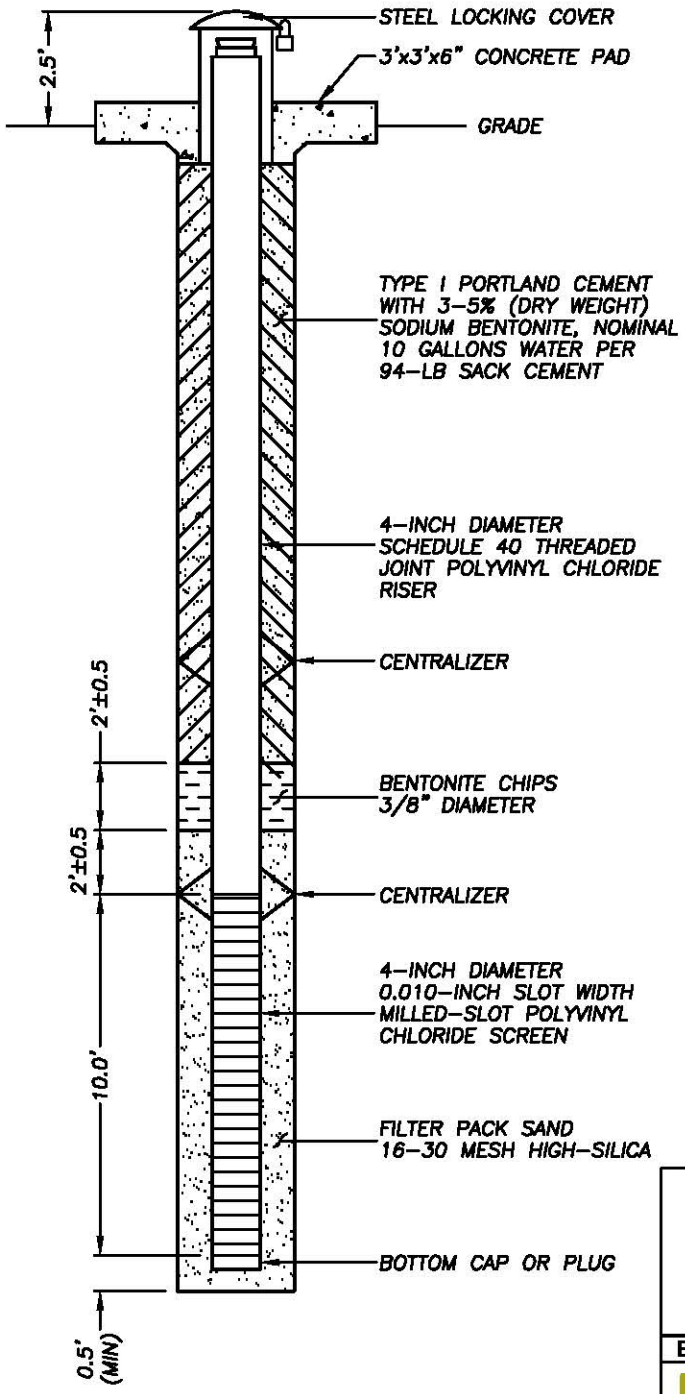
Helena-West Helena, Arkansas

By: HCS	Date: 1/15/08	Project No. 13636
Geomatrix		Figure 6

Date: 1/16/08 MW-DETAIL.dwg



ALTERNATE SURFACE COMPLETION



NOTE:
CENTRALIZERS WILL BE PLACED EVERY 40 FEET FROM TOP OF SCREEN TO SURFACE.

TYPICAL ALLUVIAL AQUIFER MONITORING WELL CONSTRUCTION
Cedar Chemical
Helena-West Helena, Arkansas

By: HCS	Date: 1/15/08	Project No. 13636
Geomatrix		Figure 7

Date: 1/16/08 MW-DETAIL.dwg

EXPLANATION

- DEEP MONITORING WELL (LOWER ALLUVIUM)
- SHALLOW MONITORING WELL (UPPER ALLUVIUM)
- PERCHED ZONE MONITORING WELL
- AGRICULTURAL IRRIGATION WELL
- PROPOSED CPT LOCATION

WELLS NOT SHOWN DUE TO UNKNOWN LOCATIONS:

AGI-2
AGI-3
AGI-4
AGI-6
AGI-7

APPROXIMATE LOCATION OF WELL COVERED BY ASPHALT:

4MW-2

NOTE:
ALL PROPOSED WELL AND BORING LOCATIONS ARE APPROXIMATE, AND MAY BE ADJUSTED BASED ON UTILITIES, FIELD ACCESS, AND OTHER CONDITIONS.

FINAL

0 500
APPROXIMATE SCALE IN FEET

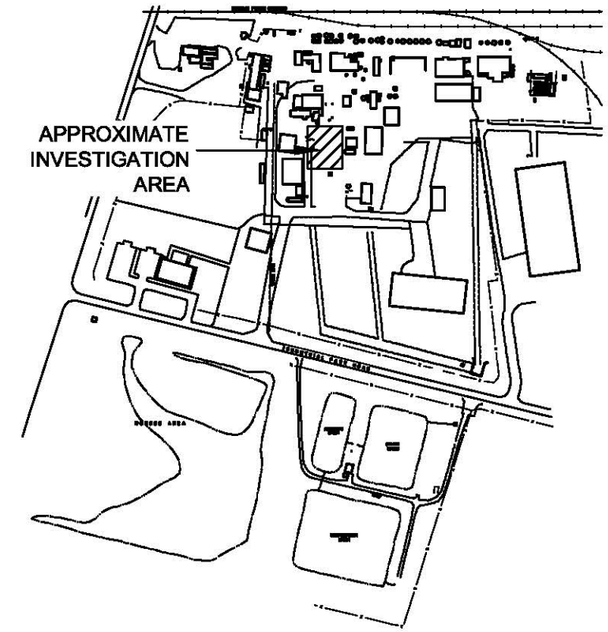
BASE MAP MODIFIED FROM:
EnSafe, 1996-Phase III FI, 2001 Groundwater Monitoring Report,
& December 2007 Site Reconnaissance
Drawings C2162GWS and C2162VC7

CPT BORING LOCATIONS

Cedar Chemical
Helena-West Helena, Arkansas

By: HCS	Date: 1/15/08	Project No. 13636
Geomatrix		Figure 8

1/16/08 ALLUVIAL-01.Dwg



KEY AREA MAP

LEGEND

- EXISTING SOIL BORING
- PROPOSED FORMER DINOSEB DISPOSAL POND DIRECT PUSH BORING
- PROPOSED DRUM VAULT DIRECT PUSH BORING

NOTE:
ALL PROPOSED WELL AND BORING LOCATIONS ARE APPROXIMATE, AND MAY BE ADJUSTED BASED ON UTILITIES, FIELD ACCESS, AND OTHER CONDITIONS.

FINAL

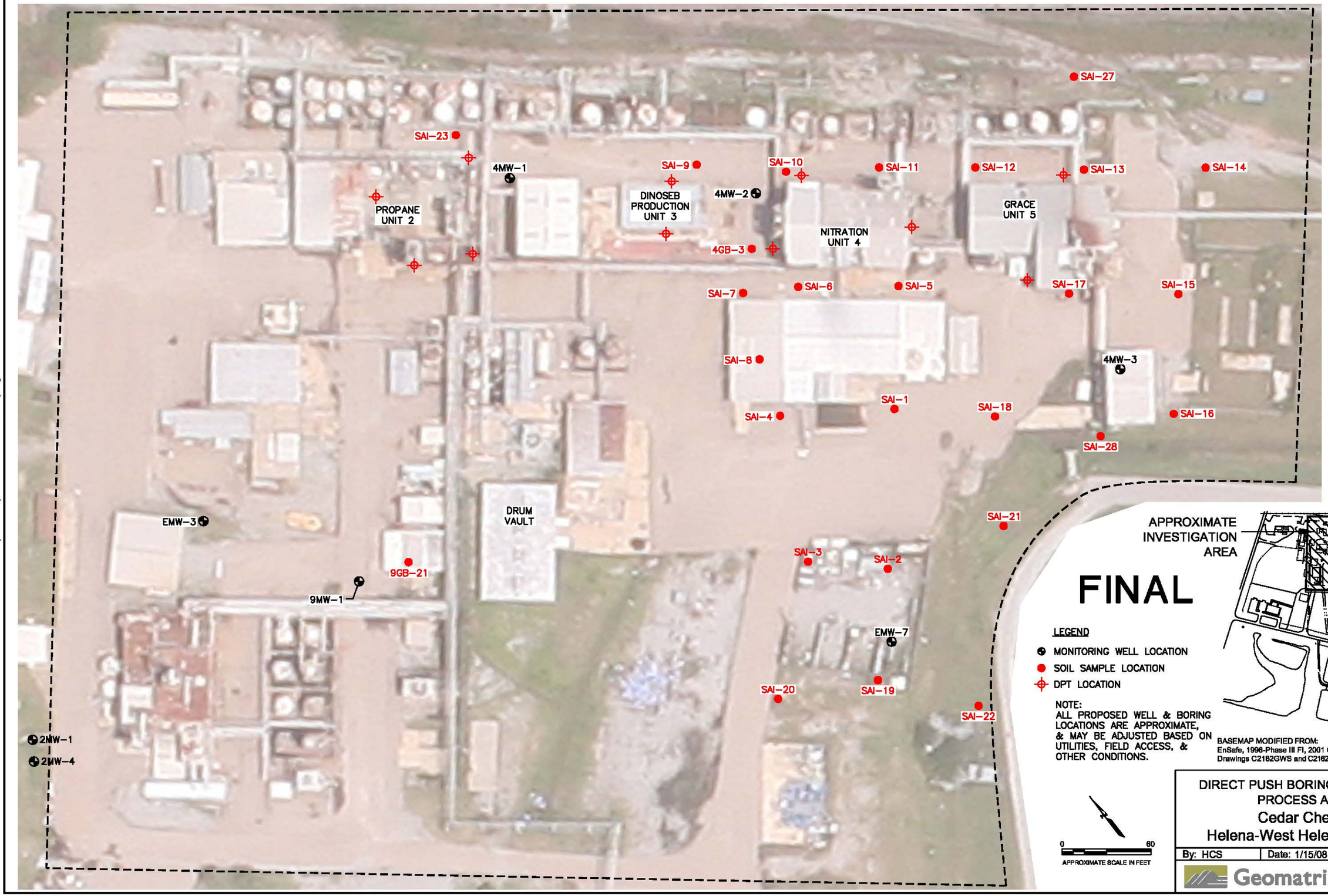
0 50
APPROXIMATE SCALE IN FEET

BASEMAP MODIFIED FROM:
EnSafe, 1996-Phase III FI, 2001 Groundwater Monitoring Report, Drawings C2162GWS and C2162VC7

DIRECT PUSH BORING LOCATIONS-
DRUM VAULT & FORMER DINOSEB
DISPOSAL PONDS
Cedar Chemical
Helena-West Helena, Arkansas

By: HCS	Date: 1/15/08	Project No. 13636
Geomatrix		Figure 9

SOIL-DATA-01.dwg 1/16/08



APPROXIMATE INVESTIGATION AREA

KEY MAP

FINAL

LEGEND

- MONITORING WELL LOCATION
- SOIL SAMPLE LOCATION
- DPT LOCATION

NOTE:
ALL PROPOSED WELL & BORING LOCATIONS ARE APPROXIMATE, & MAY BE ADJUSTED BASED ON UTILITIES, FIELD ACCESS, & OTHER CONDITIONS.

BASEMAP MODIFIED FROM:
EnSafe, 1996-Phase III FI, 2001 Groundwater Monitoring Report, Drawings C2162GWS and C2162VC7

0 60
APPROXIMATE SCALE IN FEET

DIRECT PUSH BORING LOCATIONS - PROCESS AREAS
Cedar Chemical
Helena-West Helena, Arkansas

By: HCS	Date: 1/15/08	Project No. 13636
Geomatrix		Figure 10

I:\13636 - Arkansas Helena-West Helena\ENSAFE BACKGROUND DOCUMENTS\CAD\Raw CAD Maps\Clean Maps\Perched Zone Offsite Base Map.dwg

1/16/08 BASE-60.dwg

EXPLANATION

PROPOSED BACKGROUND DPT LOCATION

NOTE:
ALL PROPOSED WELL AND BORING LOCATIONS ARE APPROXIMATE, AND MAY BE ADJUSTED BASED ON UTILITIES, FIELD ACCESS, AND OTHER CONDITIONS.

FINAL

0 500
APPROXIMATE SCALE IN FEET

BASE MAP MODIFIED FROM:
EnSafe, 1996-Phase III FI, 2001 Groundwater Monitoring Report, Drawings C2162GWS and C2162VC7

DIRECT PUSH BORING LOCATIONS - BACKGROUND SAMPLING
Cedar Chemical
Helena-West Helena, Arkansas

By: HCS	Date: 1/15/08	Project No. 13636
Geomatrix		Figure 11

1/16/08 PERCHED-01.dwg

Quality Assurance Project Plan

Cedar Chemical Corporation Facility

Helena - West Helena, Arkansas

Prepared for:

Exxon Mobil Corporation and Helena Chemical Company

Prepared by:

Geomatrix Consultants, Inc.
5725 Highway. 290 West, Suite 200B
Austin, Texas 78735

January 2008

Project No. 13636

Geomatrix

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QUALITY ASSURANCE PROJECT PLAN

Cedar Chemical Corporation Facility Investigation
Helena-West Helena, Arkansas

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared on behalf of ExxonMobil Chemical Corporation and Helena Chemical Company, which comprise the Cedar Chemical Corporation Site Joint Defense Group (the Group), to describe quality assurance/quality control (QA/QC) procedures outlined for all environmental assessment work performed at the Cedar Chemical Corporation facility ("the Facility") located in Helena-West Helena, Phillips County, Arkansas. A site location map is included as Figure 1. Assessment activities will be conducted in compliance with Arkansas Department of Environmental Quality (ADEQ) Facility Consent Administrative Order (CAO) and the related separate agreement.

In November 2007, Geomatrix submitted a Current Conditions Report (CCR) on behalf of the Group, to the ADEQ. The CCR compiled information, data, and findings from previous investigations, regulatory correspondence, and technical literature which pertained to the Facility.

The Facility Investigation (FI) Work Plan describes a scope of work intended collect needed additional information on the sources, nature, and extent of the impacted environmental media, and develop additional information needed to support remedy selection. This QAPP will apply to field and analytical procedures used in the investigation, monitoring, management, and remediation activities to be conducted at the Facility by Geomatrix. It has been written in general accord with the guidelines discussed in U.S. Environmental Protection Agency (USEPA) documents: *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, EPA/240/B-01/003* (USEPA, 2001), and *Guidance for Quality Assurance Project Plans, EPA QA/G-5 EPA/240/R-02/009* (USEPA, 2002).

2.0 PROJECT MANAGEMENT

Section 2.0 provides an overall approach to managing the work required by the FI Work Plan.

2.1 PROJECT ORGANIZATION AND ROLES AND RESPONSIBILITIES

The various responsibilities of key project personnel are presented in this section. A project organization chart is included as Figure 2.

2.1.1 ADEQ

The ADEQ Project Manager, Ms. Tammie Hynum, has oversight responsibility for the work conducted in response to the CAO.

2.1.2 Cedar Chemical Corporation Site Joint Defense Group

The Cedar Chemical Corporation Site Joint Defense Group is currently comprised of ExxonMobil Chemical Company and Helena Chemical Company. The composition of the Group is subject to change, however, as the project progresses.

2.1.3 Geomatrix Consultants, Inc.

Geomatrix Consultants, Inc. (Geomatrix) is contracted to the Group to assist with its response to the CAO. The Geomatrix project team and the role of each team member are explained in the following subsections.

Principal in Charge

Mr. Mark Hemingway, P.G. is the principal in charge (PIC) for this project. Mr. Hemingway is responsible for reviewing all deliverables of the project to ensure that all work elements meet the project objectives and technical standards, and are completed in accordance with the CAO, FI Work Plan, Health and Safety Plan (HASP), and QAPP standards.

Project Manager

Ms. Kelly Beck, P.G. is the Project Manager (PM) and will be responsible for the scope, cost, and technical considerations related to the project; staff and project coordination; and implementation of review of overall project quality related to the collection, completeness, and presentation of information. Ms. Beck will oversee the technical work conducted by the Task Leader (TL) and the quality assurance efforts of the Project QA Officer. Ms. Beck will also provide senior technical review.

The Project Manager is responsible for assembling a project team with the necessary experience and technical skills. Part of the process is to identify special training requirements or certifications necessary to successfully execute the project.

Project Quality Assurance Officer

Ms. Peggy Peischl, P.E. will be the Project QA Officer and is responsible for reviewing the project QA program as it relates to the collection and completeness of data from field and laboratory operations, including training personnel to follow established protocols and procedures.

Project Health and Safety Officer

Don Kubik, P.G., CIH, will be the Project Health and Safety Officer for the project and is responsible for overseeing the health and safety of project personnel.

Technical Staff

The technical staff for this project will be drawn from a number of technical resources within Geomatrix. The technical staff will implement project and site tasks, analyze data, and prepare reports and support materials. All technical personnel assigned will be experienced professionals who possess the degree of specialization and technical competence required to perform the required work effectively and efficiently. All technical staff will be familiar with the FI Work Plan and other relevant work plans, the Health and Safety Plan (HASP), and policies applicable to the field work performed. Each field sampling team will have a copy of the FI Work Plan, HASP, and task-specific work plans in their possession while conducting field operations.

Analytical Laboratory

Independent laboratories providing analytical services will be chosen as appropriate for the various tasks to be performed under the CAO which include investigation, monitoring, and remediation activities. Analytical laboratories will be registered in the ADEQ Laboratory Certification Program.

The laboratory staff is required to include a qualified QA Manager who reports directly to project management and is independent of the technical operations of the laboratory. This arrangement is required to manage technical adherence to the laboratory QA programs and this QAPP.

Other Subcontractors

Other subcontractors retained by Geomatrix for work under this project will be directly managed by the Geomatrix Project Manager or designated project staff. Subcontractors are responsible for performance in accordance with individual subcontracts with Geomatrix, as well as pertinent portions of this QAPP. They are also responsible for notifying the PM or his/her designee regarding nonconformance with this QAPP or QA/QC problems affecting project operations.

Geologic documents prepared for this project will require the signature of an Arkansas Professional Geologist, pursuant to applicable state requirements.

No other specialized training or certifications are anticipated for this work.

2.2 PROBLEM DEFINITION

2.2.1 Site Description and Setting

The Facility is located just to the south of the city of Helena-West Helena, in Phillips County, Arkansas (Figure 1). The Facility consists of approximately 48 acres located within the Helena-West Helena Industrial Park, approximately 1.25 miles southwest of the intersection of U.S. Highway 49 and State Highway 242. The surrounding property usage is predominantly industrial and agricultural.

Site history and use at the Facility (discussed further in Section 2.2.2) have resulted in environmental impacts to site media over time. Information as to the nature and extent of impacted has been collected from historical environmental investigations which have identified a number of chemicals in soil and groundwater on site and off site. A detailed chronology of Facility history and the summary of investigation work can be found in the 2007 CCR. The most recent phase of environmental sampling at the Facility was performed by a USEPA contractor in August 2005 (Geomatrix, 2007).

The CCR concluded that there were several areas where additional information was needed, to supplement existing information and meet project objectives. The acquisition, development, and review of that information is the purpose of the planned FI.

2.2.2 Site History and Use

The plant was constructed and initially operated by Helena Chemical. The construction date of the Facility is not documented in available records; but several reports state that operations

began at the site around 1970 with the manufacture of pesticides. The Facility exchanged ownership between several companies between 1972 and 1986. In 1986 the Facility was bought by Cedar Chemical Corporation, which operated the site up to 2002. On March 8, 2002, Cedar Chemical filed for bankruptcy. Manufacturing and plant operations were shut down soon after, and the Facility has remained inactive to date.

During its operational life, the Facility manufactured various agricultural chemicals, including insecticides, herbicides, polymers, and organic intermediates. Plant processes were batch operations, with seasonal production fluctuations and the frequent introduction of new products. The plant also produced a variety of chemicals on a toll manufacturing basis for a number of customers. From 1970 to 2002, the plant employed approximately 100 people and operated 24 hours per day, seven days per week (EnSafe, September 1991). The ADEQ assumed control of the site on October 12, 2002.

The former operational portion of the property is divided into two major areas: (1) the manufacturing area, to the north of Industrial Park Road and (2) the wastewater treatment system area, to the south of Industrial Park Road. Of the 48 acres, approximately 40 acres contain the former manufacturing area of the Facility, and are fenced. The remaining 8 acres contain the wastewater treatment ponds.

2.2.3 Site Geology and Hydrogeology

The site is underlain by a series of alluvial strata, which overlie the regional confining clays of the Jackson Group. The following description of site geology and hydrogeology is summarized from the November 2007 CCR that was prepared for the Facility.

A 1993 Facility investigation identified five stratigraphic units within the Quaternary alluvium at the site (EnSafe, 1996):

1. Unit 1 extends from ground surface to approximately 32 feet below ground surface (bgs) and consists of silts, clays and sands. Unit 1 includes a perched groundwater-bearing zone referred to as the perched zone or perched aquifer.

2. Unit 2 extends from approximately 32 to 47 feet bgs, and consists of clays and silts. Unit 2 is referred to as the semi-confining unit.

3. Unit 3 extends from 47 to 116 feet bgs, and consists of a coarsening downward sand and gravel sequence with clay stringers. Unit 3 corresponds to the upper portion of the alluvial aquifer.

4. Unit 4 extends from 116 to 131 feet bgs, and consists of clay. Unit 4 is the middle section of the alluvial aquifer. This unit was not observed through lithologic sampling but identified by geophysical logging.

5. Unit 5 extends from 131 to 152 feet bgs, and consists of sand and gravel. Unit 5 is the lower section of the alluvial aquifer, and overlies the regional confining layer (Jackson Group clay). This unit was not observed through lithologic sampling, but was identified by geophysical logging.

2.3 DESCRIPTION OF PROJECT APPROACH

The current scope of work consists of several elements, including:

- Installation of new perched zone and alluvial aquifer monitoring wells.
- Cone-penetrometer evaluation of the alluvial aquifer geology.
- Direct push technique borings in the vicinity of waste disposal areas.
- Aquifer testing.
- Sampling and analysis of groundwater and soils.
- Supply well surveys

These activities will improve the characterization of sources and potential pathways for migration of hazardous waste or hazardous constituents; further define source area(s), help complete delineation of soil and groundwater impacts; and identify of actual or potential receptors. If there is a substantial change in the scope of work or project tasks, the FI Work Plan and QAPP will be revised to reflect any modifications.

2.4 APPLICABLE REGULATORY STANDARDS OR CRITERIA

The regulatory standards for screening that will be used include the following:

- Soil – The Residential Soil Screening Level, Region 6 USEPA Human-Health Medium-Specific Screening Levels (MSSLs) dated May 2007 (Version 9b) and background concentrations for metals; and

- Groundwater – Groundwater conditions at the Facility will be evaluated against a hierarchy of regulatory limits in the following order:

    1. The National Primary Drinking Water Standards (i.e. maximum contaminant level [MCL]),

    2. National Secondary Drinking Water Standards;

    3. Region 6 USEPA Human-Health MSSLs May 2007 (Version 9b) for Tap Water

2.5 SPECIAL EQUIPMENT AND PERSONNEL REQUIREMENTS

Special equipment requirements for the anticipated work include, but are not limited to, subsurface utility locators; drill rigs (sonic, hollow-stem auger, direct push (DPT), cone penetrometer [CPT], etc.), well development rigs, various heavy equipment (backhoe, excavator, concrete truck, etc.), and support vehicles and equipment for utility locating, field investigation, sampling, and operations and maintenance activities.

Those Geomatrix employees who perform the activities defined in the Occupational Safety and Health Administration (OSHA) requirements under 29 CFR 1910.120 at the Facility must complete the 40-hour health and safety training program (HAZWOPR). In addition, each employee must complete the required 8-hour refresher training provided on an annual basis to maintain the HAZWOPR certification.

Additionally, all contractors working at the Site should have the appropriate health and safety training. No other specialized training or certifications are anticipated for this work.

2.6 DATA QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The DQOs outlined in this section are provided to identify the appropriate type of data required to support project decisions. The DQOs for anticipated tasks associated with this project, the performance criteria necessary to maintain the DQOs, and the measurement system that will be used to assess performance criteria, are discussed in the following sections.

2.6.1 DQO Development

DQOs are qualitative and quantitative statements that define the type, quality, and quantity of environmental data appropriate for the intended application. These objectives are based on the *Guidance for the Data Quality Objective (DQO) Process, EPA 600/R-96/055* (USEPA, 2000) and outline acceptance and performance criteria which establish the quality and quantity of data necessary to meet the project DQOs. Acceptance and performance criteria may be specified as

precison, accuracy, representativeness, completeness, comparibility, and sensitivity (PARCCS) parameters. The following subsections summarize each component of the PARCCS parameter set.

Precision

Precision measures the reproducibility of measurements (either field or analytical) under a given set of conditions. It is a quantitative measure of the variability of a data population (or group of measurements) compared to their average value (i.e. standard deviation or coefficient of variation). It can also be measured as the relative percent difference (RPD) between two values. Precision also considers instrument or method detection limits and multiple field sample variance. Sources of variance can be sample matrix heterogeneity, sample error, and analytical error.

Field Precision

Field precision will be assessed through the collection and measurement of field duplicates. Field duplicates will only be collected for groundwater samples. Soil or sediment samples will not be collected in duplicate because the inherent variability of these samples' matrix precludes obtaining a true duplicate. Duplicate samples will be analyzed to check for overall variability introduced by sampling and analytical procedures. Field precision also will be assessed on the basis of reproducibility by multiple readings of a single sample.

Laboratory Precision

Laboratory precision accuracy is assessed through the calculation of relative percent differences for two replicate samples. The precision of the analysis can be inferred through the use of one of the following: Matrix spike and matrix spike duplicate (MS/MSD) samples, laboratory control sample and associated duplicate (LCS/LCSD), or unspiked duplicate samples. The MS/MSD samples provide information about the effect of the sample matrix on extraction and measurement methodology. An MS/MSD pair will be analyzed at a rate of one per batch of 20 (or fewer) investigative samples per matrix. The laboratory also analyzes one or more of the LCS/LCSD or unspiked duplicate samples at a rate of one per batch of 20 (or fewer) project samples per matrix (soil or water).

The precision of laboratory analyses will be assessed by calculating the RPD for each pair of duplicate samples (MS/MSD, LCS/LCSD, unspiked duplicate samples) and field duplicate sets using the following equation:

$$\% RPD = \frac{S_1 - S_2}{S_{av}} x\, 100$$

where:

S_1 = first sample result (original or MS value)
S_2 = second sample result (duplicate or MSD value)
S_{av} = average of sample and duplicate = (S1 + S2)/2
% RPD = Relative Percent Difference

Accuracy

Accuracy measures the bias of the measurement system. Sources of bias can be found in the sampling process, field contamination, preservation, sample handling, sample matrix, sample preparation, and sample analysis. Other sources of bias can also be found in data interpretation and reporting. Analytical accuracy is evaluated using three types of samples: spiked samples, blank samples and background samples. Through the analysis of spiked samples accuracy can be evaluated by the measurement of percent recovery or the average (arithmetic mean) of the percent recovery for specific parameters. Blank samples provide is another measurement of accuracy and is used to assess sampling and analytical bias (such as sample contamination). The analysis of background samples provides a third measure of bias sourced in the nature of the environmental media.

Field Accuracy

Field accuracy is assessed through the use of appropriate Equipment rinsate blanks and trip blanks, and achieved through adherence to all sampling handling, preservation, and holding time requirements. Sampling handling requirements are provided in Section 3.3 of this QAPP and discussed in the Sampling and Analysis Plan (SAP). Preservation and holding time requirements are outlined in Table 2 of Appendix A. Equipment rinse blanks are used to assess the adequacy of decontamination of sampling equipment between individual sample collections. Accuracy of field instruments will be assessed by daily instrument calibration and calibration checks.

Laboratory Accuracy

Laboratory accuracy is assessed through the analysis of matrix spike samples and laboratory control samples. The results are expressed as a percent recovery. Surrogate (system monitoring compound) recoveries may also be used to assess accuracy. Method blanks are used to assess contamination resulting from laboratory procedures. Laboratory control samples, method blanks, and preparation blanks will be analyzed at least once with each analytical batch, at a frequency of one for every 20 samples (or fewer) per matrix. The percent recovery (% R) is calculated with the following equation:

$$\% R = \frac{A - B}{C} x 100$$

where:

A = The analyte concentration determined experimentally from the spiked sample.
B = The background level determined by a separate analysis of the unspiked sample.
C = The amount of the spike added.

Representativeness

Consideration of the representativeness of a data set or data point is another important evaluation. This parameter describes to what degree data expresses a characteristic of a population, a parameter variation at a sampling point, or an environmental condition. Representativeness is a qualitative parameter used to assess the design of a sampling or measurement program. Sample or measurement locations may be biased (judgmental) or unbiased (random or systematic). For unbiased programs, the sampling must be designed not only to collect samples that represent conditions at a sample location, but also to select sample locations that represent the total area to be sampled.

Completeness

Completeness can be defined as the percentage of field or analytical measurements that are determined to be valid. This parameter is quantitative in nature and is evaluated in consideration of a numerical goal specified. The completeness goal is, however, to generate a sufficient amount of valid data for project decisions. Percent completeness is calculated with the following equation:

$$\%\,Completeness = \frac{Valid\ Data\ Obtained}{Total\ Data\ Planned} \times 100$$

Comparability

Comparability is a qualitative parameter which is used to express the confidence with which one data set is compared to another. Sample data should be comparable with other sample data for similar samples under similar conditions. This parameter is determined though the use of standard techniques (i.e., USEPA-approved analytical methods and sampling methods explained in the FI Work Plan) to collect and analyze samples.

Project samples analyzed by the laboratory and from the same media are generally considered comparable if the same procedures for collecting and analyzing the samples are used; the samples comply with the same QA/QC procedures; and if the units of measurement are the same.

Sensitivity

Sensitivity is the measure of the concentration at which an analytical method can positively identify and report analytical results. The sensitivity of a given method is commonly referred to as the detection limit. Although there is no single definition of this term, the following terms and definition of detection limits will be used:

- Instrument detection limit (IDL) is the minimum concentration that can be measured from instrument background noise under ideal conditions.

- Method detection limit (MDL) is a statistically determined concentration. It is the minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero as determined in the same or a similar matrix. Because of the lack of analytical precision at this range, sample results greater than the MDL but less than the reporting limit (RL) would be qualified as “estimated” and marked with a “J”.

- Reporting limit (RL) is the concentration of the target analyte that the laboratory has demonstrated the ability to measure within specified limits of precision and accuracy during routine laboratory operating conditions. This variable is a quantitative measurement reflected as the first bracket in the calibration curve. It is the minimum concentration that will be reported as unqualified by the laboratory.

The analytical sensitivity requirements for this project require that the laboratory reporting limit be below the applicable regulatory standards cited in Section 2.4 of this QAPP. Table 1 of Appendix A lists the target analyte list (TAL) with the required reporting limits for this project.

In some cases, while using standard USEPA analytical methods, the reporting limits for certain compounds exceed the applicable regulatory standard due to technical limitation problems. In this scenario, the laboratory's achievable reporting limit has been provided in Table 1 of Appendix A.

2.7 DOCUMENTATION AND RECORDS

This section identifies critical field and laboratory records required for the anticipated work, information to be included in reports, the data reporting format for analytical data report packages, and the document control procedures to be used.

2.7.1 Field Sampling Documentation

Team members will maintain field notes to provide a daily record of significant events, observations, and measurements during sampling. All information pertinent to sampling will be recorded in the field notes or on activity-specific data forms. Field notes or activity-specific data forms include sample collection logs, daily field reports, drilling logs, chain-of-custody forms, and calibration forms. Field note documentation will include:

- Date and time of entry, and weather and ambient conditions during the field activity;
- Project name and number;
- Location of sampling activity;
- Name of field crew;
- Name of site visitors;
- Description of routine and non-routine activities performed during the field day

The following documentation will also be included during any investigation or sampling activities:

- Sample media (e.g., groundwater);
- Sample collection method (e.g., bailer, split spoon);
- Number of samples taken:
- Investigation location;
- Sampling method;

- Volume and number of samples taken;
- Date and time of collection;
- Sample depth;
- Sample identification number(s);
- Sample destination (e.g. laboratory);
- Water-level measurement data;
- Date and time of calibration runs for field instrumentation; and
- Field measurements (e.g. pH, temperature, and conductivity);

Selected field record forms to be used during this project are provided in Appendix D of this QAPP.

All original data recorded in field notes, field data forms, sample labels, and COC forms must be written with waterproof, indelible ink. If an error is identified at the time the log is being prepared, corrections will be made by the individual maintaining the log by crossing a line through the error, initialing and dating the correction, and entering the correct information. The erroneous information will not be obliterated.

2.7.2 Laboratory Records

All analytical results will be reported in the laboratory's approved format, described below. In addition to the reported data, the laboratory data report will, at a minimum, include a narrative that will discuss any problems or discrepancies, and sufficient calibration and QC information to determine that the method was within control limits at the time that the samples were analyzed. At a minimum the analytical report will include:

- Case narrative;
- Final analyte concentration including reporting limit, method detection limit, laboratory qualifiers, dilution and re-analysis information;
- Laboratory sample ID, field sample ID, matrix, and dilution factors;
- Sample collection receipt, extraction, and analysis dates for holding time verification;
- Percent recovery of each surrogate (System Monitoring Compound);

- Surrogate control limits;
- Percent recovery of each compound in the MS sample;
- MS recovery control limits;
- RPD for all MS/MSD results;
- RPD control limits for MS/MSD reports;
- Percent recovery of each compound in the LCS (and LCSD if available);
- Recovery control limits for LCS (and LCSD if available);
- Condition and temperature of samples upon receipt;
- Results for method blanks, field blanks, equipment blanks, and trip blanks reported down to the method detection limit; and
- Method blank cross-reference indicating batch-associated samples.

In addition to the hard-copy report requirements, the laboratory will provide electronic data deliverables (EDDs) conforming to an ASCII comma-delimited or Microsoft Excel format as specified for all data reported.

The laboratory's internal records management protocols are described in their Quality Assurance Manual (Appendix B).

2.7.3 Records Maintenance and Storage

All documents relating to the project will be controlled to assure proper distribution, filing, and retrieval, and to assure that revisions are properly recorded, distributed, and filed. Project records will be stored and maintained by Geomatrix staff. The Project Manager is responsible for organizing, storing, and cataloging all project information. He or she also is responsible for collecting records and supporting data from project team members. Once catalogued, project records are appropriately filed by category in the correct project file. Individual project team members may maintain separate files or notebooks for individual tasks.

3.0 SAMPLING METHODS AND GENERAL DATA ACQUISITION

This section describes all aspects of measurement design and implementation, and discusses the methods that will be used for sampling, analysis, data handling, and QC in support of the tasks performed for this project.

3.1 ANTICIPATED MEASUREMENTS

Various measurements may be collected for this project, including:

- Photo Ionization Detector (PID) and Flame Ionization Detector (FID) measurements for soil samples collected from soil borings;
- PID, FID, and explosimeter measurements for monitoring the breathing zone and work zone during project activities that involve work around impacted environmental media. This mainly pertains to Health and Safety;
- Water level measurements; and
- Groundwater parameter measurements (i.e. Temperature, Conductivity, pH, oxidation-reduction potential [ORP], dissolved oxygen content, turbidity)

3.2 FIELD SAMPLING AND DECONTAMINATION METHODOLOGY

This section outlines the methods used to collect soil and groundwater data for this project. Sample collection intervals, monitoring well construction details, and collection methodology are also outlined in the FI Work Plan.

3.2.1 Calibration Methods for Equipment

All instruments used in the field will be calibrated to the manufacturer's recommendation prior to field use. At the beginning of each sampling day, the water quality meters (pH, conductivity, temperature, turbidity, dissolved oxygen, and oxidation-reduction potential) will be calibrated prior to use. Geomatrix field representatives will document the time of calibration along with the name of the calibration standard, matrix of the calibration standard, the concentration or pH, the serial number, and the expiration date of the standard. Results of calibrations and final calibration checks will be recorded on the Field Instrument Calibration Sheet.

If anomalous instrument readings are observed during sampling, the Geomatrix field representative will stop sampling and recalibrate the instrument. The anomalous instrument readings, the date and time which the sampling was stopped, and the calibration standard information (as described above) will be documented in the field notes or log book.

3.2.2 Water Level Measurement Protocols

Prior to development or sampling of on-site wells, a complete round of initial depth-to-groundwater measurements will be obtained at each well, beginning with the wells with the least concentrations of the chemicals of concern and ending with the wells with the highest concentrations.

Depth-to-groundwater levels and total depth will be measured using a pre-cleaned electronic water level meter to the nearest 0.01 foot, relative to a marked reference point on the inner casing. All measurements will be recorded in the field notes or log book. Although not anticipated, monitoring wells that are suspected of containing immiscible layers (phase-separated layers) will be tested using an interface probe. The depth to the immiscible layer will be recorded in the field notes or log book. Samples will be collected within 48 hours of water level measurement gauging.

The electronic water level meter will be decontaminated between each well. Decontamination procedures will follow the protocol described in Section 3.2.6.

3.2.3 Well Inspection Protocols

Each of the wells (either monitoring wells or irrigation well) will be visually inspected by a Geomatrix field representative to determine the aboveground integrity of the well. The aboveground inspection includes documentation of the condition of the well pad, well casing, manhole cover, well cap, and security devices (i.e. locks and/or bolts). Inoperable or suspect locks will be replaced. In situations where the well is seriously damaged and thereby prevents sampling or water level gauging; is inaccessible; or, is suspected of being compromised with contaminants, the Geomatrix field representative photograph the subject condition, and notify the Project Manager of the situation. All observations will be recorded in the field notes.

3.2.4 Soil Sampling Methods

Soil samples will be collected periodically during drilling activities. Surface soil samples may also be collected as needed, using hand methods, such as hand auger, drive sampler, shovel, etc. Equipment used for sample collection will be decontaminated prior to each use, following the protocols discussed in Section 3.2.6.

Field headspace measurements for soil samples will be performed as follows:

1. The field geologist will select the depth interval for field headspace measurement.

2. Approximately 200 to 300 g of soil will be collected from the designated depth, and placed into a resealable plastic bag. The bag will be labeled with the sampling location, depth, and time of collection.

3. Bagged samples will be allowed to rest for 30 to 60 minutes. If ambient temperatures are below 70°F, bagged samples will be placed in a warm location, such as within a heated vehicle or building.

4. A PID or FID will be inserted in to the bag, and the organic vapor levels will be measured. The level will be recorded on the drilling log for the respective depth interval.

The target depths at which to collect soil samples for laboratory analysis, the frequency at which these analytical soil samples will be collected from drilling operations, as well as field screening procedures are specified in the FI Work Plan.

3.2.5 Groundwater Sampling

Groundwater samples will be collected from each monitoring well using low-flow (a.k.a. micro-purge) methods, as follows:

1. A low-flow peristaltic or electric submersible pump will be lowered into the well, to approximately the mid-point of the screened interval.

2. The pump discharge will be directed through a flow-through cell. Sensors within the cell will allow field meters to measure dissolved oxygen, temperature, pH, and specific conductance.

3. Pumping rates will be maintained in the range of 500 to 1200 ml per minute. Water levels will be checked periodically to ensure that the pumping rate used does not result in drawdown that exceeds 10 percent of that available. If drawdown does exceed this level, the pumping rate will be reduced, or an alternate purging and sampling method will be used as discussed below.

4. Purging will continue until field measurements stabilize to within 10 percent.

5. Samples will be collected directly from the pump discharge.

Purging rates, depth of pump intake, and periodic measurements will be recorded for each well in a sample collection log.

If a monitoring well does not have sufficient yield to support this method without excessive drawdown, the well will be purged dry using a disposable polyethylene bailer. Upon recovery, the bailer will be used to sample the well. The use of this method will be documented in the field notes and sample collection log.

The low flow pump will be decontaminated before and after being used at each monitoring well following the decontamination protocols defined in Section 3.2.6. New sample collection tubing will be used for each well. Tubing may be dedicated to each well for use in subsequent sampling events.

All groundwater samples will be collected in laboratory-supplied, pre-cleaned, appropriate containers. Any necessary preservative will be added by the laboratory prior to shipping the containers to the field.

If a supply well, including irrigation well, are to be sampled, the well will be purged by operating the well pump for at least 60 minutes. If the well is known to be infrequently operated, the purging period will be extended, if practicable. If well construction is known, then a purge of one well volume will be used as the purge objective for infrequently pumped wells. The sample will be collected from the existing tap, port, or other point of discharge which is closest to the well, as long as the rate of discharge at that point can be reduced sufficiently to make sampling practicable. The duration of pumping and sampling location will be documented in the sample collection log.

3.2.6 Equipment Decontamination

All sampling and field measurement equipment, other than new or disposable equipment, will be decontaminated prior to each use as follows:

1. Brush the sampling device to remove any soil or visible contamination.

2. Wash equipment with trisodium phosphate or laboratory-grade detergent in potable water.

3. Rinse with tap water.

4. Rinse with distilled water.

5. Let equipment air dry.

Larger equipment, such as augers, drill casing, bits, and DPT equipment, will be decontaminated before each borehole, and before demobilization from the site. This will be performed through a high-pressure wash using potable water. This wash will be performed at a site decontamination pad constructed to contain decontamination water and sediment, and minimize overspray. The pad will be constructed with a low-permeability liner.

3.2.7 Sample Identification

The method of sample identification used depends on the type of sample collected and the sample container type. The field analysis data are recorded in field notes or recorded on data sheets along with sample identity information while in the custody of the sampling team. A sample label will be completed and attached to each sample container for every sample retained for off-site analysis. Labels consist of a waterproof material backed with a water-resistant adhesive. Labels are to be filled out using waterproof ink or pre-printed, and are to contain at least the following information:

- Project name and number;
- Sampling date and time;
- Sample identification number;
- Preservatives, if any; and
- Sampler's initials

Each analytical sample will be named using the sample location, depth (for soils), and date collected. For example, a groundwater sample collected from the Site 2 monitoring well MW-2 on April 15, 2008 will have the following nomenclature: 2MW-2(051508). A sample collected from off-site monitoring well MW-1, on the same date, will be identified as: OFFMW-1(041508). These names will be tracked from collection through laboratory analysis and into the final reports. The sample number will be cross-referenced with the site name and sample location on the COC. Additional sample volume will be collected for the laboratory QC (i.e., MS/MSD).

The following designations will be used for other types of samples, as appropriate:

- DOM – Domestic Supply Well
- AGI – Agricultural Supply Well
- TW – Temporary Well
- SB – Soil Boring
- GP – Direct Push Soil Sample
- SED – Sediment Sample
- EX – Excavation Sample
- SW – Surface Water Sample
- HA – Hand Auger
- BG – Background Surface Soil Location

Field duplicate names will also include the word "DUP." Matrix Spike/Matrix Spike Duplicates (MS/MSD) samples that are collected with an additional sample volume will be designated on the COC Record (e.g. in the comments column). For these samples the suffix of the sample ID will contain the "MS" and "MSD."

Equipment Blanks (Rinsate blanks) and field blanks will be labeled using "EB" or "FB," respectively and the date and time of collection.

The following matrix codes will be used on the COC and EDD:

SD	Sediment
SL	Sludge
SO	Soil
SQ	Soil/Solid Quality Control Matrix
WG	Groundwater
WP	Drinking Water

WQ	Water Quality Control Matrix
WS	Surface Water
WW	Waste Water

3.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

3.3.1 Sample Custody

Sample custody and documentation procedures described herein must be followed throughout all sample collection activities. Components of sample custody procedures include the use of field notes, sample labels, custody seals, and COC forms. The COC form must accompany the samples during shipment from the field to the laboratory.

A sample is under custody under the following conditions:

- It is in one's actual possession;
- It is in one's view, after being in his or her physical possession;
- It was in one's physical possession and that person then locked it up to prevent tampering; and
- It is in a designated and identified secure area.

The following procedures must be used to document, establish, and maintain custody of field samples:

- One individual from the field sampling team should be designated as the responsible individual for all sample transfer activities. This responsible individual will be responsible for the care and custody of the samples until they are properly transferred to another person or facility.
- All samples will be accompanied by a Chain-of-custody (COC) record. This record documents the transfer of custody of samples from the field investigator to another person, to the laboratory, or other organizational entities, as each change of possession must be accompanied by a signature for relinquishment and receipt of the samples. One COC will be prepared for each shipping container (or other applicable transfer increment) of samples.
- Each COC will be prepared in triplicate. Two of the three copies (white and yellow) will accompany the samples to the laboratory. The pink copy will be retained in the project file. The chain-of-custody form makes provision for documenting sample

integrity and the identity of any persons involved in sample transfer. Information entered on the chain-of-custody will consist of the following:

- Project name and number;
- Chain-of-custody serial number;
- Number of containers/samples;
- Sample numbers;
- Sampler/recorder's signature;
- Date and time of collection of each sample;
- Collection location;
- Sample media;
- Analyses requested;
- Inclusive dates of possession;
- Name of person receiving the samples (at the laboratory);
- Date of receipt by the laboratory receiving department;
- Laboratory Sample Delivery Group ID; and
- Date of receipt of sample.

Prior to shipment to the laboratory, completed COC forms will be inserted into a plastic cover and placed inside of the shipping container used for sample transport from the field to the laboratory.

When samples are relinquished to a shipping company for transport, the tracking number from the shipping bill or receipt will be recorded on the COC form and in the field notes.

All copies of COCs will be retained in the Austin Geomatrix office project files. If the samples are shipped using a commercial carrier, the shipping record will also be retained in the project filed of the Austin Geomatrix office

3.3.2 Laboratory Sample Handling and Custody

The PM or his/her designee will notify the Laboratory Project Manager of upcoming field sampling activities and the related analytical needs. This notification will include information

concerning the number and type of samples to be shipped, analyses requested, and the expected date of arrival. Upon arrival at the laboratory, the samples will be received and logged in by a trained sample custodian in accordance with the laboratory's sample handling and internal sample custody program. A description of the general program is provided in the Quality Assurance Manual (Appendix B) for each laboratory and is summarized below.

Upon sample receipt, the sample custodian is responsible for performing the following activities during sample receipt where appropriate:

- Measuring and documenting the shipping container temperature on the COC record.
- Examining all sample containers for damage.
- Comparing samples received against those listed on the COC record.
- Verifying sample holding times have not been exceeded.
- Immediately signing and dating COC record after shipment is accepted.
- Noting any sample receipt problems on the COC record, and notifying the Laboratory Project Manager. If any problems are identified upon sample receipt, the Laboratory Project Manager is responsible for timely contacting the PM.
- Placing the samples in proper laboratory storage.

Following sample receipt, the sample custodian is also responsible for logging the samples in the laboratory sample log-in book, and/or the Laboratory Information Management System (LIMS) with the following information:

- Laboratory project number;
- Sample numbers (laboratory and client);
- Type of samples;
- Required tests; and
- Date received.

The sample custodian is also responsible for notifying the Laboratory Project Manager and appropriate Group/Team Leader(s) of sample arrival and placing completed COCs records, waybills, and any additional documentation in the project file.

Samples will be stored appropriately within the laboratory to maintain any prescribed temperature, protect against contamination, and to maintain the security of the samples.

Sample custody procedures within the laboratory will be followed with appropriate documentation to trace the handling and possession of the sample from receipt until final analysis and disposal. If any samples are transferred to a different laboratory, the transfer will be done under chain-of-custody procedures and the laboratory will maintain the appropriate documentation to preserve the traceability of the samples through final analysis and disposal.

3.3.3 Sample Packing and Shipping

Samples will be delivered to the designated laboratories by commercial shipping services (such as UPS or Federal Express). The method of sample shipment will be noted on the COC. Hard plastic ice chests or coolers with similar durability will be used for shipping samples. The samples must be cushioned to minimize the potential for breakage.

When transferring samples for shipment, samples must be accompanied by a COC record. When transferring possession of samples, the individuals relinquishing and receiving must sign, date, and note the time on the record. This record documents transfer of custody of samples from the field sampler to another person or to the laboratory. Overnight shipping companies will not be required to sign the COC record. A copy of the receipt of shipment will accompany the COC record.

3.3.4 Support Facilities for Sampling Methods

The primary laboratory for analysis of samples collected by these sampling methods is TestAmerica, Inc. in Austin, Texas.

3.3.5 Sampling/Measurement System Failure Response and Corrective Action

If QC surveillance and/or field audits result in detection of unacceptable conditions or data, the PM, in conjunction with the Project QA Officer, will be responsible for developing and directing implementation of corrective actions. Corrective actions will include one or more of the following:

- Identifying the source of the violation;
- Evaluating and amending sampling and analytical procedures; and
- Accepting data and flagging the data to indicate the level of uncertainty associated with failure to meet the specified QC performance criteria.

Any finding requiring corrective action must be documented to the PM. As necessary given the significance of the problem, the Project QA Officer will check to ensure that corrective actions have been implemented and that the problem has been resolved.

3.3.6 Sample Equipment, Preservation, and Holding Time Requirements

The sample containers, preservative requirements, and technical holding times for common analytical methods are provided in Table 2 of Appendix A.

3.4 ANALYTICAL REQUIREMENTS

This subsection presents the analytical methods requirements for analyses that may be performed; including preparation/extraction procedures where appropriate and method performance requirements.

Laboratory analyses will include analyses of soil and groundwater. The main bulk of analytical analysis will be performed by TestAmerica, Inc. of Austin, Texas. Some of the target analytes, such as the pesticides, herbicides, and dissolved gases, require the expertise of two TestAmerica sister labs to be involved: TestAmerica, Inc. of Denver, Colorado and TestAmerica, Inc. of Pensacola, Florida. Those analyses that cannot be performed at the Austin laboratory due to special analytical methods required for this project will be sent from the Austin lab to the Denver or Pensacola under proper chain-of-custody procedures outlined in Section 3.3. The Quality Assurance manuals for each of these TestAmerica labs are presented in Appendix B and contain summary information from the analytical methods including the following:

- Sample containers, preservatives, and holding times;
- Calibration requirements including frequency and acceptance criteria;
- Laboratory quality control samples including frequency, acceptance criteria, and corrective action; and
- Method detection limits (MDLs) and reporting limits (RLs).

This information is generally used to evaluate the laboratory's overall method performance and to perform external data review.

3.4.1 Analytical Methods

In general, all analyses will utilize EPA-approved methods or other recognized standard methods. Groundwater samples will be analyzed for one or more of the following parameters:

Parameter	Analysis Method
Volatile Organic Compounds (VOCs)	SW-846 Method 8260B
Semivolatile Organic Compounds (SVOCs)	SW-846 Method 8270C
Organochlorine Pesticides (OC-Pests)	SW-846 Method 8081A
Chlorinated Herbicides (Dinoseb)	SW-846 Method 8151A
Metals	SW-846 Method 6010B and 7470A
Bicarbonate	Method 310.1
Hardness	SW-846 Method 2340B
Nitrate, Nitrite	Method 353.2 or 300
Sulfate	SW-846 Method 9056 or 300
Alkalinity	Method 310.1
Ammonia	Method 350.1
Chloride	Method 300
Fluoride	Method 300
Cyanide	SW-846 Method 9012B or 335.4
Dissolved Gases	RSK-175

Soil samples will be collected and analyzed for one or more of the following parameters:

Parameter	Analysis Method
Volatile Organic Compounds (VOCs)	SW-846 Method 8260B
Semivolatile Organic Compounds (SVOCs)	SW-846 Method 8270C
Organochlorine Pesticides (OC-Pests)	SW-846 Method 8081A
Chlorinated Herbicides (Dinoseb)	SW-846 Method 8151A
Metals	SW-846 Method 6010B and 7471

3.4.2 Laboratory Method Performance Requirements

A description of the method-specific QC samples that the laboratory uses are provided in Appendix B including the types of QC samples to be run, frequency, acceptance criteria, and corrective action to be taken when acceptance criteria are not met. Results of the QC samples are reviewed against the acceptance criteria by the laboratory analyst. Any identified discrepancies will trigger the laboratory's internal corrective action system as described below.

3.4.3 Laboratory Corrective Action

The laboratory has a formal corrective action system in place to assure that prompt action is taken when an unplanned deviation from a procedure or plan occurs and that whenever possible, corrective actions include measures to prevent the reoccurrence of deviations. Specific corrective actions to be taken when a QC sample does not meet acceptance criteria are presented in laboratory quality assurance manuals.

The laboratory's corrective action procedure includes prompt notification of the project contact for any significant problems or discrepancies. The Laboratory Project Manager is responsible for reporting any significant problems or discrepancies that occur as analyses are conducted to the Project Manager or other identified project contact. The Laboratory Project Manager is also responsible for assuring that corrective action is taken where appropriate to prevent the reoccurrence of similar problems or discrepancies. In addition, each analytical data report will include a case narrative that discusses any problems or discrepancies, and sufficient calibration and QC information to verify that the method was in control at the time that the samples were analyzed. The case narrative will also include a discussion of any corrective action taken by the laboratory to prevent the reoccurrence of similar problems or discrepancies.

3.5 FIELD QC SAMPLES

The type and frequency of field QC samples to be collected during field investigations are summarized are described below.

Equipment Blank Samples

Equipment blanks (also referred to as rinsate blanks) are samples of DI or distilled water passed through and over the surface of decontaminated sampling equipment. The rinse water is collected in sample bottles, preserved as necessary, and handled in the same manner as the samples. These blanks are used to monitor effectiveness of the decontamination process. The planned frequency for equipment blanks is to collect one rinsate blank per 10 samples collected.

Duplicate Field Samples

Duplicates will be collected for groundwater samples only due to the inherent matrix variability of soil/sediment samples. One field duplicate will be collected for each set of approximately 10 samples. Should less than 10 samples per day be collected, then one field duplicate per day will be collected.

3.6 DATA TRANSMITTAL

The integration of field data is completed by inputting the data from field forms into a spreadsheet format by data entry personnel. The spreadsheet is reviewed for completeness and accuracy by a staff geologist or engineer by comparing the electronic spreadsheet to the original field data. The reviewed spreadsheet is then uploaded into the project database.

Analytical laboratory data are provided in both a hard copy and in EDD format. The EDD should be submitted on a diskette or via email, with the disk label including the Sample Delivery Group, submittal date, laboratory name, and project name.

Information included in the EDD will follow specific guidelines to maintain data consistency. The laboratory will need to utilize the following conventions in the EDD to remain consistent with the project database:

Laboratory Sample Type:

LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LB	Laboratory Blank
LS	Laboratory Sample Duplicate
MB	Method Blank
MS	Matrix Spike
MSD	Matrix Spike Duplicate (considered separate from MS)

The EDD will also include the following information:

- Laboratory name, laboratory work order, date and time samples were received;

- Sample ID, Laboratory Sample ID, date sampled, time sampled, matrix, beginning depth and ending depth (as separate fields and where applicable), pH, and percent moisture;

- Sample Delivery Group ID, test code, test name, analyte, analyte type, sample type, CASRN, date and time prepared, date and time analyzed, preparation batch ID, analytical batch ID, result, laboratory qualifier, MDL, RL, dilution factor; and

- QC Data. The field referenced for project samples will also be populated with information for method blanks, surrogates for all samples, LCS percent recovery, and MS/MSD percent recovery. QC data will also include QC sample type, recoveries, RPDs, control limits, and associated qualifiers. No calibration data is needed at this time.

3.7 DATA TRACKING

The PM is ultimately responsible for all activities conducted for this project, including data management. The PM has the authority to enforce proper procedures as outlined in this plan and to implement corrective procedures to assure the accurate and timely flow and transfer of data. The PM will review the final data reports.

Data will be generated from the geological investigations (drilling and sampling) and environmental sampling and analysis. The generators of data (geologists, samplers, and chemical analysts) will be responsible for accurate and complete documentation of data required under the task, and for assuring that these data are presented to their supervisor in a timely manner.

The PM or his/her designee will be responsible for the day-to-day monitoring of data collected in the field, and assuring that data are collected in the format specified in the task's work plan, assigns sample designations, and routes data to the project files. Original documents will be maintained in the project file.

The PM or his/her designee shall also be responsible for evaluating geological data for accuracy and completeness.

The PM or his/her designee will be responsible for the day-to-day monitoring of activities related to the generation and reporting of chemical data, ensuring that samples are analyzed according to the specified procedures; that data are verified properly coded, checked for accuracy, entered into the data management system, and routed to the project files.

4.0 DATA VALIDATION AND USABILITY

Data validation is the process of reviewing data and accepting, qualifying, or rejecting data on the basis of sound criteria using established USEPA guidelines. Implementation of this section will determine whether the data conform to the specified criteria, thus meeting the project objectives.

4.1 DATA REVIEW AND VERIFICATION

Laboratory data generated during field investigations will be reported by the laboratory as Level II data packages. All of this data will be subjected to a limited data verification performed according to Geomatrix internal data quality control procedures as discussed below.

The data verification approach will consist of a systematic review of the analytical results, associated QC methods and results. Best professional judgment will be utilized in any area not specifically addressed by USEPA guidelines as necessary.

Data verifications will include a data completeness check of each data package, a transcription check for sample results, and a thorough review of all laboratory reporting forms. Specifically, this review will include:

- Review of data package completeness;
- Review of the required reporting summary forms to determine if the QC requirements were met and to determine the effect of exceeded QC requirements on the precision, accuracy, and sensitivity of the data;
- Review of the overall data package to determine if contractual requirements were met (based upon National Functional Guidelines);
- Review of additional QA/QC parameters, such as field duplicates and field blank contamination, to determine technical usability of the data; and
- Application of standard data quality qualifiers to the data.

In addition, data verification will include a comprehensive review of the following QA/QC parameters as indicated in the National Functional Guidelines:

- Holding times (to assess potential for degradation that will affect accuracy);
- Blanks (to assess contamination for all compounds);
- Surrogates or System Monitoring Compounds (to assess method accuracy);

- Matrix Spikes/Matrix Spike Duplicates or Laboratory Fortified Blanks (to assess accuracy of the methods and precision of the method relative to the specific sample matrix);

- Compound RLs and MDLs (to assess sensitivity as compared to project-specific requirements); and

- Field Duplicate Relative Percent Differences (or RPDs, to assess precision of the method relative to field sampling techniques, the specific sample matrix, and representativeness of the sample aliquot to the area sampled).

The results of the data verification and any corrective actions implemented are recorded on a QA/QC worksheet.

Sample results will then be qualified as appropriate, following USEPA protocols. Samples that do not meet the acceptance limit criteria will be indicated with a qualifying flag, which is a one or two-letter abbreviation that indicates a problem with the data.

During verification, the entire data set generated from a single sampling event will be verified for overall trends in data quality and usability. Information summarized as part of the data quality verification will include frequencies of detection, dilution factors that might affect data usability, and patterns of target compound distribution. The data set also will be evaluated to identify potential data limitations or uncertainties in the laboratory.

All analytical data will be supported by a data package. The data package contains the supporting QC data for the associated field samples. Data verification documentation will include the following information:

- A completed data review worksheet;

- A comprehensive narrative detailing all QC exceedances, explaining qualifications of data results. In cases where data are qualified due to quantifiable QC exceedances, the bias (high or low) will be identified (if possible);

- Data summary tables in tabular format reporting all data results with the qualifiers that were added during the data validation review. These tables will include sample ID, laboratory ID, date sampled, sample type (e.g., field duplicate, field blank), units, concentration of analytes, and validation qualifiers. These tables may be modified to report other information as needed (such as depth of soil samples, date analyzed, dilution factor);

- Re-submittal requests sent to the laboratory indicating missing information, verification of analytical information, etc.; and

- Pertinent communication records about data usability (between Geomatrix and the laboratory).

4.2 RECONCILIATION WITH USER REQUIREMENTS

The usability of the verified data will be assessed by comparing the data to the verification criteria and DQOs. The usability assessment will provide an overall summary of data quality; defining acceptability or problems with accuracy, precision, sensitivity, and representativeness of the results with clear guidance to the data users of the uncertainties in the data that have been qualified as estimated (J). Because of cumulative effects of QC exceedances, some specific results may be determined to be unusable. Alternatively, based upon the USEPA guidelines and best professional judgment, specific results may be determined to be usable for DQOs when they are not significantly outside the QC criteria. The standard validation codes (data qualifier definitions) are provided in Table 5 of Appendix A.

The final activity of the data verification process is to assess whether the data meets the DQOs. The final results, as adjusted for the findings of any data verification/data evaluation, will be checked against the DQOs and an assessment will be made as to whether the data are of sufficient quality to support the DQOs. The decision as to data sufficiency may be affected by the overall precision, accuracy, and completeness of the data as demonstrated by the data validation process. If the data are sufficient to achieve project objectives, the PM will release the data and work can proceed. If the data are insufficient, corrective action will be required.

5.0 REFERENCES

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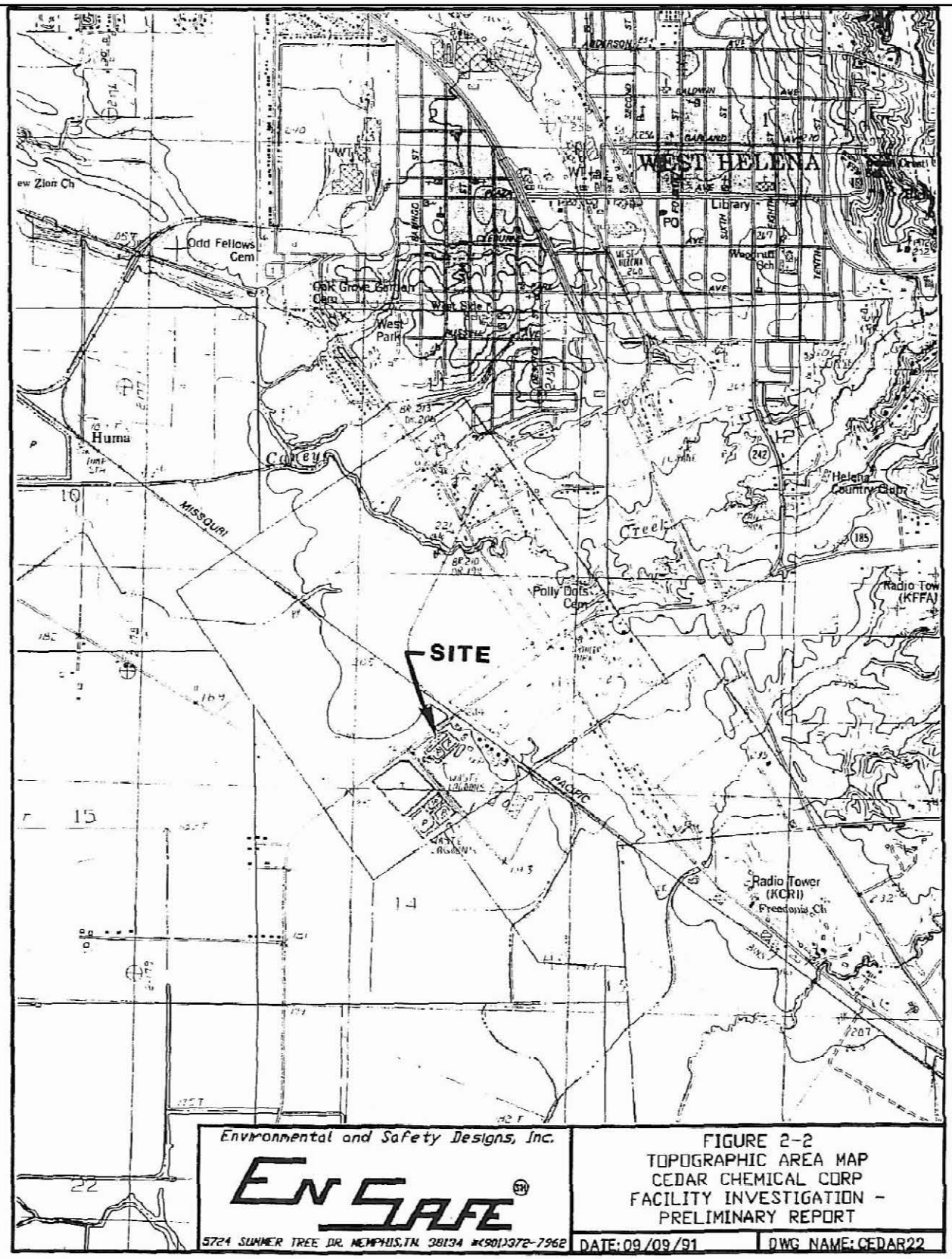
Figures

(QAPP)



SOURCE: EnSafe, Phase II Investigation Report, 1995

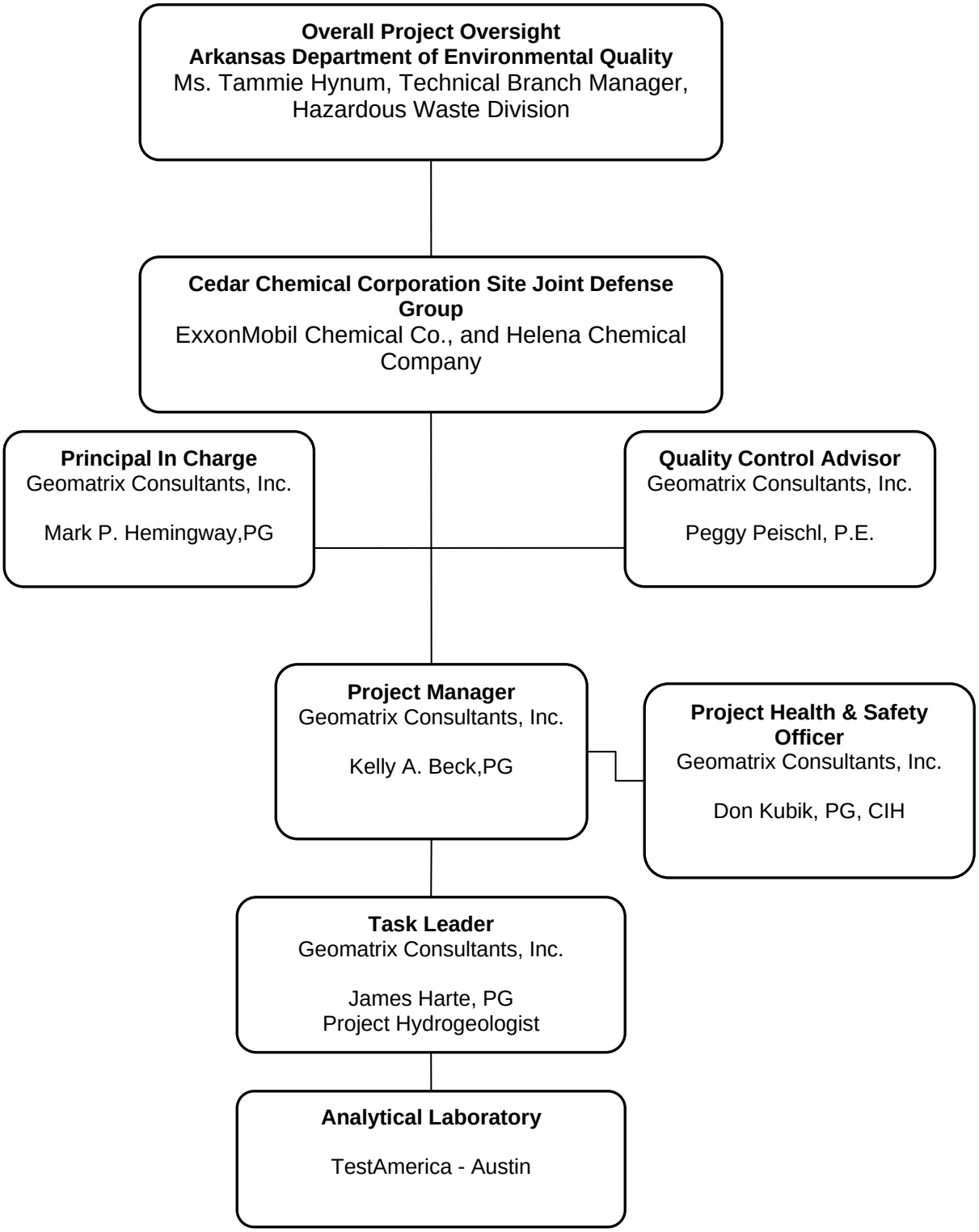
SITE LOCATION MAP

Cedar Chemical
Helena-West Helena, Arkansas

Geomatrix | Project 13636 | Figure 1

I:\13636 - Arkansas Helena-West Helena\2007 CCR\FINAL FIGURES\ FIG 1 Site Location Map\FIG 1.dwg

Figure 2.
Project Organization Chart



Appendix A

Tables (QAPP)

Table 1
Target Analyte List and Required Reporting Limits for Soil Samples
Quality Assurance Project Plan
Cedar Chemical Corporation Facility
Helena-West Helena, Arkansas

Parameters	Regulatory Limit (mg/kg)	Laboratory Reporting Limit (mg/kg)	Method Detection Limit (mg/kg)
Metals			
Aluminum	76000	10	0.806
Antimony	31	0.1	0.0038
Arsenic	0.39	0.1	0.0059
Barium	16000	0.1	0.007
Beryllium	150	0.1	0.005
Cadmium	39	0.1	0.0042
Calcium	NA	100	1.148
Chromium, Total	210	0.1	0.0486
Cobalt	900	0.1	0.0032
Copper	2900	0.1	0.027
Iron, Total	55000	5	2.984
Lead	400	0.1	0.004
Magnesium	NA	100	0.6934
Manganese, Total	3200	0.1	0.0256
Mercury	23	0.1	0.0019
Nickel	1600	0.1	0.0108
Potassium	NA	100	0.6031
Selenium	390	0.1	0.0127
Silver	390	0.1	0.002
Sodium	NA	100	0.7199
Thallium	5.5	0.1	0.0014
Vanadium	390	0.1	0.0065
Zinc	23000	1	0.2775
Organochlorine Pesticides			
4,4'-DDD	2.4	0.0017	0.000546
4,4'-DDE	1.7	0.0017	0.000238
4,4'-DDT	1.7	0.0017	0.00059
Aldrin	0.029	0.0017	0.000251
alpha-BHC	0.09	0.0017	0.000214
alpha-Chlordane	NA	0.0017	0.000323
beta-BHC	0.32	0.0017	0.000286
Chlordane	1.6	0.025	0.00779
Delta-BHC	NA	0.0017	0.000166
Dieldrin	0.03	0.0017	0.00021
Endosulfan I	370	0.0017	0.000176
Endosulfan II	NA	0.0017	0.000287
Endosulfan Sulfate	NA	0.0017	0.000276
Endrin	18	0.0017	0.000306
Endrin aldehyde	NA	0.0017	0.000213
Endrin ketone	NA	0.0017	0.000213
gamma-BHC (Lindane)	0.44	0.0017	0.000143
gamma-Chlordane	NA	0.0017	0.000266
Heptachlor	0.11	0.0017	0.000214
Heptachlor Epoxide	0.053	0.0017	0.000426
Methoxychlor	310	0.0033	0.00045
Toxaphene	0.44	0.17	0.0158

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Target Analyte List and Required Reporting Limits for Soil Samples
Quality Assurance Project Plan
Cedar Chemical Corporation Facility
Helena-West Helena, Arkansas

Parameters	Regulatory Limit (mg/kg)	Laboratory Reporting Limit (mg/kg)	Method Detection Limit (mg/kg)
Chlorinated Herbicides			
Dinoseb	61	0.012	0.00189
Semivolatile Organics			
1,2,4-Trichlorobenzene	140	0.33	0.0449
1,2-Dichlorobenzene	280	0.33	0.03963
1,3-Dichlorobenzene	69	0.33	0.03419
1,4-Dichlorobenzene	3.2	0.33	0.02987
2,4,5-Trichlorophenol	6100	0.33	0.03428
2,4,6-Trichlorophenol	44	0.33	0.0439
2,4-Dichlorophenol	180	0.33	0.04337
2,4-Dimethylphenol	1200	0.33	0.07859
2,4-Dinitrophenol	120	1.67	0.17923
2,4-Dinitrotoluene	120	0.33	0.15725
2,6-Dinitrotoluene	61	0.33	0.04096
2-Chloronaphthalene	3900	0.33	0.0313
2-Chlorophenol	64	0.33	0.02913
2-Methylnaphthalene	NA	0.33	0.03212
2-Methylphenol (o-Cresol)	3100	0.33	0.03982
2-Nitroaniline	180	0.33	0.04249
2-Nitrophenol	NA	0.33	0.06298
3,3'-Dichlorobenzidine	1.1	1.67	0.02385
3,4-Dichloroaniline	NA	0.33	To be Developed
3-Nitroaniline	NA	0.33	0.03188
4,6-Dinitro-2-methylphenol	NA	1.67	0.14174
4-Bromophenyl-phenylether	NA	0.33	0.0302
4-Chloro-3-methylphenol	NA	0.33	0.05272
4-Chloroaniline	240	0.33	0.03749
4-Chlorophenyl-phenylether	NA	0.33	0.02555
3&4-Methylphenol (m & p-Cresol)*	310*	0.33	0.06478
4-Nitroaniline	NA	0.33	0.1
4-Nitrophenol	490	1.67	0.15098
Acenaphthene	3700	0.33	0.03468
Acenaphthylene	NA	0.33	0.03275
Aniline	85	0.33	0.03157
Anthracene	22000	0.33	0.02465
Benzo(a)anthracene	0.15	0.33	0.01988
Benzo(a)pyrene	0.015	0.33	0.02275
Benzo(b)fluoranthene	0.15	0.33	0.05218
Benzo(g,h,i)perylene	NA	0.33	0.02682
Benzo(k)fluoranthene	1.5	0.33	0.03972
Benzoic acid	100000	1.67	0.1157
Benzyl alcohol	18000	0.33	0.08314
bis(2-Chloroethoxy)methane	NA	0.33	0.03249
bis(2-Chloroethyl)ether	0.21	0.33	0.03427
bis(2-Chloroisopropyl)ether	2.9	0.33	0.02721
bis(2-Ethylhexyl)phthalate (BEHP)	35	0.33	0.04188
Butylbenzylphthalate	240	0.33	0.02609

Table 1
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Quality Assurance Project Plan
Cedar Chemical Corporation Facility
Helena-West Helena, Arkansas

Parameters	Regulatory Limit (mg/kg)	Laboratory Reporting Limit (mg/kg)	Method Detection Limit (mg/kg)
Semivolatile Organics (continued)			
Chrysene	15	0.33	0.02261
Dibenz(a,h)anthracene	0.015	0.33	0.08399
Dibenzofuran	150	0.33	0.03585
Diethylphthalate	49000	0.33	0.02148
Dimethylphthalate	100000	0.33	0.02382
Di-n-butylphthalate	6100	0.33	0.02457
Di-n-octylphthalate	NA	0.33	0.12099
Dinoseb	61	To be Developed	To be Developed
Fluoranthene	2300	0.33	0.02439
Fluorene	2600	0.33	0.02309
Hexachlorobenzene	0.3	0.33	0.02802
Hexachlorobutadiene	6.2	0.33	0.04056
Hexachlorocyclopentadiene	370	1.67	0.16893
Hexachloroethane	35	0.33	0.04302
Indeno(1,2,3-cd)pyrene	0.15	0.33	0.05153
Isophorone	510	0.33	0.0427
Naphthalene	120	0.33	0.03179
Nitrobenzene	20	0.33	0.04909
N-Nitroso-di-n-propylamine	0.069	0.33	0.02431
N-Nitrosodiphenylamine	99	0.33	0.0227
Pentachlorophenol	3	1.67	0.05039
Phenanthrene	NA	0.33	0.02212
Phenol	18000	0.33	0.03278
Propanil	310	0.33	To be Developed
Pyrene	2300	0.33	0.02331
Volatile Organics			
1,1,1-Trichloroethane	1400	0.005	0.000771
1,1,2,2-Tetrachloroethane	0.38	0.005	0.003186
1,1,2-Trichloroethane	0.84	0.005	0.000525
1,1-Dichloroethane	850	0.005	0.000623
1,1-Dichloroethene	280	0.005	0.000862
1,2-Dibromoethane	0.028	0.005	0.000757
1,2-Dichlorobenzene	280	0.005	0.001718
1,2-Dichloroethane	0.35	0.005	0.000769
1,2-Dichloroethene (total)	NA	0.005	0.001191
1,2-Dichloropropane	0.35	0.005	0.000681
1,3-Dichlorobenzene	69	0.005	0.000863
1,4-Dichlorobenzene	3.2	0.005	0.001125
2-Butanone (MEK)	32000	0.01	0.001831
2-Chloroethylvinylether	NA	0.01	0.000564
2-Hexanone	NA	0.01	0.002972
4-Methyl-2-Pentanone (MIBK)	5800	0.01	0.001685
Acetone	14000	0.05	0.001742
Benzene	0.66	0.005	0.00067
Bromobenzene	73	0.005	0.000585
Bromodichloromethane	1	0.005	0.00062

Table 1
Target Analyte List and Required Reporting Limits for Soil Samples
Quality Assurance Project Plan
Cedar Chemical Corporation Facility
Helena-West Helena, Arkansas

Parameters	Regulatory Limit (mg/kg)	Laboratory Reporting Limit (mg/kg)	Method Detection Limit (mg/kg)
Volatile Organics (continued)			
Bromoform	62	0.005	0.001119
Bromomethane	3.9	0.01	0.000657
Carbon disulfide	720	0.005	0.000825
Carbon tetrachloride	0.24	0.005	0.00114
Chlorobenzene	270	0.005	0.000582
Chlorobromomethane	NA	0.005	0.000797
Chloroethane	3	0.01	0.000697
Chloroform	0.25	0.005	0.00073
Chloromethane	1.3	0.01	0.000622
cis-1,2-Dichloroethene	43	0.005	0.000635
cis-1,3-Dichloropropene +	0.7 +	0.005	0.00058
Dibromochloromethane	1	0.005	0.000653
Dibromomethane	140	0.005	0.000887
Ethylbenzene	230	0.005	0.000851
m+p Xylene	NA	0.01	0.00159
Methylene chloride	8.9	0.005	0.000903
o-Xylene	280	0.005	0.000571
Styrene	1700	0.005	0.000531
Tetrachloroethene	0.55	0.005	0.001576
Toluene	520	0.005	0.000805
trans-1,2-Dichloroethene	120	0.005	0.000692
trans-1,3-Dichloropropene +	0.7 +	0.005	0.000638
Trichloroethene	0.043	0.005	0.000946
Trichlorofluoromethane	390	0.01	0.001036
Vinyl acetate	430	0.01	0.001069
Vinyl chloride	0.043	0.005	0.000768
Xylene (total)	210	0.015	0.002107

Note:
MDL or RL highlighted in RED exceeds the target regulatory level for this project
NA - No Regulatory Limit published for this chemical
To be Developed - Laboratory will need to develop calibration curves and MDLs for these chemicals
- : No MDL or RL is available for this analyte
* : Laboratory reports single result for 3 & 4-Methylphenol due to co-elution issues.
The regulatory limit for these isomers will be compared to the MSSL established for 4-Methylphenol.
+ : results for cis and trans-1,3-Dichloropropene isomers will be compared to the MSSL established for 1,3-Dichloropropene

Table 1
Target Analyte List and Required Reporting Limits for Groundwater Samples
Quality Assurance Project Plan
Cedar Chemical Corporation Facility
Helena-West Helena, Arkansas

Parameters	Regulatory Limit (ug/l)	Laboratory Reporting Limit (ug/l)	Method Detection Limit (ug/l)
General Chemistry Parameters			
Alkalinity (as CaCO3)	NA	5000	268
Ammonia (as N)	210	100	36
Bicarbonate	NA	5000	-
Chloride	250000	1000	26
Fluoride	2000	1000	78
Hardness	NA	33000	493.4
Cyanide	200	10	3.5
Nitrate	10000	500	15
Nitrite	1000	500	22
Sulfate	250000	1000	132
Metals			
Aluminum	50	50	30.27
Antimony	6	1	0.0286
Arsenic	0.045	1	0.0338
Barium	2000	1	0.1766
Beryllium	4	1	0.0229
Cadmium	5	1	0.0231
Calcium	NA	1000	13.28
Chromium, Total	100	1	0.5568
Cobalt	730	1	0.0242
Copper	1000	1	0.1333
Iron, Total	300	50	13.76
Iron, Dissolved	300	50	13.76
Lead	15	1	0.0497
Magnesium	NA	1000	9.581
Manganese, Total	50	10	0.2247
Manganese, Dissolved	50	10	0.2247
Mercury	2	0.2	0.0601
Nickel	730	1	0.1323
Potassium	NA	1000	22.05
Selenium	50	1	0.1143
Silver	100	1	0.0395
Sodium	NA	1000	35.2
Thallium	2	1	0.0194
Vanadium	180	1	0.1516
Zinc	5000	10	2.091
Organochlorine Pesticides			
4,4'-DDD	0.28	0.05	0.0077
4,4'-DDE	0.2	0.05	0.0075
4,4'-DDT	0.2	0.05	0.0148
Aldrin	0.004	0.05	0.0059
Alpha-BHC	0.011	0.05	0.0053
alpha-Chlordane	NA	0.05	0.0053
Beta-BHC	0.037	0.05	0.0087
Chlordane	0.19	0.5	0.14
Delta-BHC	0.037	0.05	0.0058
Dieldrin	0.0042	0.05	0.0063
Endosulfan I	220	0.05	0.0058
Endosulfan II	NA	0.05	0.007
Endosulfan Sulfate	NA	0.05	0.0057
Endrin	2	0.05	0.0079
Endrin aldehyde	NA	0.05	0.0088
Endrin ketone	NA	0.05	0.007
gamma-BHC (Lindane)	0.052	0.05	0.0069
gamma-Chlordane	NA	0.05	0.0091
Heptachlor	0.015	0.05	0.0077
Heptachlor Epoxide	0.0074	0.05	0.0075
Methoxychlor	180	0.1	0.013
Toxaphene	0.061	5	0.367

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Target Analyte List and Required Reporting Limits for Groundwater Samples
Quality Assurance Project Plan
Cedar Chemical Corporation Facility
Helena-West Helena, Arkansas

Parameters	Regulatory Limit (ug/l)	Laboratory Reporting Limit (ug/l)	Method Detection Limit (ug/l)
Chlorinated Herbicides			
Dinoseb	7	0.236	0.6
Semivolatile Organics			
1,2,4-Trichlorobenzene	8.2	10	0.84
1,2-Dichlorobenzene	49	10	0.973
1,3-Dichlorobenzene	15	10	0.994
1,4-Dichlorobenzene	0.47	10	0.809
2,4,5-Trichlorophenol	3700	10	1.005
2,4,6-Trichlorophenol	6.1	10	1.094
2,4-Dichlorophenol	110	10	1.03
2,4-Dimethylphenol	730	10	1.902
2,4-Dinitrophenol	73	50	3.745
2,4-Dinitrotoluene	73	10	2.882
2,6-Dinitrotoluene	37	10	1.026
2-Chloronaphthalene	490	10	1.461
2-Chlorophenol	30	10	1.486
2-Methylnaphthalene	NA	10	0.969
2-Methylphenol (o-Cresol)	1800	10	1.824
2-Nitroaniline	110	50	1.189
2-Nitrophenol	NA	10	1.054
3,3'-Dichlorobenzidine	0.15	50	1.708
3,4-Dichloroaniline	NA	10	To Be Developed
3-Nitroaniline	NA	50	1.215
4,6-Dinitro-2-methylphenol	NA	50	3.557
4-Bromophenyl-phenylether	NA	10	0.933
4-Chloro-3-methylphenol	NA	10	1.074
4-Chloroaniline	150	10	1.659
4-Chlorophenyl-phenylether	NA	10	1.436
3 & 4-Methylphenol (m & p-Cresol)*	180*	20	2.581
4-Nitroaniline	NA	50	1.088
4-Nitrophenol	290	50	4.102
Acenaphthene	370	10	1.098
Acenaphthylene	NA	10	0.905
Aniline	12	10	2.046
Anthracene	1800	10	1.131
Benzo(a)anthracene	0.029	10	1.121
Benzo(a)pyrene	0.0029	10	1.109
Benzo(b)fluoranthene	0.029	10	0.788
Benzo(g,h,i)perylene	NA	10	0.762
Benzo(k)fluoranthene	0.29	10	1.232
Benzoic acid	150000	50	13.47
Benzyl alcohol	11000	10	1.639
bis(2-Chloroethoxy)methane	NA	10	1.127
bis(2-Chloroethyl)ether	0.0098	10	1.197
bis(2-Chloroisopropyl)ether	0.27	10	1.22
bis(2-Ethylhexyl)phthalate (BEHP)	4.8	10	2.737
Butylbenzylphthalate	7300	10	0.987
Chrysene	3	10	1.073
Dibenz(a,h)anthracene	0.003	10	1.009
Dibenzofuran	12	10	1.054
Diethylphthalate	29000	10	1.473
Dimethylphthalate	370000	10	1.264
Di-n-butylphthalate	3700	10	1.132
Di-n-octylphthalate	NA	10	1.11
Dinoseb	7	20	0.542
Fluoranthene	1500	10	0.921
Fluorene	240	10	1.014
Hexachlorobenzene	0.042	10	1.474
Hexachlorobutadiene	0.86	10	1.275

Table 1
Target Analyte List and Required Reporting Limits for Groundwater Samples
Quality Assurance Project Plan
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Helena-West Helena, Arkansas

Parameters	Regulatory Limit (ug/l)	Laboratory Reporting Limit (ug/l)	Method Detection Limit (ug/l)
Semivolatile Organics (continued)			
Hexachlorocyclopentadiene	220	50	3.407
Hexachloroethane	4.8	10	0.94
Indeno(1,2,3-cd)pyrene	0.029	10	1.145
Isophorone	71	10	1.094
Naphthalene	6.2	10	0.876
Nitrobenzene	3.4	10	1.12
N-Nitroso-di-n-propylamine	0.0096	10	1.039
N-Nitrosodiphenylamine	14	10	0.936
Pentachlorophenol	0.56	50	5.438
Phenanthrene	NA	10	0.998
Phenol	11000	10	2.135
Propanil	180	10	To Be Developed
Pyrene	180	10	0.917
Volatile Organics			
1,1,1-Trichloroethane	200	1	0.3599
1,1,2,2-Tetrachloroethane	0.055	1	0.3102
1,1,2-Trichloroethane	0.2	1	0.3522
1,1-Dichloroethane	1200	1	0.3743
1,1-Dichloroethene	7	1	0.4267
1,2-Dibromoethane	0.0056	1	0.2984
1,2-Dichlorobenzene	49	1	0.434
1,2-Dichloroethane	0.12	1	0.39226
1,2-Dichloroethene (total)	NA	2	0.7304
1,2-Dichloropropane	0.16	1	0.3734
1,3-Dichlorobenzene	15	1	0.3857
1,4-Dichlorobenzene	0.47	1	0.3756
2-Butanone (MEK)	7100	5	0.8406
2-Chloroethylvinylether	NA	-	0.623
2-Hexanone	NA	5	0.2664
4-Methyl-2-Pentanone (MIBK)	2000	5	0.4163
Acetone	5500	5	0.819
Benzene	0.35	1	0.3923
Bromobenzene	23	1	0.3942
Bromodichloromethane	0.18	1	0.3689
Bromoform	8.5	2	0.2693
Bromomethane	8.7	2	0.7234
Carbon disulfide	1000	1	0.383
Carbon tetrachloride	0.17	1	0.4073
Chlorobenzene	91	1	0.333
Chlorobromomethane	NA	1	0.3681
Chloroethane	3.9	2	0.4493
Chloroform	0.17	1	0.3486
Chloromethane	2.1	2	0.4221
cis-1,2-Dichloroethene	61	1	0.3674
cis-1,3-Dichloropropene [+]	0.4[+]	1	0.3071
Dibromochloromethane	0.13	1	0.2783
Dibromomethane	61	1	0.407
Ethylbenzene	700	1	0.4156
m+p Xylene	NA	2	0.8265
Methylene chloride	4.3	1	0.4221
o-Xylene	1400	1	0.3863
Styrene	100	1	0.31
Tetrachloroethene	0.11	1	0.3978
Toluene	1000	1	0.3912
trans-1,2-Dichloroethene	100	1	0.372
trans-1,3-Dichloropropene [+]	0.4[+]	1	0.2091

Table 1
Target Analyte List and Required Reporting Limits for Groundwater Samples
Quality Assurance Project Plan
Cedar Chemical Corporation Facility
Helena-West Helena, Arkansas

Parameters	Regulatory Limit (ug/l)	Laboratory Reporting Limit (ug/l)	Method Detection Limit (ug/l)
Volatile Organics (continued)			
Trichloroethene	0.028	1	0.4487
Trichlorofluoromethane	1300	2	0.4743
Vinyl acetate	410	2	0.2933
Vinyl chloride	0.015	2	0.402
Xylene (total)	200	3	1.2022
Dissolved Gases			
Methane	NA	0.5	0.211
Ethane	NA	0.5	0.0615
Ethene	NA	0.5	0.0569
Carbon Dioxide	NA	50	7
Carbon Monoxide	NA	50	13
Oxygen	NA	50	39
Nitrogen	NA	50	40

Note:
MDL or RL highlighted in RED exceeds the target regulatory level for this project
NA - No Regulatory Limit published for this chemical
In Development - Laboratory is developing calibration curves for these chemicals for quantitative analysis
To Be Developed - Laboratory will develop MDLs for these chemicals
- : No MDL or RL is available for this analyte
* : Laboratory reports single result for 3 & 4-Methylphenol due to co-elution issues.
The regulatory limit for these isomers will be compared to the MSSL established for 4-Methylphenol.
+ : cis and trans-1,3-Dichloropropene isomers will be compared to the MSSL established for 1,3-Dichloropropene

Table 2
Summary of Analytical Method, Containers, Preservatives, and Holding Times
Quality Assurance Project Plan
Cedar Chemical Corporation Facility
Helena-West Helena, AR

Parameter	Matrix	Preparation Method	Analytical Method	Container	Preservative	Holding Time
Volatile Organic Compounds	Water	5030	8260B	3 x 40-mL glass	Cool 4 ^{o}C, pH < 2 HCL	14 days
	Soil	5030	8260B	1 x 4 oz glass	Cool 4 ^{o}C	14 days
Semivolatile Organic Compounds	Water	3520	8270C	1 x 1-L amber glass	Cool 4 ^{o}C	7 days until extraction; 40 days to analysis
	Soil	3550	8270C	1 x 4 oz amber glass	Cool 4 ^{o}C	14 days until extraction; 40 days to analysis
Metals (Including Mercury)	Water	3005	6010 or 6020, 7470	1 x 250 mL polyethylene	Cool 4 ^{o}C, pH < 2 HNO_3	6 months
	Soil	3050	6010 or 6020, 7471	1 x 4 oz glass	Cool 4 ^{o}C	6 months
Organochlorine Pesticides	Water	3510	8081A	1 x 1-L amber glass	Cool 4 ^{o}C	7 days until extraction; 40 days to analysis
	Soil	3550	8081A	1 x 4-oz glass	Cool 4 ^{o}C	14 days until extraction; 40 days to analysis
Chlorinated Herbicides (Dinoseb)	Water	3510	8151A	1 x 1-L amber glass	Cool 4 ^{o}C	7 days until extraction; 40 days to analysis
	Soil	3550	8151A	1 x 4 oz amber glass	Cool 4 ^{o}C	14 days until extraction; 40 days to analysis
Dissolved Gases *	Water	NA	RSK175	3 x 40-mL glass	Cool 4 ^{o}C, pH < 2 HCL	14 days
Dissolved Gases **	Water	NA	RSK175	3 x 40-mL glass	Cool 4 ^{o}C	14 days
Alkalinity	Water	NA	310.1	1 x120-mL polyethylene	Cool 4 ^{o}C	14 days
Chloride	Water	NA	300.0	1 x120-mL polyethylene	Cool 4 ^{o}C	28 days
Hardness	Water	NA	2340B	1 x 250-mL polyethylene	Cool 4 ^{o}C, pH < 2 HNO_3	6 months
Nitrate	Water	NA	353.2 / 300.0	1 x 250-mL amber glass / 1 x 120-mL polyethylene	pH <2 H2SO4 / Cool 4 ^{o}C	28 days / 48 hours
Nitrite	Water	NA	353.2 / 300.0	1 x 250-mL amber glass / 1 x 120-mL polyethylene	pH <2 H2SO4 / Cool 4 ^{o}C	28 days / 48 hours
Sulfate	Water	NA	9056 / 300.0	1 x120-mL polyethylene	Cool 4 ^{o}C	28 days
Cyanide, Total	Water	NA	9012 / 335.4	1 x 250-mL polyethylene	Cool 4 ^{o}C, pH > 12 NaOH	14 days
Ammonia	Water	NA	350.1	1 x 250-mL amber glass	Cool 4 ^{o}C	28 days
Bicarbonate	Water	NA	310.1	1 x 120-mL polyethyelene	Cool 4 ^{o}C	14 days
Fluoride	Water	NA	300.0	1 x 120-mL polyethyelene	Cool 4 ^{o}C	28 days

Notes:
* - Includes Methane, Ethane, Ethene
** - Carbon Dioxide, Oxygen, Carbon Monoxide
^{o}C - Degrees Celsius
HCL - Hydrochloric Acid
HNO3 - Nitric Acid
H2SO4 - Sulfuric Acid
NAOH - Sodium Hydroxide
mL - Milliliters
L - Liter
oz. - Ounce

TABLE 3

METHOD PERFORMANCE OBJECTIVES—ACCEPTANCE CRITERIA

Cedar Chemical Corporation Facility
Helena-West Helena, Arkansas

Method Performance Objective	Type of Quality Control Sample	Frequency	Project Acceptance Criteria
Precision—Field	Duplicate field sample	1 per 10 groundwater samples. If less than 10 field samples are collected per day then 1 field duplicate is collected per day	Relative percent difference, RPD <30
Precision—Laboratory	Laboratory control samples (LCS) and laboratory control duplicate (LCSD) samples	1 per batch of 20 samples per matrix	Defaults to Laboratory QC Limits
	Matrix spike (MS) and matrix spike duplicate (MSD) samples	1 per batch of 20 or fewer investigative samples per matrix	Defaults to Laboratory QC Limits
	Unspiked duplicate samples	1 per batch of 20 samples per matrix	Relative percent difference, RPD <30
Accuracy—Field	Equipment rinsate blank	1 per 10 groundwater samples collected per equipment type (non-dedicated equipment)	USEPA National Functional Guidelines Protocol
Accuracy—Laboratory	Matrix spike (MS) samples	1 per batch of 20 or fewer investigative samples per matrix	Defaults to Laboratory QC Limits
	Laboratory control samples (LCS)	at least once with each analytical batch, with a minimum of 1 for every 20 samples	Defaults to Laboratory QC Limits
	Method blanks	at least once with each analytical batch, with a minimum of 1 for every 20 samples	No compounds should be detected in laboratory method blanks
	Preparation blanks	at least once with each analytical batch, with a minimum of 1 for every 20 samples	Defaults to Laboratory QA/QC Protocol
	Surrogates		Defaults to Laboratory QC Limits

TABLE 3 (continued)

METHOD PERFORMANCE OBJECTIVES—ACCEPTANCE CRITERIA
Cedar Chemical Corporation Facility
Helena-West Helena, Arkansas

Method Performance Objective	Type of Quality Control Sample	Frequency	Acceptance Criteria
Representativeness	Not applicable	Not applicable	Numerical goals cannot be used to evaluate this subjective measure.
Completeness	Not applicable	Not applicable	90% completeness
Comparability	Not applicable	Not applicable	Comparable if the same procedures for collecting and analyzing the samples are used, if the samples comply with the same QA/QC procedures, and if the units of measurement are the same
Sensitivity	Not applicable	Not applicable	Reporting limits (RLs) below or equal to the task-specific target analysis goals or concentrations

TABLE 4

FIELD QUALITY CONTROL SAMPLES

Cedar Chemical Corporation Facility
Helena-West Helena, Arkansas

Type of Quality Control Sample	Frequency	Acceptance Criteria
Trip blanks	1 per cooler of VOC samples	U.S. EPA National Functional Guidelines Protocol
Equipment rinsate blank	1 per 10 groundwater samples collected per equipment type (non-dedicated equipment)	U.S. EPA National Functional Guidelines Protocol
Field Duplicate	1 per 10 groundwater samples. If less than 10 field samples are collected per day then 1 field duplicate per day will be collected.	Relative percent difference, RPD <30

Abbreviations used:
RPD = relative percent difference
VOCs = volatile organic compounds
U.S. EPA = U.S. Environmental Protection Agency

TABLE 5

DATA QUALIFIER DEFINITIONS

Cedar Chemical Corporation Facility
Helena-West Helena, Arkansas

Qualifier	Explanation of Qualifier
Organic Analyses [1]	
U	The compound was analyzed for, but was not detected above the reported sample quantitation limit.
UB	Not detected substantially above the concentration reported in the laboratory or field blanks. For organics – 5X (10X for common laboratory contaminants) or for metals 10X. Data point considered non-detect at the reported value.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
Inorganic Analyses [2]	
U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J	The result is an estimated quantity.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
R	The data are unusable. The sample results are rejected due to serious deficiencies in meeting Quality Control (QC) criteria. The analyte may or may not be present in the sample.
Bias Codes	
H	Potential High bias
L	Potential Low Bias

1 U.S.EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA540/R-99/008, October 1999.
2 U.S.EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA540/R-04/004, October 2004.

Appendix B

Test America Quality Assurance Manuals (QAPP)

SEVERN TRENT STL

Controlled Copy Number: UNCONTROLLED COPY

Laboratory Quality Manual
STL Austin

14050 Summit Park, Suite A100
Austin, Texas 78728
512-244-0855

Revision 3
Effective Date: 3/31/06

Approved by:

Karmen L. Miller

Karmen L. Miller – Quality Assurance Manager

Richard Laster

Richard Laster – Operations/Technical Manager

Carl W. Skelley

Carl W. Skelley – Laboratory Director

Robert Wyeth

Robert Wyeth – General Manager

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Preface

The purpose of the STL Austin Laboratory Quality Manual (LQM) is to provide quality assurance (QA) guidance to STL Austin. This guidance allows STL Austin to operate under a standardized, rigorous Quality System and ensures that our clients are consistently provided with data that are of known and documented quality. The LQM outlines the purpose, policies, organization, responsibilities, and operations related to ensuring high quality performance in all STL Austin activities. The LQM also fulfills the requirement of our clients and of government programs to document our Quality System.

The LQM contains many references to other essential STL quality documents. These include the QMP, Policy Documents, and Standard Operating Procedures (SOPs), both corporate and laboratory-specific, that help ensure the quality of our products and intertwine to produce a strong Quality System within STL Austin. This system is the foundation that provides our operations with guidance and ensures consistently produced quality deliverables. The project-specific requirements delineated in project plans may supersede the general quality requirements described in this manual.

The document is designed to follow the basic outline required for a quality management plan as described by the United States Environmental Protection Agency (EPA). Table 2.3-1 cross-references the narrative sections of the LQM to the appropriate sections of the EPA document and other nationally recognized quality standards. This revision reflects specific changes to meet the Quality Standard Requirements of the National Environmental Accreditation Conference (NELAC) (approval date June 5, 2003, effective date July 1, 2005), as shown in the NELAC cross-reference Table 2.3-2.

There are two basic types of information included in the LQM; General information and Operation-specific information. Operation-specific information, provided in the Appendices, describes the quality control (QC) requirements that apply only to a specific operation. The Operation-Specific Appendices include information such as method detection limits (MDLs) and laboratory SOPs that cannot be standardized throughout the STL Austin laboratory operations due to their client-specific, laboratory-specific, or instrument-specific nature.

Foreword

STL Austin LQM Revision 3 Implementation:

The Quality Assurance Manager, or designee, is to distribute the document and conduct training on the LQM within 45 days of the effective date. Implementation of the LQM shall be completed within 60 days of the effective date.

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Acronyms and Initialisms

A2LA	American Association for Laboratory Accreditation
AA	Atomic Absorption
ANSI	American National Standards Institute
AR/COC	Analysis Request/Chain-of-Custody
ASQC	American Society for Quality Control
ASTM	American Society for Testing and Materials
BFB	Bromofluorobenzene
BLK	Blank
BOD	Biochemical Oxygen Demand
CCC	Calibration Check Compound
CEO	Chief Executive Officer
CF	Calibration Factor
CFR	Code of Federal Regulations
CHP	Chemical Hygiene Plan
CLP	Contract Laboratory Program
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act (Superfund)
COC	Chain-of-Custody
COD	Chemical Oxygen Demand
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantitation Limit
CSM	Customer Service Manager
CSRM	Certified Standard Reference Material
CST	Customer Service Team
CUR	Condition Upon Receipt
CV	Coefficient of Variation
CVAA	Cold Vapor Atomic Absorption (Spectroscopy)
DFTPP	Decafluorotriphenylphosphine
DOC	Dissolved Organic Carbon
DOE	Department of Energy
DOT	Department of Transportation

Acronyms and Initialisms (continued)

DQO	Data Quality Objective
EH&S	Environmental Health and Safety
EPA	(U. S.) Environmental Protection Agency
FAS	Field Analytical Services
FLAA	Flame Atomic Absorption (Spectroscopy)
FTIR	Fourier Transform Infrared (Spectrometry)
GC	Gas Chromatograph(y)
GC/MS	Gas Chromatography/Mass Spectrometry
GFAA	Graphite Furnace Atomic Absorption (Spectroscopy)
HDPE	High Density Polyethylene
HPLC	High Performance Liquid Chromatography
HRGC	High Resolution Gas Chromatography
HRMS	High Resolution Mass Spectrometry
ICAP	Inductively Coupled Argon Plasma (Spectroscopy)
ICAP/MS	Inductively Coupled Argon Plasma/Mass Spectrometry
ICS	Interference Check Sample
IDL	Instrument Detection Limit
IR	Infrared (Spectroscopy)
IS	Information Systems
IS	Internal Standard
ISO	International Organization for Standardization
IT	Information Technology
KRI	Key Result Indicator
LAN	Local Area Network
LCL	Lower Control Limit
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
LRGC	Low Resolution Gas Chromatography
LRMS	Low Resolution Mass Spectrometry

Acronyms and Initialisms (continued)

LWL	Lower Warning Limit
MBAS	Methylene Blue Active Substance
MDC	Minimum Detectable Concentration
MDL	Method Detection Limit
MS	Matrix Spike
MSA	Method of Standard Additions
MSD	Matrix Spike Duplicate
MSDS	Material Safety Data Sheet
NELAC	National Environmental Laboratory Accreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
NCM	Nonconformance Memo
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards Technology
NMOC	Non-Methane Organic Compounds
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NRM	National Reference Material
PAH	Polynuclear Aromatic Hydrocarbons (or PNA)
PC	Personal Computer
PCB	Polychlorinated Biphenyls
PDS	Post Digestion Spike
PE	Performance Evaluation
PEM	Performance Evaluation Mixture
PM	Project Manager
PQL	Practical Quantitation Limit
PSRL	Project-Specific Reporting Limit
PUF	Polyurethane Foam
QA	Quality Assurance
QAMP	Quality Assurance Management Plan
QAPP	Quality Assurance Project Plan or Quality Assurance Program Plan

Acronyms and Initialisms (continued)

QAS	Quality Assurance Summary
QC	Quality Control
QS	Quality System
QuantIMS	Laboratory Information Management System
QRI	Quality-Related Item
RCRA	Resource Conservation and Recovery Act
RF	Response Factor
RFP	Request for Proposal
RFQ	Request for Quote
RL	Reporting Limit
RPD	Relative Percent Difference
RRF	Relative Response Factor
RSD	Relative Standard Deviation
RSO	Radiation Safety Officer
SDG	Sample Delivery Group
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCC	System Performance Check Compounds
SPLP	Synthetic Precipitation Leaching Procedure
SRL	Standard Reporting Limit
SRM	Standard Reference Material
TCLP	Toxicity Characteristic Leaching Procedure
TIC	Tentatively Identified Compound
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TOX	Total Organic Halides
UCL	Upper Control Limit
UPS	Uninterruptable Power Supply
USEPA	United States Environmental Protection Agency
UWL	Upper Warning Limit

Acronyms and Initialisms (continued)

VOA	Volatile Organic Analysis
VOST	Volatile Organic Sampling Train
WAN	Wide Area Network
WS	Water Supply
WP	Water Pollution

1.0 Management Commitment and Organization

This section discusses the management commitment to quality and the organizational structure and management responsibilities for implementing a quality system that fulfill that commitment. The commitment to quality is established at the highest levels of management at Severn Trent Laboratories, Inc. (STL) and is maintained at the individual laboratories throughout the STL system. This *Laboratory Quality Manual* (LQM) describes the specific quality systems for the STL laboratory in Austin, Texas, known as STL Austin.

1.1 STL Vision, Mission and Shared Values

Vision: STL will be the recognized industry leader for environmental analysis.

Mission: Through the innovation and dedication of our people, together with the quality of our systems, we will deliver levels of performance that delight our clients, retain the confidence of our stakeholders and enable the profitable growth of our business.

1.2 STL Quality Assurance Policy

It is STL's policy to:

- Provide high quality, consistent, and objective environmental testing services that meet all federal, state, and municipal regulatory requirements.
- Ensure employee adherence to quality documentation and implementation of Corporate Policies and Procedures.
- Generate data that are scientifically sound, legally defensible, meet project objectives, and are appropriate for their intended use.
- Provide STL clients with the highest level of professionalism and the best service practices in the industry.
- Build continuous improvement mechanisms into all laboratory, administrative, and managerial activities.
- Maintain a working environment that fosters open communication with both clients and staff and ensures data integrity.

1.3 STL Management Commitment to Quality Assurance

STL management is committed to providing data of known and documented quality and the best service in the environmental testing industry. To ensure that the data produced and reported by STL meet the requirements of its clients and comply with the letter and spirit of municipal, state and federal regulations, STL maintains quality and data integrity systems that are clear, effective, well communicated, and supported at all levels in the company.

1.4 Prevention of Waste, Fraud and Abuse

STL is committed and dedicated to providing the highest quality analytical data possible to its clients. This means that the data produced, managed and reported by STL must meet the requirements of its clients and comply with both the letter and spirit of the various municipal, state and federal regulations and guidelines.

Establishing and maintaining a high ethical standard is an important element of a Quality System. STL Austin has developed a proactive program for prevention and detection of improper, unethical or illegal actions. Components of this program include: periodic QA meetings to train, review and discuss laboratory practices; single- and double-blind proficiency testing; electronic data audits; post-analysis data review by the QA Manager or designee; internal audits and inspections; and procedures identifying appropriate and inappropriate laboratory and instrument manipulation practices.

Ethics is a major component of the STL QA training program. Each employee is trained in ethics as part of corporate QA training that includes review of the ethics policy, as well as group discussions about data integrity and data misrepresentation. Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. In order to ensure that all personnel understand the importance the company places on maintaining high ethical standards at all times, STL has established an Ethics Policy P-L-006 and Ethics Agreement (see Figure 1.4-1). All employees must sign the STL Ethics Agreement upon employment, signifying agreed compliance with its stated purpose. The ethics agreement is required to be re-signed on an annual basis.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize STL's ability to do work on Government contracts, and for that reason, STL has a Zero Tolerance approach to such violations.

STL, through its ethics policy and training, requires and encourages all employees to report any activity that may be considered wasteful, unethical, or fraudulent. Any incidents reported are subject to a complete investigation. A data integrity hotline (1-800-736-9407) is prominently displayed in the laboratory and is administered by the Corporate QA Director.

1.5 STL Austin Overview

This LQM summarizes the policies and operational procedures associated with the STL Austin Laboratory in Austin, Texas. Specific protocols for sample handling and storage, chain-of-custody, and laboratory analyses, data reduction, corrective action and reporting are described. All policies and procedures have been structured in accordance with the NELAC standards adopted on June 5, 2003, effective July 1, 2005 (current as of the date of this publication) and applicable EPA requirements, regulations, guidance and technical standards. This manual has been prepared in accordance with the quality guidance documents listed in Section 2.3. Further

details on these policies and procedures are contained in SOPs and related documents. This LQM, SOPs and related documentation describe the quality system for STL Austin.

STL Austin performs chemical and physical analyses for inorganic and organic constituents in a variety of environmental and industrial processes, including water, air, sediment, sludge, waste and soil. STL Austin's goal is to produce data that are scientifically valid, defensible and of known and documented quality in accordance with standards developed by the National Environmental Laboratory Accreditation Conference (NELAC) and any applicable state or EPA regulations or requirements.

FIGURE 1.4-1

STL ETHICS AGREEMENT

I understand that STL is committed to ensuring the highest standard of quality and integrity of the data and services provided to our clients. I have read the Ethics Policy of the Company.

With regard to the duties I perform and the data I report in connection with my employment at the Company, I agree that:

- I will not intentionally report data values that are not the actual values obtained;
- I will not intentionally report the dates, times, sample or QC identifications, or method citations of data analyses that are not the actual dates, times, sample or QC identifications, or method citations;
- I will not intentionally misrepresent another individual's work;
- I will not intentionally misrepresent any data where data does not meet Method or QC requirements. If it is to be reported, I will report it with all appropriate notes and/or qualifiers;
- I agree to inform my Supervisor of any accidental reporting of non-authentic data by me in a timely manner; and I agree to inform my Supervisor of any accidental or intentional reporting of non-authentic data by other employees; and
- If a supervisor or a member of STL management requests me to engage in or perform an activity that I feel is compromising data validity or quality, I will not comply with the request and report this action immediately to a member of senior management, up to and including the President of STL.
- I will not share the pricing or cost data of Vendors or Suppliers with anyone outside of the Severn Trent family of companies.

As a STL employee, I understand that I have the responsibility to conduct myself with integrity in accordance with the ethical standards described in the Ethics Policy. I will also report any information relating to possible kickbacks or violations of the Procurement Integrity Act, or other questionable conduct in the course of sales or purchasing activities. I will not knowingly participate in any such activity and will report any actual or suspected violation of this policy to management.

The Ethics Policy has been explained to me by my supervisor or at a training session, and I have had the opportunity to ask questions if I did not understand any part of it. I understand that any violation of this policy subjects me to disciplinary action, which can include termination. In addition, I understand that any violation of this policy which relates to work under a government contract or subcontract could also subject me to the potential for prosecution under federal law.

EMPLOYEE SIGNATURE _____ Date _____

Supervisor/Trainer: _____ Date _____

1.6 STL Austin Organizational Structure and Relationships

STL is incorporated in the state of Delaware with corporate headquarters located in Colmar, Pennsylvania. The current corporate organizational structure (as of 11/05) is presented in the STL Quality Management Plan (QMP). All STL laboratory locations, including STL Austin, are listed in the STL QMP. A list of key corporate personnel and an organizational chart for STL including Corporate QA management are also provided in the STL QMP. The current organizational structure (as of 03/06) for STL Austin is presented in this LQM (see Figure 1.6-1). The responsibilities and authorities of the members of the organization, as they relate to quality management, are outlined in Section 1.7.

Each STL laboratory has day-to-day independent operational authority that is overseen by the following corporate functions: senior management, health and safety, technology, quality assurance, finance and human resources. The STL Austin laboratory has the following operational staff supported by local management: QA manager, safety officer, operations manager, technical director, human resources coordinator, controller, reporting personnel and administrative support. This team is directed by the laboratory director to meet daily workload commitments with a degree of autonomy. The team participates in the planning and execution of projects as defined in Section 7.0. These support functions have a level of responsibility to the corporate level staff and management. The QA Manager (QAM) is independent from the laboratory's day-to-day operations and is free from financial and other undue pressures which might adversely affect the quality of work. The QAM, a key member of the laboratory's management team, has direct access to the Corporate Quality Assurance Director on all matters involving quality. The QAM, if required, has the authority to cease operations adversely affecting the production of quality data.

1.7 Quality Organization

All employees are responsible for complying with the quality management system. Quality-related responsibilities within the organization provide for the implementation of the LQM and for completion of QC activities. It is the responsibility of each STL employee to perform their job-related duties in compliance with all STL corporate and laboratory SOPs and policies applicable to their position. The following sections describe these activities for key STL Austin positions.

1.7.1 Laboratory Director

The Laboratory Director has the following responsibilities:

- Reports directly to the General Manager;
- Is responsible for implementing and adherence to the STL QMP and all corporate policies and procedures within the laboratory;

- Annually assesses the effectiveness of the QMP within the operation;
- Approves the Laboratory Quality Manual and laboratory SOPs;
- Oversees the daily operations of the laboratory;
- Achieves the financial, business and quality objectives of the laboratory;
- Supervises staff, sets goals and objectives for both the business and the employees;
- Maintains adequate trained staffing documented on organization charts;
- Ensures timely compliance with internal/external audit findings and corrective actions; and
- Responsible for maintaining a working environment which encourages open, constructive problem solving and continuous improvement.

1.7.2 Laboratory Technical Managers

Laboratory Technical Managers have the following responsibilities:

- Report directly to Operations Manager (or Laboratory Director);
- Available to laboratory staff for technical questions/support;
- Responsible for coordinating the development and implementation of SOPs;
- Provide educational direction in area(s) of expertise;
- Overall, responsible for a defined technical area(s) of the laboratory;
- Interface with management on technical needs and solving day-to-day technical issues;
- Determine qualification required for technical positions and evaluates job candidates against those requirements;
- Investigate technical issues related to projects as directed by QA;
- Evaluate new methods, technical proposals and statements of work;
- Certify technical laboratory personnel based on education and background to ensure that staff have demonstrated capability in the activities for which they are responsible; and
- Perform other tasks as required by NELAC.

1.7.3 Operations Manager

The Laboratory Operations Manager has the following responsibilities:

- Reports directly to the Laboratory Director;
- Supervises daily activities of the laboratories;
- Schedules analytical operations;
- Supervises QC activities performed as a part of routine analytical operations;
- Implements data review procedures;
- Ensures the preparation and maintenance of laboratory records;
- Ensures maintenance of instruments and scheduling of repairs;
- Works with the Project Managers and Laboratory Managers to assure the requirements of projects are met in a timely manner;
- Is responsible for meeting quality requirements, and;
- Is responsible for general facility maintenance and repairs.

1.7.4 Laboratory Quality Assurance Manager

The Laboratory Quality Assurance (QA) Manager has the following responsibilities:

- Reports directly to the Laboratory Director and for all QA matters to the Corporate QA Manager to maintain independence in QA oversight;
- Serves as a focal point for QA and QC and is responsible for the implementation and communication of the STL QMP specifications at the laboratory;
- Maintains, approves, and implements the Laboratory Quality Manual (LQM);
- Approves laboratory SOPs;
- Ensures and improves quality within laboratory operations;
- Recommends resolutions for ongoing or recurrent nonconformances within the laboratory;
- Supervises and provides guidance and training to laboratory QA staff; provides Quality Systems training to all new personnel;
- Has the authority to accept or reject data and to stop work in progress in the event that procedures or practices compromise the validity and integrity of analytical data;
- Assists in maintaining regulatory analytical compliance;
- Assists in the identification of appropriate resolution of complaints received from clients involving data quality issues;
- Monitors data quality measures via statistical methods to verify that the laboratory routinely meets stated quality goals;
- Performs QA assessments and tracks findings from external and internal audits;
- Issues QA directives, policy or QA SOPs to meet the Corporate requirements or to clarify such requirements for the laboratory;
- Reviews and approves corrective action plans for nonconformances, trends nonconformances to detect systematic problems and initiates additional corrective actions as needed;
- Participates in the selection, review and approval of subcontractors;
- Assists in the preparation of and approves Quality Assurance Project Plans (QAPPs);
- May serve as a QA Coordinator for specific projects;
- Coordinates laboratory certification and accreditation programs;
- Oversees the maintenance of QC records and maintains controlled quality documents;
- Notifies lab management of deficiencies in the quality system and prepares a monthly report to management; and
- Responsible for approving reference data and changes to LIMS.

1.7.5 Office Administrator

The Office Administrator has the following responsibilities:

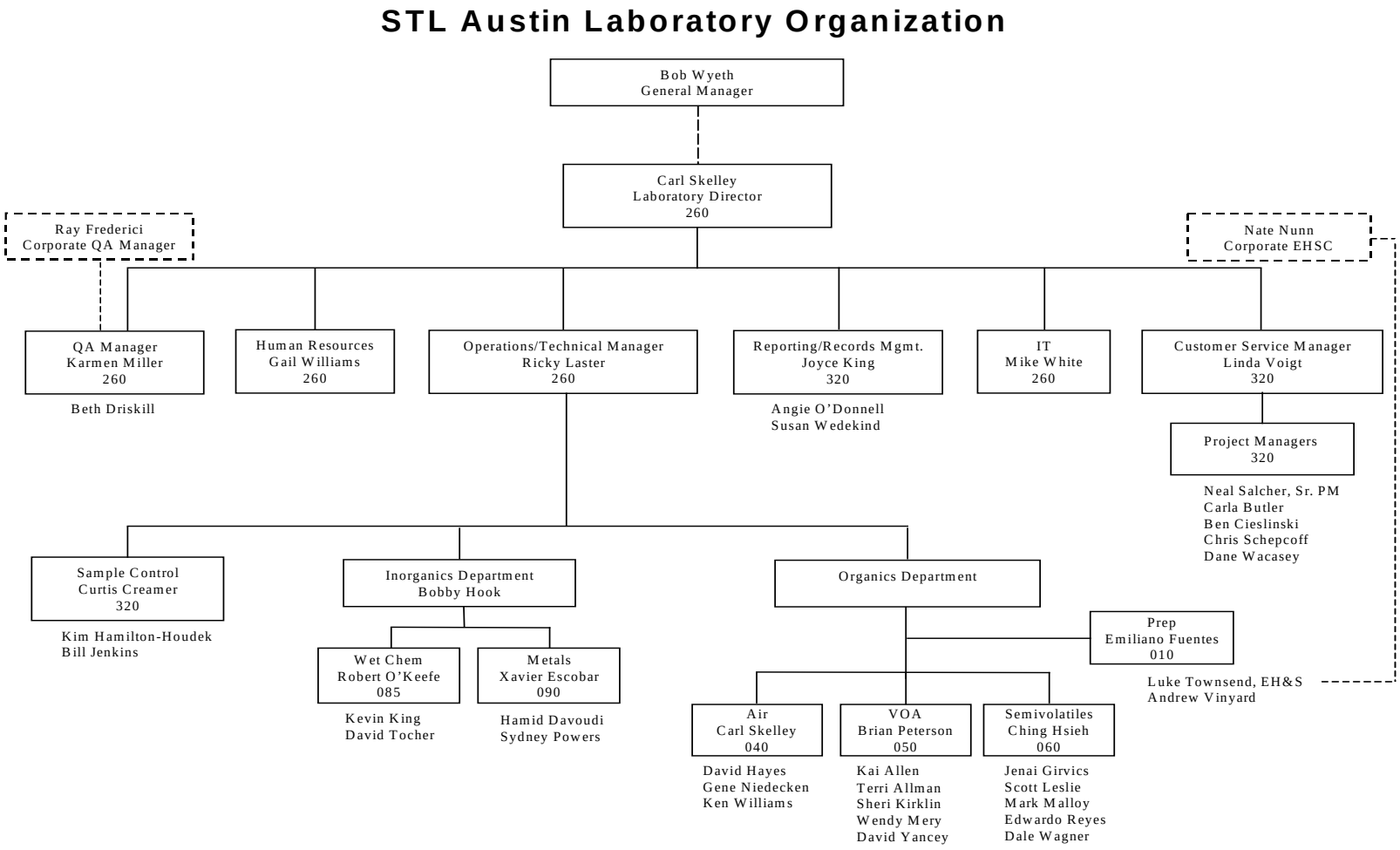
- Reports directly to Laboratory Director;
- Responsible for daily requirements of supplies, including stockroom and for services required for efficient operation of laboratory;
- Responsible for purchasing and accounts payable, and;
- Responsible for the Human Resources (HR) functions at the laboratory.

1.7.6 Customer Service Manager & Client Manager

The Customer Service Manager (CSM) and Client Manager (CM) have the following responsibilities:

- Report directly to the Laboratory Director;
- Define customer requirements through project definition;
- Assess and assures customer satisfaction;
- Provide feedback to management on changing customer needs;
- Bring together resources necessary to ensure customer satisfaction;
- Participate in the selection, review, and approval of subcontractors;
- Assist sales as needed with developing and implementing sales strategies and plans for the organization;
- Assume lead responsibility for assigning new projects/work to the Project Managers under his/her direct supervision;
- Represent the company to outside organizations and maintains client relations;
- Assess client needs, formulates technical approaches and assists with proposal preparation; and
- In conjunction with the Laboratory Director and the Operations Manager, schedule work through the laboratory to meet client needs, expectations and deadlines.

FIGURE 1.6-1
STL Austin Laboratory Organization



1.7.7 Project Managers

The Project Managers (PM) have the following responsibilities:

- Report directly to the Laboratory CSM;
- Monitor analytical and QA project requirements for specified projects;
- Act as a liaison between the clients and the laboratory staff;
- Prepare Quality Assurance Summary (QAS) or equivalent summary form and communicates project-specific requirements to all parties involved;
- Assist the laboratory staff with interpretation of work plans, contracts and QAPP requirements;
- Review project data packages for completeness and compliance to client needs;
- Signature authority for final reports;
- Keep the laboratory and client informed of project status;
- Together with the Technical Director and QA Manager, approve customer requested variances to methods and to standard laboratory protocols;
- Monitor, review, and evaluate the progress and performance of projects;
- Report client inquiries involving data quality issues or data acceptability to the facility QA Manager and to the operations staff;
- Conduct project reviews to assess the laboratory's performance in meeting customer requirements, as required;
- Prepare reissue requests for project data; and
- Responsible for meeting quality requirements.

1.7.8 Laboratory Managers

Laboratory Managers have the following responsibilities:

- Report directly to the Operations Manager (or Laboratory Director in the absence of an Operations Manager);
- Maintain the required staffing levels, technical expertise, and resources for their laboratory area;
- Maintain laboratory safety, including safety training and waste disposal;
- Supervise daily activities of analysts within the group;
- Supervise QC activities performed as a part of routine analytical operations;
- Implement data review procedures;
- Supervise the preparation and maintenance of laboratory records;
- Evaluate instrument performance and supervises the calibration, preventive maintenance and scheduling of repairs;
- Oversee or perform review and approval of all analytical data;
- Report nonconformances to the appropriate managers;
- Train their laboratory staff; and
- Responsible for meeting quality requirements.

1.7.9 Analysts

Analysts have the following responsibilities:

- Perform analytical methods and data recording in accordance with documented procedures;
- Perform and document calibration and preventive maintenance;
- Perform and document data processing and data review procedures;
- Report nonconformances to the Laboratory Manager, Project Managers, and QA Manager, as appropriate;
- Ensure sample and data integrity by adhering to appropriate sample and data handling procedures; and
- Responsible for meeting quality requirements defined in this LQM and other supporting QA policies and procedures.

1.7.10 Sample Custodians

Sample Custodian shall have the following responsibilities:

- Ensure implementation of proper sample receipt procedures, including maintenance of chain-of-custody;
- Report nonconformances associated with condition-upon-receipt of samples;
- Supervise log-in of samples into the LIMS;
- Ensure that all samples are stored in the proper environment;
- Evaluate equipment performance and supervises the calibration, preventive maintenance and scheduling of repairs;
- Assist Environmental Health and Safety staff with sample disposal; and
- Are responsible for meeting quality requirements.

1.7.11 Records Management / Report Production Staff

The Records Management and Report Production Staff have the following responsibilities:

- Generate and compile analytical reports and associated deliverables for delivery to the client;
- Responsible for meeting quality requirements; and
- Produce as needed reports that meet the NELAC requirements.

1.8 Laboratory Capabilities

STL Austin provides full-service environmental analyses. The laboratory has extensive experience serving the analytical needs of a variety of state and federal agencies, engineering and consulting firms, and commercial clients. The 26,900 square-foot facility is designed to provide analyses of environmental samples that include groundwater, wastewater, air, soil, sediment, sludge and hazardous waste samples. The STL Austin floorplan is shown in Figure 1.8-1.

The design of the laboratory promotes data quality, safety, efficiency, automation and security. Instrument laboratories are separate from the sample preparation laboratories to eliminate the potential for sample cross contamination. Ventilation of the instrument laboratory for volatile

organic analyses is set up to minimize solvent contamination. The reagent water systems provide water of the required quality standard for QC sample preparations and laboratory operations. The laboratory provides ample space for processing and analytical operations.

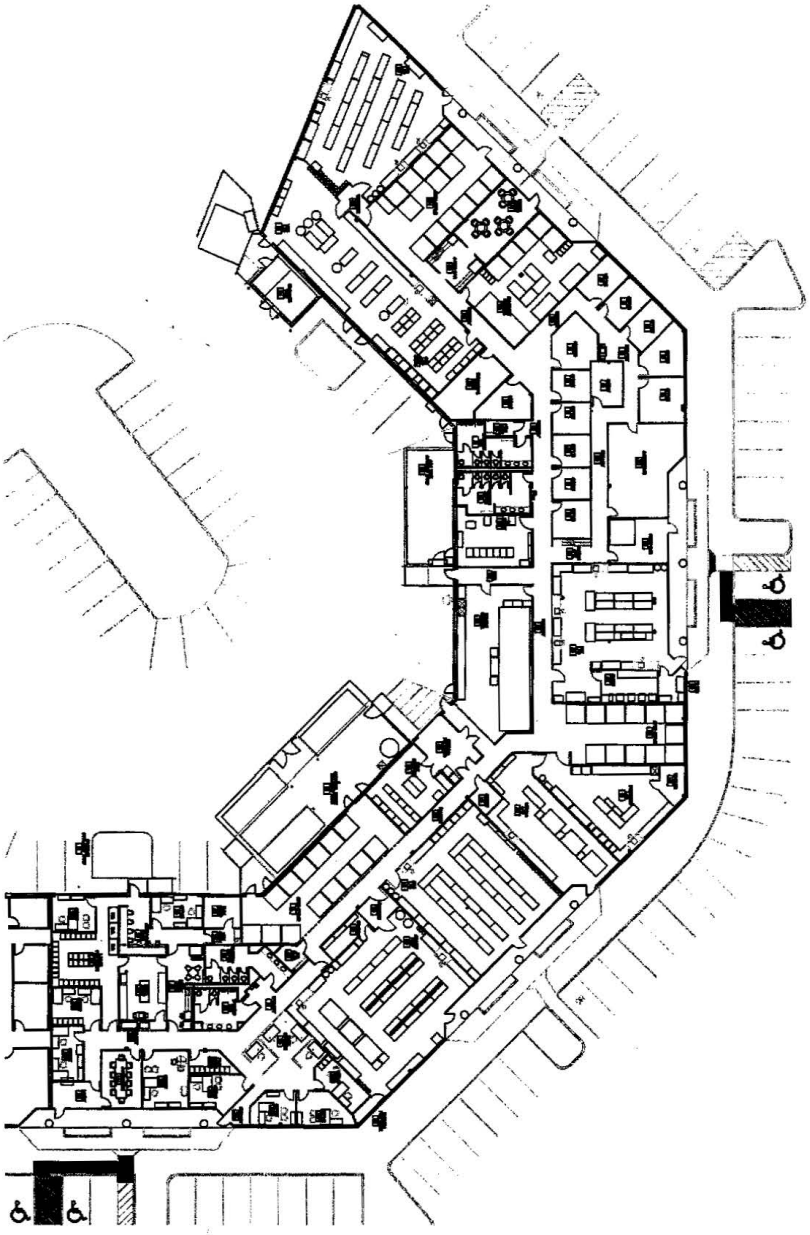
STL Austin analyzes Proficiency Test samples a minimum of two times per year from a NIST-approved PT provider for the analytes established by EPA for water samples. STL Austin also analyzes Proficiency Test samples a minimum of two times per year from an ISO 9001 registered PT provider for other analytes and matrices. The specific analytes and matrices analyzed are based on the current scope of the laboratory services.

The technical and service requirements of all requests to provide analyses are thoroughly evaluated before commitments are made to accept the work. This includes a review of facilities and instrumentation, staffing, and any special QC or reporting requirements to ensure that analyses can be performed within the expected schedule. All measurements are made using published reference methods or methods developed by STL Austin. Competence with all methods is demonstrated according to the procedure described in Section 3.3.2 prior to use.

The STL Austin Laboratory utilizes a Laboratory Information Management System (LIMS), which consists of modules that address all major processes of laboratory management; including price quotations, shipment of sample bottles and supplies, sample receipt, laboratory data collection, status reporting and scheduling, and identification and production of client deliverables. The modules are fully integrated so that information is passed seamlessly between them without the need for reentry. The laboratory can provide electronic data on diskette or transmit directly by modem in virtually any program format, depending on the prearranged requirements. Customized data packages are also an option.

FIGURE 1.8-1

STL AUSTIN FLOORPLAN



2.0 Quality System and Description

Quality is defined as meeting client requirements for both internal and external clients. The Quality System provides the structure to achieve the total quality management goals necessary to maintain standards of performance and quality in all areas.

2.1 Quality System

The goal of the Quality System is to ensure that business and technical operations are conducted with the highest standards of professionalism and ethics in the industry. The Quality System is a well structured management system of principles, objectives, policies, responsibilities and implementation plans at the organizational and project-specific levels. At the organizational level, the Quality System provides the framework within which project-specific planning, implementation and performance assessment may occur. The STL QMP and LQM document the Quality System and describes both the organizational and project-specific principles, goals, controls and tools of the Quality System. The Quality System is described in detail in the STL QMP, LQM, Quality Policy Documents and SOPs.

It is the responsibility of all STL directors and managers to implement the Quality System elements by setting goals and objectives that lead to this achievement. It is the responsibility of all STL employees to work within the framework of the Quality System to achieve the established goals.

2.2 Quality Assurance

Quality Assurance (QA) is defined as an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets the defined standards of quality with a stated level of confidence. QA is an integral part of STL Austin's Quality System.

The organizational and project-specific systems of the Quality System, discussed in Section 2.1, are used to define QA goals. Controls at the organizational level regulate activities that support common or standardized functions such as employee qualifications and training, document control and material procurement. Controls at the project level regulate the definition and implementation of customer requirements to produce the desired type and quality of product. Some specific examples of quality controls are:

- Measuring lab and instrument performance on a daily basis to ensure that the measurement systems are in statistical control;
- Demonstrating lab capability through data quality assessments which document the overall qualification of the laboratory to perform environmental analyses;
- Using SOPs to ensure uniformity and compliance in the measurement process;
- Providing controlled flexibility in routine methodology to meet project-specific sample and data requirements;
- Monitoring operational performance of the laboratory on a routine basis and providing corrective action if needed;

- Recognizing and promptly correcting any factors which adversely affect quality; and
- Maintaining complete records of sample receipt, laboratory analysis, data evaluation and reporting, and sample disposal.

2.3 Quality Guidance Documents

The Quality System is defined by a series of documents that are described in Sections 2.3.1 through 2.3.6. The review and control of these documents are described in Section 5.0.

A number of quality assurance guidance documents have been used to develop STL's quality management program. The requirements of several of these documents are cross-referenced with the content of the LQM in Table 2.3-1. A cross-reference of the LQM and STL documents to NELAC Quality Systems Standards is presented in Table 2.3-2. Documents used in the development of the STL Austin LQM include the following:

- National Environmental Laboratory Accreditation Conference (NELAC), Constitution, Bylaws, and Standards, EPA600/R-98/151, US EPA Office of Research and Development, July 1, 2003.
- EPA Requirements for Quality Management Plans, EPA QA/R-2, US EPA, Office of Environmental Information, March 2001.
- EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, US EPA, Office of Environmental Information, March 2001.
- EPA Quality Manual for Environmental Programs, 5360 A1, US EPA Office of Research and Development, National Center for Environmental Research and Quality Assurance, Quality Assurance Division, May 2000.
- EPA Guidance for Preparing Standard Operating Procedures (SOPs) for Quality Related Documents, EPQ QA/G-6, US EPA, Office of Environmental Information, March 2001.
- Good Automated Laboratory Practices, EPA 2185, August 1995.
- Shell for Analytical Chemistry Requirements, U.S. Army Corps of Engineers, 2/1/2001.
- Quality Assurance Project Plan (QAPP), HQ Air Force Center for Environmental Excellence, Version 4.0, February 2005.
- Quality Systems Manual for Environmental Laboratories, Department of Defense, Version 3, January 2006.
- Quality Management and Quality System Elements for Laboratories – Guidelines, American National Standard, American Society for Quality Control, ANSI/ASQC Q2-1991.
- Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, American Society for Quality Control, Energy and Environmental Quality Division, Environmental Issues Group, ANSI/ASQC E4-1994 (Formerly EQA-1), January 1994.

2.3.1 STL Quality Management Plan

The purpose of the STL corporate Quality Management Plan (QMP) is to describe the STL Quality System and to outline how that system enables all employees of STL to meet the Quality Assurance

(QA) policy. The QMP also describes specific QA activities and requirements and prescribes their frequencies. Roles and responsibilities of management and laboratory staff in support of the Quality System are also defined in the QMP.

The requirements set forth in the QMP are applicable to all STL facilities. The policies and practices outlined in the QMP are set forth as minimum guidelines only. Requirements that are more rigorous may be applied for specific client or regulatory programs.

2.3.2 STL Austin Laboratory Quality Manual

This Laboratory Quality Manual (LQM), along with Quality Policy Documents and SOPs, provides the criteria and specifications for the generation of environmental analytical data. The LQM provides the framework for establishing QC criteria for standard procedures and laboratory instrumentation as well as method detection limit (MDL) information.

2.3.3 Quality Policy Documents

Quality Policy Documents including QA and Technical Directives provide further detail to the QMP and LQM. They describe the requirements for a specific program. Quality Policy Documents use the concepts and requirements contained in the QMP and LQM and provide sufficient detail so that SOPs can be developed, if necessary.

2.3.4 Standard Operating Procedures

Standard Operating Procedures (SOPs) describe step-by-step instructions for performing a method or activity. In addition, there are SOPs that relate to support services performed in the laboratory. Format and document control are described in SOP AUS-QA-0029, “Standard Operating Procedures.” A list of STL Austin SOPs is presented in Table 8.2-1 of this LQM. SOPs may supersede some requirements in this document until the annual LQM update.

2.3.5 Quality Assurance Project or Program Plans

A Quality Assurance Project Plan (QAPP) or similar documents may detail unique or project-specific requirements that differ from standard STL Austin specifications. Client-specified requirements are reviewed during project initiation and compared with laboratory capabilities and known requirements to ensure that the laboratory can meet the project-specific requirements. The project specifications are then incorporated into the laboratory processes for that specific activity.

If requested and approved by the client, project-specific requirements may be more or less stringent than the STL Austin quality program. Typical specifications contained in a QAPP or documentation include:

- New or modified testing methods;
- Unique QC logic;
- Special requirements for equipment use and maintenance;

- Special handling due to safety considerations;
- Project-specific detection and reporting limits;
- Project-specific accuracy and precision limits or the statistical treatment of data; and
- Additional or unique documentation or records management requirements.

2.3.5.1 Quality Assurance Summaries

Quality Assurance Summaries (QAS), including Quality Trackers and QuantIMS Checklists, are used within STL Austin to summarize client-specific requirements typically documented in project QA plans in a concise format. These tools are used to address the technical, procedural and operational specifications for each analytical protocol, such as requirements for quality control samples, batching schemes, flagging conventions, deliverables or other special client requests that may differ from routine laboratory operations. They are disseminated to laboratory operations by the Project Manager or Quality Assurance Manager to document client or program-specific requirements. The QAS may be used alone or in conjunction with the project-specific QA plans.

2.3.6 Other Documents

Other documents that can affect the quality program may include the Corporate Safety Manual (CSM), memos, guidance documents, work instructions and periodic management assessment reports. These documents may further define or guide the implementation of quality standards at STL Austin but shall not conflict with the QMP or LQM or diminish the effectiveness of the Quality System.

TABLE 2.3-1

STL Austin Laboratory Quality Manual Requirements Matrix

STL Austin LQM (Rev3)	EPA QA/R-2	ANSI/ASQC E4-1994	ANSI N 13.30	ANSI/ASQC Q2-1991[1]
1.0 Management Commitment and Organization	3.2 Management and Organization	2.1 Management and Organization	1.1 Introduction 1.2 Purpose 1.3 Scope	5.0 Management Responsibility
2.0 Quality System and Description	3.3 Quality System Components	2.2 Quality System and Description	2.1 Special Word Usage 2.2 Specific Terms 5.1 Quality Assurance 5.2 Quality Control	5.2 Quality System
3.0 Employee Qualification and Training	3.4 Personnel Qualification and Training	2.3 Personnel Training and Qualification	3.2 Personnel	14.0 Personnel
4.0 Procurement of Items and Services	3.5 Procurement of Items and Services	2.4 Procurement of Items and Services	N/A	7.0 Quality in Procurement 13.0 Subcontracting
5.0 Documentation and Recordkeeping System	3.6 Documents and Records	2.5 Documents and Records	3.6 Direct Bioassay-Record Retention 4.5 Indirect Bioassay-Record Retention	8.4 Quality Documentation and Records
6.0 Computer Hardware and Software	3.7 Computer Hardware and Software	2.6 Computer Hardware and Software	N/A	ISO 9000-3[2]
7.0 Planning	3.8 Planning	2.7 Planning 3.1 Planning and Scoping 3.3 Implementation of Planned Operations	3.1 Facility Criteria 3.4 Direct Bioassay-Performance Criteria for Service Laboratories 3.5 Direct Bioassay-Reporting Results 4.1 Indirect Bioassay-Responsibilities of the Service Laboratory Customer 4.2 Indirect Bioassay-Analytical Methodology 4.3 Indirect Bioassay-Performance Criteria for Service Laboratories 5.2 Quality Control	6.3.3 Quality Plans

TABLE 2.3-1
STL Austin Laboratory Quality Manual Requirements Matrix
(Continued)

STL Austin LQM (Rev 1)	EPA QA/R2	ANSI/ASQC E4-1994	ANSI N 13.30	ANSI/ASQC Q2-1991[1]
8.0 Work Processes and Operations	3.9 Implementation of Work Processes	2.8 Implementation of Work Processes 3.2 Design of Data Collection Operations	3.1 Facility Criteria	8.0 Laboratory Operations Quality Assurance 9.0 Control of Measuring and Test Equipment 10.0 Data Validation 15.0 Use of Statistical Methods
9.0 Quality Assessment and Response	3.10 Assessment and Response	2.9 Assessment and Response 3.4 Assessment and Response 3.5 Assessment and Verification of Data Usability	3.3 Direct Bioassay-Interpretation of Measurements 3.5 Direct Bioassay-Reporting Results 4.4 Indirect Bioassay-Reporting Results 6.1 Direct Bioassay Measurements 6.2 Indirect Bioassay Measurements	16.0 Nonconformity 17.0 Corrective Action 18.0 Auditing the Quality System
10.0 Quality Improvement	3.11 Quality Improvement	2.10 Quality Improvement	N/A	N/A

(1) Technically equivalent to ISO 9001.
(2) Quality Management and Quality Assurance Standards, ISO 9000, Part 3, "Guidelines for the Application of ISO 9001 to the Development, Supply and Maintenance of Software."

TABLE 2.3-2

Cross-Reference of LQM Sections Addressing NELAC Quality Manual Requirements

NELAC QUALITY MANUAL CHAPTER 5.4.2.3: REQUIRED ELEMENTS*	STL AUSTIN LQM REVISION 3, QMP, QA SOP OR POLICY REFERENCE
a) A quality policy statement, including objectives and commitments, by top management	LQM Section 1
b) The organization and management structure of the laboratory, its place in any parent organization and relevant organizational charts	LQM Section 1
c) The relationship between management, technical operations, support services and the quality system	LQM Section 1 LQM Section 7
d) Procedures to ensure that all records required under this chapter are retained as well as procedures for control and maintenance of documentation through a document control system which ensures that all standard operating procedures (SOPs), manuals, or documents clearly indicate the time period during which the procedure or document was in force	LQM Section 2 LQM Section 5
e) Job descriptions of key staff and reference to the job descriptions of other staff	LQM Sections 1 and 3 Separate document of job descriptions available from HR and/or STL intranet
f) Identification of the laboratory's approved signatories; at a minimum, the title page of the Quality Manual must have the signed and dated concurrence, (with appropriate titles) of all responsible parties including the quality manager(s), technical director(s), and the agent who is in charge of all laboratory activities such as the laboratory director or laboratory manager	LQM Title/Approval Page
g) The laboratory's procedures for achieving traceability of measurements	LQM Section 8
h) A list of all test methods under which the laboratory performs its accredited testing	LQM Section 8

*National Environmental Laboratory Accreditation Conference Standard, Quality Systems; approval date June 5, 2003, effective date July 1, 2005

TABLE 2.3-2

Cross-Reference of LQM Sections Addressing NELAC Quality Manual Requirements (Continued)

NELAC QUALITY MANUAL CHAPTER 5.4.2.3: REQUIRED ELEMENTS*	STL AUSTIN LQM REVISION 3, QMP QA SOP OR POLICY REFERENCE
i) Mechanisms for ensuring that the laboratory reviews all new work to ensure that it has the appropriate facilities and resources before commencing such work	LQM Section 7
j) Reference to the calibration and/or verification test procedures used	LQM Section 8 Tables 8-4,5,6,7
k) Procedures for handling submitted samples	LQM Section 8
l) Reference to the major equipment and reference measurement standards used as well as the facilities and services used by the laboratory in conducting tests	LQM Section 8
m) Reference to procedures for calibration, verification and maintenance of equipment	LQM Section 8
n) Reference to verification practices which may include interlaboratory comparisons, proficiency testing programs, use of reference materials and internal quality control schemes	LQM Section 9
o) Procedures to be followed for feedback and corrective action whenever testing discrepancies are detected, or departures from documented policies and procedures occur	LQM Sections 9 and 10 SOP AUS-QA-0013, “Nonconformance and Corrective Action”
p) The laboratory management arrangements for exceptionally permitting departures from documented policies and procedures or from standard specifications	LQM Section 9
q) Procedures for dealing with complaints	LQM Section 9 QMP Section 4.8

*National Environmental Laboratory Accreditation Conference Standard, Quality Systems; approval date June 5, 2003, effective date July 1, 2005

TABLE 2.3-2

Cross-Reference of LQM Sections Addressing NELAC Quality Manual Requirements (Continued)

NELAC QUALITY MANUAL CHAPTER 5.4.2.3: REQUIRED ELEMENTS*	STL AUSTIN LQM REVISION 3 QMP, QA SOP OR POLICY REFERENCE
r) Procedures for protecting confidentiality (including national security concerns) and proprietary rights.	LQM Section 5
s) Procedures for audits and data reviews	LQM Section 8 LQM Section 8 and 9 SOP AUS-QA-0023, "Conduct of Internal Surveillance and Audits" QMP Section 5.3.6
t) Processes/procedures for establishing that personnel are adequately experienced in the duties they are expected to carry out and/or receive any needed training	LQM Section 3 QMP Section 5.1.2
u) Reference to procedures for reporting analytical results	LQM Section 8
v) A table of contents and applicable list of references, glossaries, and appendices	LQM Table of Contents List of QA Policies and SOPs Table 2.3-2

*National Environmental Laboratory Accreditation Conference Standard, Quality Systems; approval date June 5, 2003, effective date July 1, 2005

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3.0 Employee Qualification and Training

All activities performed by STL shall be accomplished by qualified employees. The following definitions are relevant to the discussion of employee qualification and training presented in this section.

- Qualification - The characteristics or abilities gained through education, training, or experience that enable an individual to perform a required task.
- Orientation - The act or process of acquainting individuals with an existing situation, environment or condition.
- Training - In-depth instruction to develop proficiency in the application of requirements, methods, and procedures. Instruction may be internal or external classroom sessions, courses or on-the-job training.

Employee orientation and training is performed in compliance with SOP AUS-QA-0030, “Employee Orientation and Training.” Training requirements are based on job-specific profiles. Training attendance is documented and training records are maintained at the laboratory.

3.1 Employee Qualification

The laboratory shall maintain job descriptions for all positions. These job descriptions specify the minimum qualifications for education and experience, knowledge and skills that are necessary to perform at a satisfactory level. An employee's performance shall be compared with the requirements of his/her job description at least annually, as part of the annual performance review. Due to their length and detailed nature, job descriptions for all employees are provided on the STL Intranet.

All employees are responsible for complying with all quality assurance/quality control (QA/QC) requirements that pertain to their organizational/technical function. Each technical employee has a combination of experience and education to adequately demonstrate a specific knowledge of their particular function and a general knowledge of laboratory operations, test methods, QA/QC procedures and records management. Qualifications of professional employees are documented by resumes that include academic credentials, employment history, experience and professional registrations. The resumes are placed in the employee’s training file or may be maintained in electronic format.

3.2 Orientation and Training of Laboratory Staff

Employees receive internal, external, formal and informal training, as appropriate. Training is performed to develop and maintain proficiency, and to promote improvement. Individuals knowledgeable in the subject matter perform training.

STL employees are qualified based on the experience and training documented in the individual's training file, and are assigned duties within their experience and training. Each new employee shall receive orientation and training in quality and health and safety. Each new employee shall be supervised in their assigned duties by their supervisor or designee. The authorization to perform independently shall be documented in the training files and must be approved by the Laboratory/Technical Manager or designee. In addition, training for employees may include professional, managerial, communication and interpersonal skills as appropriate. On-going or periodic assessments will be performed to determine training needs and effectiveness of instruction. A summary of the minimum training requirements is provided in Table 3.2-1.

TABLE 3.2–1

STL Employee Minimum Training Requirements

Required Training	Time Frame*	Employee Type
Environmental Health & Safety	Month 1	All
Ethics – New Hires	1-2 days of hire	All
Ethics – Comprehensive Data Integrity Quality Assurance	30 days of hire (All training	All Technical and PMs All
Ethics Refresher	Annually	All
Initial Demonstration of Capability (IDOC)	Prior to unsupervised method performance	Technical

3.2.1 Ethics and Data Integrity

Ethics is also a major component of the STL training program. Each employee shall be trained in ethics within 1-2 days of hire. Comprehensive Ethics and Data Integrity training will take place within 30 days of their hire. This training includes an overview of regulatory programs and program goals, a review of the ethics statement, and group discussions about data integrity and data misrepresentation. Employees shall be trained as to the legal and environmental repercussions that result from data misrepresentation. A data integrity hotline (1-800-736-9407) is maintained by STL and administered by the Corporate QA Director.

3.2.2 Health and Safety Orientation Training

Each newly hired STL employee, contract worker or working visitor is required to go through health and safety orientation and training as per the laboratory Corporate Safety Manual (CSM). The orientation must be performed as soon as possible after the employee's report-to-work date and before chemicals are handled. STL employees and contract workers shall be given comprehensive health and safety training within one month of the start-to-work date. Documentation is maintained in the employee's training file. A detailed description of this training is also provided in the CSM.

3.2.3 Quality Program Orientation

Each newly hired STL employee receives a Quality Program orientation. The QA Manager or designee shall conduct this orientation within thirty (30) days of the employee's report-to-work date. This orientation will be documented in the employee's training file. The QA Manager shall review the following topics (at a minimum) with the new employee as they apply to individual's assigned responsibilities:

- STL Quality System and applicable documents including the STL QMP and LQM;
- STL policies on ensuring data integrity, meeting client requirements and ethics;
- Identification and documentation of nonconformance and corrective action procedures;
- Proper data recording practices; and
- Key elements of STL Quality Control Program.

3.2.4 Technical Training

Technical training is accomplished within each laboratory by management to ensure method comprehension. All new technical personnel shall be required to demonstrate competency in performing a particular method by successfully completing an Initial Demonstration of Capability (IDOC) before conducting analysis independently on client samples.

3.3 Employee Training Files

A training file for each of the STL employees shall be maintained by the QA Manager or designee. These training files may be maintained either in hardcopy or electronic format. The types of training documents included in the training file are as follows:

- Employee resume;
- Quality assurance and quality control;
- Health and Safety;
- Technical proficiency;
- Professional Development;
- Regulatory/Compliance; and
- Ethics and Confidentiality.

The specific types of training records will depend upon the employee job function and tenure with the company.

3.3.1 Employee Resumes

The employee's resume will be placed in the employee's training file or maintained in electronic format. Qualifications of employees, as documented on resumes, include academic credentials, employment history, experience, and professional memberships and registrations.

3.3.2 Individual Training Records for the Areas of Quality, Health and Safety, and Technical Proficiency Monitoring

Training of each employee shall be summarized and documented on training forms or in a database. These include documentation of participation in training, one-on-one training, on-the-job training, initial and ongoing proficiency, or participation in classes and other presentations, and any other formal training sessions, either internal or external. Examples of some of the hardcopy forms used to document this training are provided in the SOP AUS-QA-0030, "Employee Orientation and Training." Initial or ongoing technical proficiency training records shall include documentation of the ability to perform sample preparation or analysis using internally prepared laboratory control samples and/or externally available blind standard reference materials. All new personnel are required to demonstrate competency in performing a particular method by successfully completing an Initial Demonstration of Capability (IDOC) before conducting analysis independently on client samples.

IDOCs are performed by analysis of four replicate of a second source standard. The accuracy and precision, measured as average recovery and standard deviation (using n-1 as the population), of the 4 replicate results are calculated and compared to those in the test method (where available). If the test method does not include accuracy and precision requirements, the results are compared to target criteria set by the laboratory. The laboratory sets the target criteria such that they reflect the requirements of the specific test method or project data quality objectives. A DOC Certification Statement is recorded and maintained in the employee's training file. Figure 3.3-1 shows an example of a DOC Certification Statement. The Technical Director or designee must approve technical proficiency of analysts.

On-going DOCs are performed by analysis of four replicate QC check samples. Results of successive LCS analyses can be used to fulfill the DOC requirement. Proficiency testing sample results can also serve as an on-going demonstration of capability. For tests without spikes, duplicate analyses results can meet DOC requirement.

3.3.3 Training Records for Professional Development

This category includes documentation of all courses taken relating to an individual's professional development. Course topics may include conflict resolution, management/supervision, time management, conducting effective meetings and interviewing skills.

3.3.4 Training Records for Regulatory/Compliance Information

This category provides for documentation of training on regulatory or legal topics. Examples of this category are Sexual Harassment, Drug-Free Workplace and STL ethics.

3.3.5 Ethics and Confidentiality Records

The following documents are re-signed each year and maintained in the personnel files:

- Ethics Agreement; and
- Confidentiality Agreement.

FIGURE 3.3-1
EXAMPLE CERTIFICATION STATEMENT FOR METHOD VALIDATION

ANALYST DEMONSTRATION OF CAPABILITY CERTIFICATION STATEMENT

STL AUSTIN
14050 Summit Park, Suite A100
Austin, Texas 78728

Analyst Name: _____Date: _____

Matrix: __Laboratory pure reagent water __Ottawa sand __Other_____

Method and Analyte: _____

We, the undersigned, CERTIFY that:

1. The analyst identified above, using the cited test method, which is in use at this facility for the analyses of samples under the STL AUSTIN LQM and the National Environmental Laboratory Accreditation Program, has met the Initial or Ongoing Demonstration of Capability.
2. The test method was performed by the analyst identified on this certification following the STL Austin SOP.
3. A copy of the laboratory-specific SOP is available for all personnel on-site.
4. The data associated with the initial/ongoing demonstration of capability are true, accurate, complete and self-explanatory (*).
5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized inspectors.

Comments/Observations:
_____
_____

_____	_____	_____
Analyst's Name	Signature	Date
_____	_____	_____
Technical Director's Name	Signature	Date
_____	_____	_____
Quality Assurance Manager's Name	Signature	Date

(*) True: Consistent with supporting data.
Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.
Complete: Includes the results of all supporting performance testing.
Self-explanatory: Data properly labeled and stored so that the results are clear and require no additional explanation.

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4.0 Procurement of Items and Services

Controlling the quality of items and services procured by STL Austin helps to ensure that the needs of the customers are met. The purchase of items and services affecting quality shall be planned and controlled to ensure conformance with established requirements. The STL procurement program requires the following:

- Assurance that purchased items and services meet STL-established requirements and perform as expected;
- Definitions and descriptions of the documentation levels required for the applicable technical and administrative requirements;
- Evaluation and qualification of vendors; and
- Maintenance of records of all suppliers from whom we obtain services or supplies required for our analytical testing.

4.1 Selection of Vendors

Materials and supplies are purchased from approved vendors. Prospective vendors are selected based upon criteria appropriate to the materials or services provided according to Policy No. P-Pu-006, "Procurement and Contracts." Vendors are selected by the appropriate company contact (Director of Procurement and Contracts for national vendors and contracts and in conjunction with the Laboratory Director and/or the General Manager for local vendors and contracts) through a competitive proposal/bid process, strategic business alliance or negotiated vendor partnership. Prospective vendors are required to complete a vendor acceptance application and are evaluated on the following criteria, as appropriate:

- The vendor's history of providing identical or similar products that perform satisfactorily in actual use;
- The vendor's service record and ability to provide a complete product line and commensurate service;
- The vendor's ability to administer inventory at the STL Austin facility through an inventory management system that will ensure correct stocking levels as well as shelf-life tracking;
- Objective evaluation of the vendor's current quality records, supported by documentation; and
- Results of audits by STL of the vendor's technical and quality capabilities.

STL's Corporate QA Director will determine the appropriate level of evaluation criteria for the item or service being purchased. Vendors that provide test and measuring equipment, solvents, standards, instrument-related service contracts, or subcontracted laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use.

National contracts will be approved and signed by STL's President who is not directly involved in negotiations and finalization of terms and conditions. Local and regional contracts will be approved and signed by the Chief Operating Officer or the Commercial Director.

Vendors and suppliers are considered national in scope if they meet the majority of the following criteria: (a) have multiple locations; (b) the ability to service the majority of STL facilities; and (c) local sales, service, or technical representation for the majority of STL facilities. Contracts or agreements with vendors and suppliers considered national in scope fall under the direction of the Director of Procurement and Contracts.

Vendors and suppliers are considered local in scope if they meet the majority of the following criteria: (a) have primarily local or regional locations; (b) perform services or supply materials primarily of a local interest; and (c) sell materials or services that could be classified as "spot purchases." "Spot purchases" would be considered those materials or services that are required on a time sensitive basis and typically represent a small cost. Examples of local vendors and suppliers would be building maintenance or cleaning services, HVAC contractors, emergency office supplies, etc. Contracts or agreements with vendors and suppliers considered local in scope fall under the direction of the Laboratory Director or General Manager.

4.2 Procurement of Quality-Related Items

The quality of instruments, equipment, standards, reagents, solvents, other chemicals, gases, water and laboratory containers used in analyses must be known so that their effect upon analytical results can be defined. Quality-related items (QRIs) are items that are used in the laboratory that must meet a minimum quality requirement. The quality specifications are derived from analytical method requirements, client contracts, project-specific requirements, measurement quality objectives (MQOs) and defined national standards for analytical testing.

Quality specifications of materials are typically described in analytical SOPs. These quality specifications shall be included or referenced in the purchasing documents for the procurement of the applicable items. This includes specifications for the purity of standards, reagents, or chemicals, and technical specifications for accuracy and precision (*e.g.*, Class A volumetric glassware). Reference to an approved model, catalogue number, lot number or chemical grade may be sufficient. If items that may affect laboratory quality are requested from vendors that are not pre-approved, quality approval must be obtained prior to placing the order.

Upon receipt, a system is in place to verify the quality of the item received. The laboratory managers or designees are responsible for ensuring that the requested quality of materials ordered matches those received, for verifying that material storage is properly maintained and for removing materials from use when shelf life has expired.

4.2.1 Evaluation of Off-the Shelf Items

For items that are used regularly by STL Austin where no unique requirements or specifications exist, the items may be purchased off-the-shelf. These items are ordered from the supplier on the basis of specifications set forth in the supplier's published product description. These include items such as glassware, filter paper, pipettes and chromatography columns. These items are evaluated as a function of the standard analytical process.

4.2.2 Evaluation of Instruments

Evaluation of instruments purchased, or where the laboratory needs to use equipment outside its permanent control, shall be conducted according to an acceptance testing plan. The acceptance testing plan may be defined by the vendor or the method demonstration requirements specified in the laboratory analytical SOPs. The specifications for instrument acceptance shall be referenced or included in the purchasing or leasing documents for the procurement of that item. Acceptance criteria may include instrument reliability, sensitivity, stability, selectivity, accuracy, precision and ability to interface with the existing computer systems.

4.2.3 Evaluation of Critical Solvents and Acids

STL has a group of laboratories that conduct additional evaluations for certain solvents and chemical reagents where our criteria for purity are more stringent than the vendor's criteria. These QRIs are subject to chemical analysis on a lot-by-lot basis before they are put into use. They are tested at one of the STL laboratories, and a designated quality representative evaluates the chemical test results. If the solvents or reagents meet the specifications given in the SOP No. S-T-001, "Quality Testing of Solvents, Acids and Reagents (QRI Program)," an approval memorandum is issued to all participating laboratories. All laboratories then use the same lot, and reject any lots received at the facility that have not been tested.

4.2.4 Evaluation of Chemical Standards or Standard Reference Materials

Where available, chemical standards will be traceable to the National Institute of Standards Technology (NIST) or to an equivalent source. This is largely limited to physical and inorganic chemical standards. If NIST traceability is not commercially available, commercially certified materials shall be used, which are then tested for accuracy before use. Standards must be received with a certification report from the vendor with information such as purity/concentration, traceability, lot number, expiration date, preparation date, unique identification number, formula weight, density, mass and/or volume of standards and suggested storage requirements. Receipt, storage, evaluation, use, control and disposal of all standards as well as documentation of these activities are described in laboratory SOPs. Additional discussion of standards can be found in Section 8.5.4 of this LQM.

4.2.5 Corrective Action for Failure to Meet Required Specifications

Corrective actions for failure of an item to meet required specifications are as follows:

- Review current supplies and eliminate the problem item from use;
- Notify the STL Director of Procurement and Contracts to avoid additional problems in other STL facilities;
- Return of the problem item to the vendor;
- Evaluate a new lot or alternate supplier; and
- Evaluate the impact on product or process.

The QA Manager shall be notified of any significant or systematic quality problems. The Corporate Director of Procurement and Contracts and the Corporate Quality Assurance Director shall be notified of any quality problems with national vendors.

4.3 Procurement of Subcontract Laboratory Services

All work subcontracted from the STL Austin laboratory to another laboratory is arranged with the documented consent of the client. All QC guidelines specific to the client's analytical program shall be transmitted to the subcontract laboratory and agreed upon before sending the samples to the subcontract facility. Documentation of required certifications from the subcontract laboratory are maintained in STL project records. Where applicable, specific QC guidelines, QAPPs and similar project documents are transmitted to the subcontract laboratory. Samples are sent to the subcontract laboratory under formal Chain of Custody (COC).

Subcontract laboratories may receive an on-site audit by a representative of STL's QA staff if it is deemed appropriate by the QA Manager. The audit involves an assessment of compliance with the required test method, QC requirements and documentation, as well as any special client requirements.

Project reports received from subcontract laboratories are not altered and are included in original form in the final report provided by STL Austin. Intra-company subcontracting may also occur between STL facilities. The originating laboratory is responsible for communicating QA/QC, reporting, and other project requirements. The final report from STL Austin clearly identifies what testing was performed by other laboratories, and, per NELAP, the certification status of the lab performing the work.

5.0 Documentation and Record Keeping System

5.1 Quality Documents and Records

Quality documents are those that define the objectives, policies and procedures that ensure the quality of items and services provided by STL Austin. A system has been designed to revise, distribute and control quality documents. STL Austin quality documents are listed in Table 5.1-1 along with their approval requirements.

Records are documents that provide objective evidence of the performance of an item or process. Records are further discussed in Sections 5.5 through 5.7.

5.2 Document Review, Approval and Revision

All revisions to controlled documents, software, reference data (such as detection limits) and analytical reports must be reviewed and approved by the original approval authorities, or their successors, prior to implementation.

As part of the quality assessment activities of STL Austin, the overall quality system is reviewed on a periodic basis to determine the effectiveness of the system. This assessment includes a review of this Laboratory Quality Manual (LQM), at a minimum of every two years, to determine if any changes or modifications to the manual are needed. These changes may be a result of audit findings related to the elements in the system, and to the effectiveness of the system in achieving the overall quality objectives. Procedures for making changes to the LQM are the same as for its initial preparation, review and approval.

In addition to the periodic review of the LQM, Standard Operating Procedures and supporting documents shall be reviewed at a minimum of every two years and revised, if necessary, by the Laboratory Manager, or designee, responsible for that document. This review is meant to ensure that each document accurately represents the procedure that is currently being performed.

In addition to periodic review and revision, quality documents must be revised when the activity, policy, or procedure they describe changes in a significant manner. All changes shall be subject to the same review and approval process. Amended documents shall be uniquely identified.

5.3 Document Control and Distribution

Document control is necessary to ensure that the following occur:

- The system produces unequivocal, accurate records which document all laboratory activities;
- Employees have access to current policies and procedures located in or near the area in which work is performed at all times;
- Only current, authorized versions of policies and procedures are used;
- Obsolete documents are archived in a manner that allows easy retrieval; and
- The history of use for particular versions of documents can be reconstructed.

Quality documents that are placed under a controlled distribution include, but are not limited to, the STL QMP, this LQM, Quality Policy Documents and SOPs. Format and control of SOPs are described in STL Austin's SOP AUS-QA-0029, "Standard Operating Procedures." These documents shall clearly indicate the effective date of the document and the revision number.

Quality documents are controlled by initially distributing them either electronically or via hardcopy to the employees who need to be aware of or follow the contained information or procedures. This also applies to any revisions or updates to controlled documents. Controlled documents are marked with a control code or number. For hardcopies the controlled copy is numbered and a distribution list maintained. Electronic distribution of controlled documents is achieved by assigning a control code and placing the document in a secure centralized file; *e.g.*, on the STL controlled intranet. Employees are notified of the location and how to access. A record of the notification is maintained. Obsolete versions of documents are removed from service and archived when new revisions are issued. Further details of responsibilities and systems used for document control are described in SOP AUS-QA-0026, "Document Control and Distribution."

Copies of documents placed under controlled distribution are sometimes released as uncontrolled or information copies with the understanding that no further updates or revisions of that document will be issued to that individual document holder. Once a document is printed from the laboratory intranet, it is considered an information copy and no longer has standing as a controlled document. Quality documents are considered proprietary to STL, but may be issued to outside parties when approved by laboratory management. These are normally issued as uncontrolled copies. Documents should be considered as uncontrolled or information copies unless otherwise identified. Uncontrolled copies can also be issued to lab personnel for review prior to implementation. Uncontrolled copies of documents cannot be used to perform work in the laboratory because no updates or revisions will be provided for those copies, and they are not retrieved when new versions are released.

5.4 Effective Dates and Document History

The effective date of any quality document is the date designated by the laboratory, the date when controlled copies are distributed and the document is first put into use. The effective date is indicated on the title page of the document. Prior to this date, all required reviews of the document are complete; training is completed for personnel who will be using the document; and resources needed to perform the functions described in the document are in place. The document control systems must include a master list or file that identifies the current revision status of quality documents and records the effective date for each update and version of the documents so that the history of use for each at the facility can be demonstrated.

5.5 Records Management

Information for each business function of the organization is stored appropriately according to its type of information. The record keeping system is intended to allow historical reconstruction of all laboratory activities that produce the resultant analytical data whether manual or computerized. All

records, certificates and project reports shall be safely stored as electronic or hard copy, held secure, and in confidence for the client. Details of the records management program are described in laboratory SOPs.

STL Austin is committed to providing scientifically sound, legally defensible data of known and documented quality. Legally defensible data are referred to as data that will stand against reasonable adversarial inquiry in the courts-of-law. Specifications for laboratory performance are typically presented in project-specific documents, such as QAPPs, client agreements and contractual documents, as well as in the STL Austin LQM. Data must also be documented so that the analytical process can be reconstructed.

Project files are organized so that the project events can be reconstructed if necessary. Accountability for the completeness and accuracy of information must be specified. Supporting information, including data that demonstrates the laboratory's ability to perform specific analyses, shall be properly maintained.

Records are divided into two distinct types, Quality Records and Project Records, which are discussed in the following sections. STL Austin maintains a system to provide for appropriate and adequate implementation of these record management requirements as described in laboratory SOPs.

5.5.1 Quality Records

Quality records demonstrate overall laboratory operation. Examples of quality records include the following:

- Instrument logbooks;
- Equipment monitoring records;
- Calibration records;
- Instrument calibration data;
- Maintenance logbooks;
- QC sample data;
- Standard preparation logbooks;
- Standard certificates;
- Standard operating procedures;
- Internal and external PE sample results;
- Laboratory licenses and accreditations;
- Quality reports to management;
- Internal and external audit reports;
- Nonconformance memos; and
- Training records.

These records may apply to one or more projects, but in general they are applicable to many projects. Quality records must be properly maintained in the facility files.

5.5.2 Project Records

Project records are documents that are specific to a project or a group of samples within an on-going project. Examples of project records are as follows:

- Chain-of-custody forms;
- Raw analytical data;
- Final data reports with case narrative and/or cover letter;
- QC and calibration results;
- Project-specific nonconformance memos;
- Project correspondence including phone logs;
- Quotes and Contracts where applicable; and
- Project-specific QAPPs and SOPs.

Project records shall be properly maintained in the facility files.

5.5.3 Electronic Data

Where computers or automated equipment are used for capturing, processing, recording, reporting, storage or retrieval of analytical data, STL Austin's record handling system is designed to ensure that the following occur:

- The basic tenets in the EPA Good Automated Laboratory Practices (GALP), as expressed in our SOPs are followed;
- Computer software is documented and adequate for use;
- Procedures are established and implemented for protecting the integrity of electronic media data in terms of data entry or capture, data storage, data transmission and data processing;
- Computers and automated equipment are maintained to ensure proper functioning and the environmental and operating conditions necessary to maintain the integrity of calibration and analytical data;
- Security of data, including the prevention of unauthorized access and modification of computer data, is maintained;
- Records that are stored or generated by computers or personal computers have hard copy or write-protected backup copies; and
- Records that are stored only on electronic media must be supported by the hardware necessary for their retrieval.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors.

Further discussion of control of computer hardware and software is given in the Section 6.0 and SOP AUS-PM-0004, "Electronic Reporting."

5.6 Records Storage, Retention and Disposal

The STL Austin record system produces accurate records that document all laboratory activities. STL Austin retains on record all original observations, calculations and derived data, calibration records and a copy of the test report. The record keeping system allows for historical reconstruction of all laboratory activities that produced the resultant sample analytical data. The history of the sample is readily understood through the documentation. This includes inter-laboratory transfers of samples and/or extracts.

Records include the identity of personnel involved in sampling, preparation, calibration or testing. Information relating to the laboratory equipment, analytical test methods and related laboratory activities, such as sample receipt, sample preparation or data verification are documented. The system facilitates the retrieval of working files and archived records for inspection and verification purposes. Documentation entries are signed or initialed by responsible staff. All manually generated data are recorded directly, promptly and legibly in permanent ink. Entries in records are not obliterated. The data recording process is described in SOP AUS-QA-0017, "Data Recording Requirements."

When records, as contained in files, are transferred to a records storage area or off-site storage area, they shall be placed in suitable containers and an inventory sheet (hard copy or electronic) prepared by the person submitting the records. The contents of each container will be compared to the inventory sheet and labeled. If there are any discrepancies, the container and inventory sheet shall be returned to the supervisor or manager submitting the records for resolution. STL Austin will store all quality records and quality documents, as defined in this Section, for a minimum period of five years. Table 5.6-1 lists example record types and retention times.

Specific client projects and regulatory programs may have longer record retention requirements than the STL standard record retention time. In these cases, the longer retention requirement is noted in the archive. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data. Some programs with record retention requirements greater than five years are listed in Table 5.6-2.

Archives are indexed such that records are accessible on either a project or temporal basis. Archives are protected against fire, theft, loss, deterioration and vermin. Electronic records are protected from deterioration caused by magnetic fields and/or electronic deterioration. Access to archives is controlled and documented. STL ensures that all records are maintained as required by the regulatory guidelines and per the QMP upon facility location change or ownership transfer. Upon STL facility location change, all archives are retained by STL in accordance with the QMP. Upon ownership transfer, record retention requirements are addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established.

5.7 Data Confidentiality

STL Austin considers the data and associated information for a project to be confidential and the property of the client. In some cases the client may identify projects requiring confidentiality due to

national security. Information regarding these projects will be limited only to those STL Austin employees with a need to know. In order to preserve client confidentiality, reports and supporting records are only released to third party persons or organizations after consultation with the client and laboratory management. STL Austin's reports, and the data and information provided therein, are for the exclusive use and benefit of the client, and are not released to a third party without written consent from the client. However, if directed by courts-of-law or other statutory authorities, STL Austin will provide required records and notify its clients and provide information as to the identification of the requester and the records that will be released.

The audit reports supplied by federal, state, and local regulatory agencies are public information and can be released without written consent of those agencies. However, specific project audits are confidential and must be approved by the client before releasing them to a third party.

TABLE 5.1-1
Quality Documents and Required Approval

Quality Document	Required Approvals
Laboratory Quality Manual (LQM)	• Quality Assurance Manager • Laboratory/Technical Manager(s) • Operations/Technical Manager • Laboratory Director • General Manager
Quality Policy Documents	• Quality Assurance Manager • Laboratory Director
Standard Operating Procedures (SOPs)	• Quality Assurance Manager • Laboratory/Technical Manager(s) • Laboratory Health and Safety Coordinator • Laboratory Director
Project Specifications	• Quality Assurance Manager • Laboratory/Technical Manager(s)

TABLE 5.6-1

Example STL Record Types and Retention Times

Record Type[1]		**Archival Requirement**
Raw Data Includes: instrument calibration data, computer tapes/disks, QC sample data, sample data and software (version control)	All**	5 years from project completion
Controlled Documents Includes: QMP, LQM, SOPs and Policies	All**	5 years from document retirement date
Quality Records Includes: audits/responses, certifications, NCMs/corrective actions, logbooks*, method and software validations/verifications, standards certificates, PT results and calibration records	All**	5 years from archival
Project Records Includes: COC documentation, contracts and amendments, correspondence, QAPPs, SAPs, telephone logs and final data report	All**	5 years from project completion
Administrative		
Includes: EH&S manuals, permits, disposal records; employee handbook, OSHA 29 CFR Part 1910, personnel files, employee signature and initials, training records and technical and administrative policies	Personnel/ Training	7 years
Includes: accounting records	Accounting	See Accounting and Control Procedures Manual

* Logbooks include: maintenance, instrument, standards preparation, sample preparation, standard & reagent receipt, archiving, balance calibration and temperature/equipment monitoring

** Exceptions listed in Table 5.6-2

[1]Record Types encompass hardcopy and electronic records.

TABLE 5.6-2
Special Record Retention Requirements

Program	Retention Requirement
Colorado – Drinking Water	10 years
Louisiana – All	10 years
Massachusetts – all environmental data 310 CMR 42.14	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
Minnesota – Drinking Water	10 years
New York Potable Water NYCRR Part 55-2	10 years
Pennsylvania – Drinking Water	10 years
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
Navy Facilities Engineering Service Center (NFESC)	10 years
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
TSCA – 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement
OSHA – 40 CFR Part 1910	30 years

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6.0 Computer Hardware and Software

The primary purpose of quality assurance systems for computer hardware and software is to protect the integrity of computer-resident data. Procedures are in place at STL Austin to assure that computer-resident data and programs are accurate, traceable to a known source, protected against loss, and secure.

STL's computer and hardware controls are based on the guidance in EPA's "Good Automated Laboratory Practices" (GALP), August, 1995. This includes both corporate level Information Technology (IT) functions and STL Austin IT functions. Some GALP requirements, such as management responsibilities and the training program, are addressed in other sections of the LQM. Some corporate level IT functions, such as the system change management procedures, are described in more detail in corporate IT documents. Table 6.0-1 provides a cross reference of practices outlined in Section 8 of the GALP manual to corresponding sections of STL's QA and IT documents.

6.1 Computer Hardware

Computer hardware used in the generation, measurement or assessment of client data shall be of appropriate design and of adequate capacity to function according to specifications. Computer equipment must be installed in accordance with the manufacturer's recommendations and it must undergo documented acceptance testing.

6.1.1 Wide-Area Systems

STL Austin's LIMS and local area network (LAN) are connected to a wide-area network (WAN) serving multiple laboratories. The central node for the WAN is located at the Denver facility. The central system for the LIMS is an IBM AS-400 with multiple servers connected via the WAN. Records for the system architecture, testing and maintenance, such as Initial Program Loads (IPLs), are documented in the AS-400 System Log, which is also in Denver. Records for installation of the network hardware are maintained by the central System Administrator.

6.1.2 Local Systems

The local systems consist of computer equipment for analytical instruments, data evaluation, and upload to the LIMS. A local-area network (LAN) supports the local office software. Testing, maintenance, and repair of the local computer hardware are the responsibility of the STL Austin LAN Administrator. Documentation for the local systems is maintained by the LAN Administrator.

6.2 Facilities and Security

6.2.1 Central Computer Facilities

The environmental conditions of the facility housing the LIMS are controlled to protect against data loss. Access to the central computer facility in Denver is restricted by keypad entry used by IT staff. The central computer room is temperature controlled, and has an Uninterrupted Power Supply (UPS) plus a power generator to ensure that the WAN functions are not disrupted by power failures. Backup media, such as tapes and disks, are maintained daily. In addition, full volume backup copies of the raw data are shipped offsite to a commercial facility specially designed to store electronic data.

6.2.2 Local Computer Facilities

Facilities for housing local computer hardware must meet manufacturer's recommendations. To the extent possible, electronic data must be protected against environmental hazards such as fire, water damage, and strong electromagnetic fields. Each computer server has an individual UPS. Data files will have backup copies made at regular intervals to protect against accidental loss through hardware or software failure. Archived electronic data is stored off site at a commercial facility designed to store electronic data.

6.2.3 Controlled Software Access

The integrity of data is also assured by maintaining limited access to administrative functions through a hierarchy of operating system shells controlled by passwords. Access is granted by the LAN Administrator depending on a person's experience, training and assigned duties. See SOP S-ITQ-005 "LIMS User Profile Setup and Maintenance" (or current corporate document/revision) for more details.

Protection against unauthorized Internet access is provided by firewalls.

6.2.4 Virus Protection

Commercial virus protection programs are installed on all computers to detect and remove computer viruses. The LAN Administrator is to be notified whenever a virus is detected so that they can isolate any portions of the systems that may be at risk.

6.3 LIMS Raw Data

LIMS raw data and instrument raw data from instrument data systems such as TotalChrom, Target, IDB and Chemstation are stored on the file servers (*e.g.*, QAUSSVR02). The Systems Administrator and the LAN Administrator are responsible for maintaining the servers.

The individuals responsible for entering and recording raw data must be uniquely identified in the data, together with the date and time the data were entered. The instrument transmitting raw data must be uniquely identified, together with the date and time of transmission. Further data recording requirements exist to document manual integrations.

6.4 Software

If computer software is used to acquire, process, or report client data, that software will be tested to ensure that it correctly performs its intended function. Software is validated or verified, depending upon its complexity, size, and whether it was purchased or developed by STL. The following definitions are used by STL:

- Validation - the process of establishing documented evidence that provides a high degree of assurance that a specific process will consistently produce a product meeting predetermined specifications and quality attributes. This process demonstrates and documents that the software performs correctly and meets all specified requirements.
- Verification - the process of checking the accuracy of automatically (electronically) calculated information.

6.4.1 Industry Standard Software

Industry standard software programs are defined as those that are purchased and widely used without modification to the program itself. The program is initially verified for use by using test problems with known solutions to demonstrate that the program is operational for the desired application.

All purchased software must be used in accordance with the terms of its software license. Any use of software contrary to its license terms is expressly prohibited by STL.

6.4.2 Testing of STL-Developed Software

For programs used to process client data and developed within STL, and externally prepared programs that are modified by STL, validation or verification must be performed. The process used is dependent upon the function of the software as follows:

- Large complex systems consisting of several programs operating in unison to produce an intended result must be validated.
- For smaller software which only performs numerical manipulation, sample sets of numbers for which results are known should be processed and the results verified. In this case, known results are usually generated by performing hand calculations using the same equations and procedures as the software to verify that the software produces identical results.
- Software that performs as part of instrument operation shall be verified as previously described and by processing reference materials through the instrument system.

6.4.3 Control of Software Changes

STL has a well-established process for prioritizing and managing changes to the LIMS and LIMS-related software. See SOP S-ITQ-001 "Software and Hardware Change Management" and SOP S-ITQ-007 "Software Testing, Validation and Verification," (or current corporate documents/revisions). Proposals to modify software are written in a Software Enhancement Request, which includes a description of the task to be accomplished, the software to be modified, its functional requirements, and necessary algorithms. The Software Enhancement Request is submitted to the Change Management Committee for approval. The Committee includes representatives from each lab on the QuantIMS network. The Committee establishes a development schedule and approves the resources needed. Documentation of changes, version control and historical records of changes is the responsibility of the IT Manager of 'Change Management and QA'. Because these are modern networked systems, the documentation is kept on the network, rather than keeping redundant records at each facility as GALP suggests. All system software changes are developed in a test area and must pass the designed tests before it is installed in the working area.

The same principles of documenting software changes apply to spreadsheets, small databases or other small programs that are used solely at the STL Austin lab. The verification/validation records must explain the functional requirements, the algorithms and formulas used, the testing performed, and are maintained by the laboratory QA Manager.

6.4.4 Software Maintenance

Software problems are presented to the local LIMS Administrator (LA) in a Software Problem Report. The LA presents the issue to a group of the network LAs. The problem is discussed to make sure it is understood, and then a solution is determined and prioritized. Changes to the LIMS software for maintenance purposes are announced to each of the locations after revalidating the software.

6.4.5 Software Revalidation

Whenever a program is changed, the change will be evaluated to determine if it is significant enough to make revalidation necessary. If features have been added, previous test problems should be rerun to demonstrate that their function has not been affected. New test problems are processed, as previously discussed, to verify added performance. If software revision changes the basic operation of the program, complete revalidation of the program may be required.

Spreadsheets and unprotected software used to acquire, process or report client data must be documented and reverified when changes are made. The test problems used to provide initial verification is reprocessed and the results compared to demonstrate that performance of the software is unchanged.

Laboratory operations is responsible for the generation of the validation and verification data for instrument level software. QA will maintain the necessary documentation. STL Information Technology is responsible for generation and maintenance of documentation relating to verification and validation of the STL QuantIMS. This is described in the Policy Number P-ITQ-013R1, "Software Quality Assurance," (or current corporate document/revision).

6.5 Comprehensive System Testing

Comprehensive system testing is performed periodically. Independent auditors, such as Price Waterhouse, include computer systems in their audits, which are commissioned by the laboratory executive management. Extensive testing of all software was performed for the laboratory's Y2K readiness exercises.

As described in this LQM Section 9.2.2, the laboratory QA Manager is responsible for ensuring an annual internal audit of all lab areas is performed, including the local IT functions.

6.6 Records Retention

As required by NELAC, electronic raw data and computer documentation are stored for a minimum of five years. See this LQM Section 5.0 for further records retention details.

TABLE 6.0-1

GALP Cross Reference to LQM

GALP Section	GALP Guidance	STL Document
8.1 Laboratory Management	8.1.1 Ensure that personnel clearly understand the functions they are to perform	LQM 1.7.1, 1.7.2, and 3.0
	8.1.2 Ensure that QAU monitors LIMS activities	LQM 9.2.2
	8.1.3 Ensure that personnel, resources, and facilities are adequate and available as scheduled	LQM 1.7.1-1.7.4
	8.1.4 Receive reports of QAU inspections of the LIMS and audit of LIMS Rae Data , and ensure corrective actions are promptly taken in response to any deficiencies	LQM 9.2.2
	8.1.5 Approve SOPs setting forth the methods that assure LIMS Raw Data integrity, ensure that any deviations from SOPs and applicable GALP provisions are appropriately documented and that corrective actions are taken and documented, and approve subsequent changes to SOPs	LQM 4.2 and 9.1.4
	8.1.6 Assure that each applicable GALP provision is followed. With the exception of 8.1, 8.2, and 8.3, laboratory management may delegate GALP implementation and compliance to one or more responsible persons.	CORP Policy P-ITQ-013; LQM 6.0
8.2 Personnel	8.2.1 Must have adequate education, training, and experience to perform assigned LIMS functions	CORP Policy P-ITQ-013; LQM 3.0
	8.2.2 Must have a current summary of their training, experience, and job description, including their knowledge relevant to LIMS design and operation, maintained at the facility	LQM 3.1
	8.2.3 Personnel must be of sufficient number for timely and proper operation of the LIMS	LQM 1.7.1
8.3 Quality Assurance Personnel	8.3.1 Shall be entirely separate from and independent of LIMS personnel, and shall report directly to laboratory management	LQM 1.7.3

GALP Section	GALP Guidance	STL Document
	8.3.2 Shall have immediate access to the LIMS data, SOPs, and other records pertaining to the operation and maintenance of the LIMS	LQM 1.7.3; LQM 9.2
	8.3.3 Inspect the LIMS at intervals adequate to ensure the integrity of the LIMS Raw Data; prepare inspection reports that include a description of the LIMS operation inspected, the dates of the inspection, the person performing the inspection, findings and problems observed, action recommended and taken to resolve existing problems, and any scheduled dates for re-inspection; and report to laboratory management any problems that may affect data integrity	LQM 9.2
	8.3.4 Determine that no deviations from approved SOPs were made without proper authorization and documentation	LQM 9.1.1
	8.3.5 Periodically audit the LIMS Raw Data to ensure their integrity	9.2
	8.3.6 Ensure that the responsibilities and procedures applicable to the QAU, the records maintained by the QAU, and the method of indexing such records are documented and are maintained.	9.2

TABLE 6.0-1

GALP Cross Reference to LQM
(continued)

GALP Section	GALP Guidance	STL Document
8.4 LIMS Raw Data	8.4.1 LIMS Raw Data and the storage media on which they reside must be identified and documented. The documentation shall be included in the lab's SOPs.	System map is with IT Director
	8.4.2 The individual(s) responsible for entering and recording LIMS Raw Data is (are) uniquely identified when the data are recorded, and the time(s) and date(s) documented	SOP AUS-QA-0017
	8.4.3 The instrument transmitting LIMS Raw Data is uniquely identified when the data are recorded, and the time and date are documented	SOP AUS-QA-0017
	8.4.4 Procedures and practices to verify the accuracy of LIMS Raw Data are documented and included in the laboratory's SOPs and managed as described 8.11	SOP S-ITQ-007; LQM 8.8, 8.8-1-8.8.3
	8.4.5 Procedures and practices for making changes to LIMS Raw Data are documented and provide evidence of change, preserve the original recorded documentation, are dated, indicate the reason for the change, identify the person who made the change and, if different, the person who authorized the change. These procedures shall be included in the laboratory's SOPs.	
8.5 Software	8.5.1 SOPs shall be established for: a. development methodology b. testing and quality assurance c. change control d. version control e. maintaining historical file	CORP Policy P-ITQ-013; SOP S-ITQ-001; SOP S-ITQ-007
	8.5.2 Documentation shall be maintained for: a. existing and commercially-available systems b. new systems	CORP Policy P-ITQ-013
	8.5.3 All documentation is readily available in the facility where the software is used and SOPs are readily available where procedures are performed	P-ITQ-013 includes this statement, but we are on a WAN and documentation is not duplicated at each lab
	8.5.4 A historical file of software and documentation shall be retained	P-ITQ-013

TABLE 6.0-1

GALP Cross Reference to LQM
(continued)

GALP Section	GALP Guidance	STL Document
8.6 Security	Laboratory management shall ensure that security practices are adequate to assure the integrity of LIMS data	LQM 6.2; SOP S-ITQ-005; P-ITQ-013
8.7 Hardware	8.7.1 Must be of adequate design and capacity, and a documented description maintained	LQM 6.1; P-ITQ-013
	8.7.2 Must be installed in accordance with manufacturer's recommendations, and at installation, undergo acceptance testing that conforms to acceptance criteria. SOPs shall be established and maintained to define the acceptance criteria, testing, documentation, and approval required for changes to LIMS hardware and communications components.	SOP S-ITQ-001; P-ITQ-013; LQM 6.1
	8.7.3 Ensure that LIMS hardware and communications components are adequately tested, inspected, and maintained. SOPs for and documentation of these routine operations shall be maintained. Documentation of non-routine maintenance shall also include a description of the problem, the corrective action, acceptance testing criteria, and the acceptance testing performed to ensure that the LIMS hardware and communications components have been adequately repaired	P-ITQ-013
8.8 Comprehensive Testing	When LIMS Raw Data are collected, analyzed, processed, or maintained, laboratory management shall ensure that comprehensive testing of LIMS performance is conducted, at least once every 24 months or more frequently as a result of software or hardware changes or modifications. These test shall be documented and the documentation shall be retained and available for inspection or audit	SOP S-ITQ-001; LQM 6.3.4
8.9 Records Retention	Laboratory management shall ensure that retention of LIMS Raw Data, documentation, and records pertaining to the LIMS comply with EPA contract, statute, or regulation; and SOPs for retention are documented, maintained, and managed	QMP; LQM 5.5-5.6

TABLE 6.0-1

GALP Cross Reference to LQM
(continued)

GALP Section	GALP Guidance	STL Document
8.10Facilities	8.10.1 The environmental conditions of the facility housing the LIMS must be controlled to protect against data loss	LQM 6.2
	8.10.2 Environmentally adequate storage capability for retention of LIMS Raw Data, LIMS Raw Data storage media, documentation, and records pertaining to the LIMS are provided	LQM 6.2
8.11SOPs	8.11.1 SOPs, as described above, must be maintained and readily available where the procedure is performed	LQM 5.3; SOP Index
	8.11.2 SOPs are periodically reviewed at a frequency adequate to ensure that they accurately describe the current procedure	LQM 5.2
	8.11.3 SOPs must be authorized and controlled, with all changes subject to the same approvals and control	LQM 5.2
	8.11.4 An historical file of SOPs must be maintained	LQM 5.6

7.0 Planning

The generation of environmental analytical data is an intricate process. Success is dependent upon the timely execution of interrelated steps. For many environmental sampling and analysis programs, testing design is site- or project-specific and is not necessarily the same as the laboratory's standard service. It is STL's intent to provide both standard and customized laboratory services to our clients, provided that any special requirements are documented in writing, and provided that performing the work in this manner does not cause the laboratory to violate relevant regulatory requirements. STL Austin has an organizational system in place to ensure that projects are properly planned prior to project initiation, and are monitored for conformance to project requirements during the course of the project. This system assures that STL Austin's clients receive quality deliverables, as well as quality service.

7.1 Contract Review

For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. The process of client request for proposal (RFP) and the laboratory's tender of a written response is a process of communication between both parties to understand project requirements and the laboratory's capabilities. Contract or RFP review shall include a review of the client's requirements in terms of compound lists, test methodology requested, sensitivity, accuracy, and precision requirements. This review also ensures that the laboratory's test methods are suitable to achieve these requirements. The laboratory's capabilities in terms of turnaround time, capacity, and resources to provide the services requested, as well as the laboratory's ability to provide the required documentation are also a part of this review.

All contracts for new work entered into by STL Austin are reviewed by the Customer Service Manager (CSM) or designee. Agreements for continuing work are the responsibility of laboratory Project Managers (PMs) or the CSM. Depending on the size and scope of the proposed project, the Laboratory Director and other STL management staff can also be involved. Technical staff including the Technical Director, Operations Manager, QA Manager and IT Manager can be called upon to perform a review of the technical and QA/QC requirements. The CSM or PM, with this internal support, will work with clients to align project requirements with laboratory capabilities. Any contract requirement or contract modification communicated to STL verbally is documented and communicated to the client in writing. Any discrepancy between client requirements and STL's capability to meet those requirements is resolved in writing before acceptance of the contract.

All contracts, Quality Assurance Project Plans (QAPPs), Sampling and Analysis Plans (SAPs), contract amendments and documented communications become part of the permanent project record as detailed in this LQM Section 5.6.

7.2 Certifications and Approvals

A necessary part of the review and work acceptance procedure is the evaluation of project needs for laboratory certification. The persons reviewing the prospective project must determine if project work plans or regulatory permits are tied to specific laboratory certifications or approvals. Where such requirements exist, the laboratory must have the certifications or approvals in place before work begins. QA personnel coordinate with the state certification agencies to maintain or add additional parameters. Copies of current laboratory certifications are maintained by the QA office, and are available upon request.

7.3 Data Collection Process

The sample collection and data generation processes are designed to produce analytical data that accurately reflect the nature of the site or sampling point. Figure 7.3-1 shows the sample collection and data collection processes. These processes are designed to produce analytical data that accurately reflect the nature of the site or sampling point.

7.4 Project Organizational Responsibilities

STL Austin communicates with its clients to identify the client's needs. Project Managers (PMs) work together with the Customer Service Manager (CSM), or designee, to assess and coordinate STL Austin's resources. Each client or project is usually assigned a single point of contact, usually a PM, to ensure that there is a strong line of communication between the client and STL Austin. Projects receive technical and QA support at the laboratory or corporate level as needed to ensure that measurement quality objectives in support of project Data Quality Objectives (DQOs) are achievable. The CSM or designee, PMs, Lab Managers and Operations Managers work together to ensure that the following will occur prior to receipt of samples at the laboratory:

- Samples are scheduled for arrival at the laboratory;
- All unique project requirements have been identified and communicated to all appropriate personnel;
- Standardized client, state, federal or STL Austin programs are appropriately selected;
- Fully-qualified subcontract laboratories have been selected if needed;
- A review has been performed on all pre-project documents such as proposals, contracts, and/or QAPPs to identify the range of tests required and within scope of laboratory being used;
- All appropriate and required preparations have been made at the laboratory to accommodate or meet project requirements as described in proposals, contracts, and/or QAPPs;
- Determine that the laboratory has the capability and the capacity to analyze the samples including equipment, staff, space and workload;
- Determine that the laboratory is able to meet the required sample holding times and is able to report the resulting data within the time line specified by the client; and
- All known safety hazards associated with the samples have been communicated to all appropriate personnel.

Approval and issuance of a quote, bid or contract document is documentation that this process has

occurred. For particularly large or involved projects, STL Austin encourages our clients to visit the laboratory and/or participate in kickoff meetings with the laboratory staff. STL has found it very effective to invite the client into the laboratory's project preparations.

7.5 Communication of Project Requirements

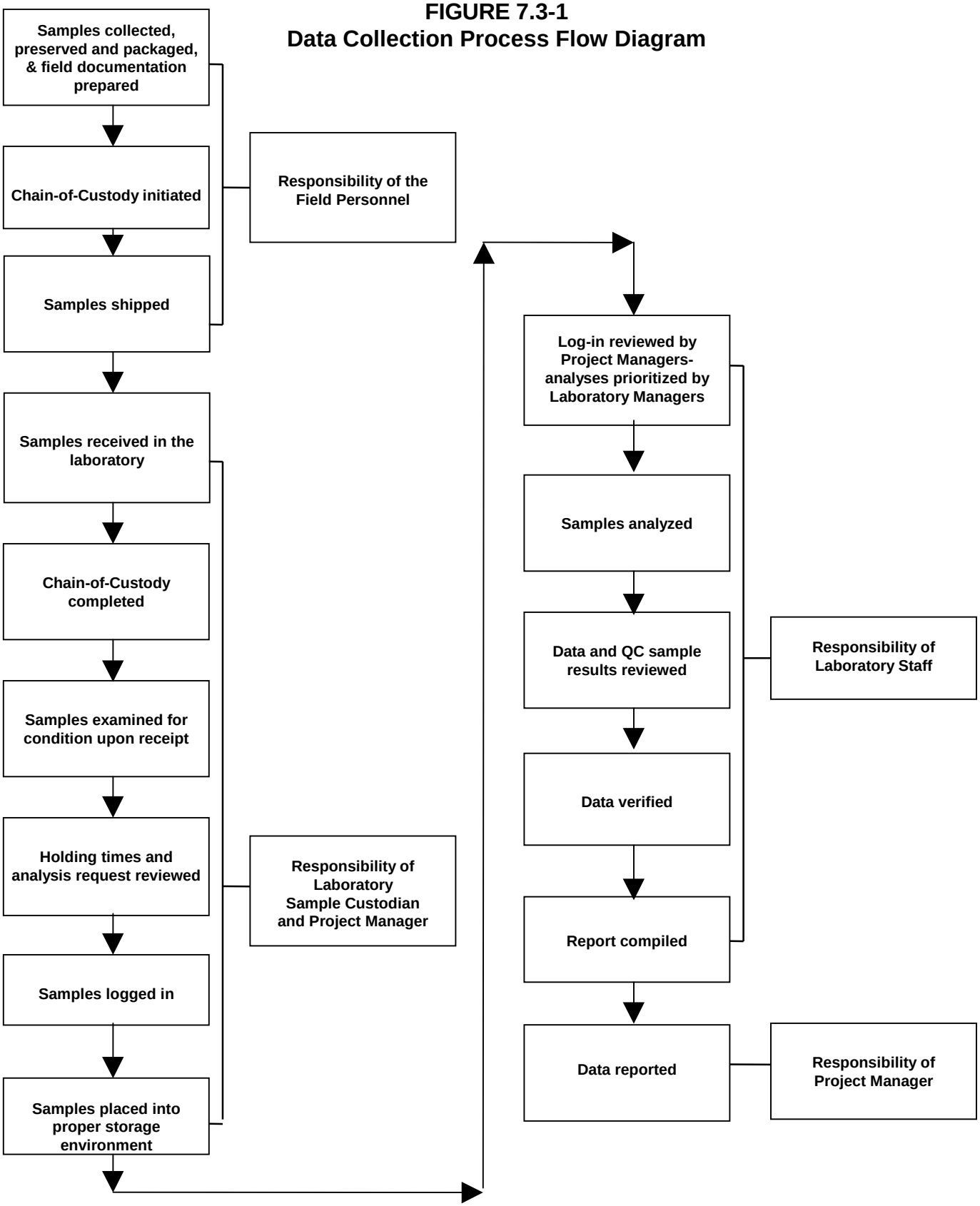
STL Austin PMs shall document project-specific requirements prior to receipt of samples. The LIMS system requires the PM to enter a 'quote' before any samples can be logged in. In addition to price information, the 'quote' is a detailed technical specification of the work to be performed. The quote includes identification of project personnel, numbers and types of samples, tests to be performed, reporting limits, QC to be performed, control limits, data qualifier flags to be used, significant figures to be used, and the types of deliverables required. This is the primary means of communicating routine requirements to the laboratory personnel.

Brief non-routine project requirements are entered into the comments section of the Client Requirements Checklist portion of the quote. The Checklist is reviewed by the analysts as analyses are being scheduled and before testing has started. If the special requirements are too lengthy for the Client Requirements Checklist, the PM must prepare a Quality Assurance Summary (QAS) or equivalent, which is a written document describing all requirements that are different than routine work. The QAS is referenced in the Client Requirements Checklist, and is distributed by the PM to each of the operational groups involved. For complex projects, project kickoff meetings are conducted by the PM with each of the operational groups involved. (Example QAS-Quality Tracker and QuantIMS Checklists are shown in Figures 7.5-1 and 7.5-2 respectively.)

7.6 Customer Service Teams

The STL Austin laboratory shall establish and maintain long term and substantive relationships with our clients, identify customer needs, and seek to attain value for our customers according to our customers' definitions. The laboratory may create, at any time, client-specific Customer Service Teams (CST). A CST may be created before any discrete projects exist, during on-going projects, or even after the completion of a project. In addition to the PM or customer service representative the team may also contain associates from the operations, technical, QA, IT, contracts and/or accounting organizations.

FIGURE 7.3-1
Data Collection Process Flow Diagram



7.7 Contingency Planning

An effective QA Program must emphasize contingency planning, actions to prevent problems from reoccurring, and to ensure timely and effective completion of a measurement effort. The following are considered relative to contingency planning.

7.7.1 Staffing

A primary objective is to ensure that qualified staff are always available to perform the necessary analytical work, regardless of employee turnover, vacation, illness or other absences. STL Austin is a relatively large laboratory with multiple staff capabilities for the majority of tests performed. However, other sources of trained personnel are potentially available to assist in the event of unforeseen absences. Given sufficient time for necessary orientation, temporary agency staff can be used. More significantly, STL is a large laboratory network and a large pool of qualified staff can be made available from other STL laboratories.

7.7.2 Backup Instrumentation

Within STL Austin, duplicate instrumentation is available for most methods to allow uninterrupted work flow if one piece of equipment fails. The laboratory may also choose to lease equipment. However, in circumstances where a catastrophic instrument failure occurs, alternative, but equivalent, methods may be recommended to the client for approval.

- Preventive Maintenance - STL Austin's preventive maintenance program is designed to minimize analytical instrument malfunctions, permit simple adjustments, and to ensure fewer and shorter breakdowns of critical analytical equipment. (See this LQM Section 8.11, "Preventive Maintenance and Service.")

- STL Laboratories & Subcontractor Laboratories - To support the laboratory during peak periods or in the event of a critical instrument malfunction, STL has the capability to arrange the use of other STL laboratories or qualified analytical laboratories as subcontractors for short-term backup analytical support. However, use of a subcontractor laboratory must be approved by the client in writing. For projects requiring NELAC approval, the subcontractor must also be NELAC approved.

- Uninterruptable Power Supply - Uninterruptable Power Supply (UPS) provides line conditioning and backup power to the server. This contingency plan provides protection of data and computer systems for power outages of shorter duration. Backups of all local network data are performed on a regular basis (daily or weekly depending on the data type) and backup copies are stored off-site. Computer servers are configured in RAID (Redundant Array, Inexpensive Disks), which provides further protection of data in the event of equipment failure.

FIGURE 7.5-1 (Page 1 of 2)

Example Quality Assurance Summary – Quality Tracker

QUALITY TRAVELER

Work Order # _____
RAS Number: _____
Protocol Spec: _____
Test Codes(s): _____ _____
_____ _____ _____ _____
_____ _____ _____ _____
Analyst's/Peer Reviewer's Initials

Client: _____
Index: ___ Version: _____
Class S B T K K K RL ___ CIT
Subclass S M C E/D L/D M/D ___ ___
Subset ___ ___ ___ ___ ___ ___ ___ ___

CSC: _____
Client-only MS/MSD: _
Method: _____
Health & Safety:

Verbal TAT: __ (days) Report TAT: __ (days)
Report As: Received
Restricted Soils? _ # Reports: __
Comments: _____

	Client Services	Sample Control	Sample Preparation	Sample Analysis	Document Control	QCER #s
	____/____	____/____	____/____	____/____	____/____	
TECHNICAL						
Target Analytes	Y/N-Test/List code(s) verified, inc TICs?	Y/N-Test/List code(s) correct, inc TICs?		Y/N-Calibrated for all target analytes?		
Precision	Y/N-Std Spec (analytes, conc, tolerances)?		Y/N-Spiking analytes/ conc per Std Spec?	0,M,L,D,E,A-Precision measure(s) different?		
Accuracy	Y/N-Std Spec (analytes, conc tolerances)?		Y/N-Spiking analytes/ conc per Std Spec?	0,M,L,S,E,A-Accuracy measure(s) different?		
Detection/Reporting Limits	Y/N-Are the PRDLs standard?			Y,S,P,C,I - Samples have DLs < PRDLs?	Y/N-Correct Reporting Limits used?	
Holding Times	SP/SA W:___/___ S:___/___	# not meeting Spec	# not meeting Spec	# not meeting Spec		
Turnaround Times	Specification days	# days TAT in area	# days TAT in area	# days TAT in area	# days TAT in area	
Lab Completeness	Specification % NA	Calc'd completeness NA	Calc'd completeness NA	Calc'd completeness NA	Calc'd completeness NA	
Other	Y/N-Add'l requirements?	Y/N/NA-Add'l req. met?	Y/N/NA-Add'l req. met?	Y/N/NA-Add'l req. met?	Y/N/NA-Add'l req. met?	
PROCEDURAL						
Demo of Capability				Date of last complete DOC		
Statistical Control				Y/R,A,P,T/NYA-Realtime stat control demo for acc/prec/trend rules?		
Detection Limit Study				Instrument ID/Date of most recent complete DL study		
Calibration/QC Criteria	Y/N-Standard Spec?		Y/N-Appropriate QC prep'd & deliv'd? Y/N-Initial Prep?	0,C,B,V,M,L,D,S,A,E-Calib/QC analyses not meeting Spec.		

FIGURE 7.5-1 (page 2 of 2)

Example Quality Assurance Summary – Quality Tracker

	Work Order #	Client Services		Sample Control		Sample Preparation		Sample Analysis		Document Control		QCER #s
PROCEDURAL CONT.	Sample Preparation, Custody and Handling	Y/N-Std Spec. (preservation, prep and storage conditions)?		Number of samples compromised in area.		Y/N-All samples prep'd according to Spec? Number of samples compromised in area.		Number of samples compromised in area.				
	Sample Processing	Y/N-Standard Spec?				Y/N-Were 20 or fewer field samples prepared in each prep batch with appropriate matrix-specific QC?		Y/N-Were 20 or fewer field samples & matrix specific QC analyzed for each analytical batch?		Y/N/NA-Appropriate prep batches reported?		
	Calc/Data Reduction	Y/N-Standard Spec?						Y/N-Performed to Spec?				
	Reporting/ Deliverables	Y/N-Export required? Y/N-Data pkg required? Y/N-Special rep req'd?								Y/N-Export required? Y/N-Data pkg required? Y/N-Special rep req'd?		
	Other	Y/N-Add'l requirements?		Y/N/NA-Add'l req. met?		Y/N/NA-Add'l req. met?		Y/N/NA-Add'l req. met?		Y/N/NA-Add'l req. met?		
OPERATIONAL	Instrument/ Equipment	Y/N-Standard Spec?				List equip/instr used.		List instrument used.				
	Training Requirements	Y/N-Standard Spec?		Y/initials and what is missing - All required training documented? (AQC, SOP, Safety)		Y/initials and what is missing - All required training documented? (AQC,DOC,SOP,Safety)		Y/initials and what is missing - All required training documented? (AQC,DOC,SOP,Safety)		Y/initials and what is missing - All required training documented? (AQC,SOP,Safety)		
	Data Review,Verif. and Certification	Y/N-Standard Spec?		Y/N-Are required QCERs attached and #s on QT?		Y/N-Are required QCERs attached and #s on QT?		Y/N-Are required QCERs attached and #s on QT?		Y/N-Are required QCERs attached and #s on QT?		
	Health and Safety	Hazards: Known (check one) Unknown		Y/N-Appropriate safety precautions followed?		Y/N-Appropriate safety precautions followed?		Y/N-Appropriate safety precautions followed?				
	Sample Disposal	Y/N-Standard Spec?		Y/N-System in place for disposal per RAS form?		Y/N-Samples consumed or ready for disposal per Spec?		Y/N-Samples & ext/dig consumed or ready for disposal per Spec?		Y/N-Hazard Information form completed?		
	Data Archival	Y/N-Standard Spec?		Check-out logbook #		Logbook/Notebook #		Run logbook #		Archival per Spec?		
	Other	Y/N-Add'l requirements?		Y/N/NA-Add'l req. met?		Y/N/NA-Add'l req. met?		Y/N/NA-Add'l req. met?		Y/N/NA-Add'l req. met?		

FIGURE 7.5-2 (page 1 of 2)
Example Quality Assurance Summary – QuantIMS Checklists

SEVERN TRENT LABORATORIES, INC.

CLIENT REQUIREMENTS - AUS-STD

Quote Number: 37111	Lot ID.....: I0G310148	Analyt Due Date: 8/18/00
Project Mngr: SCHEPCOC	Number of Smp"s: 010	Report Due Date: 8/19/00
Version.....: 1-00	SDG #.....:	Report Pkg Due.: 0/00/00
Quote Date..: 6/28/2000	Sample Date....: 7/28/00	Print Date.....: 11/02/00
Client Code.: 127159		Receipt Date...: 7/31/00
Site ID.....:		

Method List.: MSVOC- MS8260LL,

____ ------ General Category (All Groups) --------
____ Batch MS (SD) reported
____ Report method required QC
____ Retain requested RL's where ever possible
____ ------ Sample Receiving ----------
____ Notify PM ASAP if any problems (temp,pH,etc)
____ ------ Extractions ----------
____ ------ GC Volatiles ----------
____ 7 DAY HOLDS!! No preservation.
____ ------ GC Semivolatiles ----------
____ Second column confirm required on P/P hits
____ ------ MS Volatiles ----------
____ 7 DAY HOLDS!! No preservation.
____ ------ MS Semivolatiles ----------
____ ------ Metals ----------
____ ------ Wet Chemistry ----------
____ Sample duplicate required

NOTES:

OPTIONAL LAB REVIEW & DOCUMENTATION

Level I	Level II	Level III
Reviewer: _____	Reviewer: _____	Reviewer: _____
Date....: _____	Date....: _____	Date....: _____

FIGURE 7.5-2 (page 2 of 2)
Example Quality Assurance Summary – QuantIMS Checklists

SEVERN TRENT LABORATORIES, INC.

REPORT GENERATION - AUS-STD

Quote Number: 37111
Project Mngr: SCHEPCOC
Version.....: 1-00
Quote Date..: 6/28/2000
Client Code.: 127159
Site ID.....:

Lot ID.....: I0G310148
Number of Smp"s: 010
SDG #.....:
Sample Date....: 7/28/00

Analyt Due Date: 8/18/00
Report Due Date: 8/19/00
Report Pkg Due.: 0/00/00
Print Date.....: 11/02/00
Receipt Date...: 7/31/00

____ Title page
____ Executive Summary - Detection highlights
____ Analytical Methods Summary
____ QC Data Association Summary
____ Lot Sample Summary
____ Organics Reports
____ TIC Report
____ Dioxin Report
____ Metals Report
____ Wet Chemistry Report
____ Method blanks
____ LCS/LCSD Data Report
____ LCS/LCSD Evaluation Report
____ MS/MSD Data Report
____ MS/MSD Evaluation Report
____ Sample Duplicate Report
____ Dummy Invoice-Standard

OPTIONAL LAB REVIEW & DOCUMENTATION

Level I	Level II	Level III
Reviewer: _____	Reviewer: _____	Reviewer: _____
Date....: _____	Date....: _____	Date....: _____

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8.0 Work Processes and Operations

Much of the environmental project activity is planned and designed externally to the laboratory or field operation and presented in the form of a contract, work plan, sampling and analysis plan (SAP) or QA Project Plan (QAPP). Laboratory and field activities are in turn planned, implemented, and assessed by STL to meet client requirements according to approved procedures and methodologies. The QMP and LQM provide the systems to document and implement these activities. The execution and assessment of the implemented operational systems are detailed in STL SOPs. The entire process is assessed on a regular basis for conformance to prescribed requirements.

Standard practices for the STL Austin Laboratory are detailed in this section. Specific project or program requirements that differ from those described here can be met, but they must be explicitly stated in approved contracts, work plans, QAPPs or other project documents.

8.1 Traceability of Measurements

STL Austin documents all laboratory activities in sufficient detail to allow their reconstruction. To this end, documentation is generated to trace a sample from its point of origin, through receipt in the laboratory, analysis, reporting and disposal. The documentation includes, but is not limited to the following:

- Chain of custody documentation whereby the lab accepts custody of the sample from external agencies;
- Laboratory sample custody logbooks;
- Sample preparation worksheets;
- Sample analysis logbooks;
- Calibration and QC data associated with the samples;
- Instrument maintenance logbooks;
- Sample disposal logbooks; and
- Final reports.

8.2 Analytical Methods

Whenever possible, STL Austin uses industry- and regulatory agency-recognized analytical methods from source documents published by agencies such as the U.S. Environmental Protection Agency (EPA), Department of Energy (DOE), American Society for Testing and Materials (ASTM) and National Institute for Occupational Safety and Health (NIOSH), as described in STL Austin's SOPs. The analytical methods performed by STL Austin are listed in Tables 8.2-1 through 8.2-5.

Method performance data (*i.e.*, detection limits, precision and accuracy data) are developed by the laboratory operations staff. The operations staff and the QA staff evaluate and approve the performance data before a methodology is performed routinely. The method must also be described and documented with a SOP.

8.2.1 Standard Operating Procedures

SOPs are required for all repetitive analytical and administrative activities ranging from the receipt of samples in the laboratory through their analysis, reporting, and subsequent disposal. Training, health and safety procedures, QC, method procedures, and instrument and equipment calibrations are included in SOPs. Preprinted forms, shown as an example form, are included in SOPs as appropriate. SOP requirements are discussed in the SOP AUS-QA-0029, "Standard Operating Procedures," which meets the requirements of NELAC.

SOPs are reviewed by technically qualified associates. SOPs are controlled documents and are distributed and maintained as described in SOP AUS-QA-0029. Requirements for SOP approval are listed in Table 5.1-1.

All SOPs contain STL Austin's interpretation of the published methods. Significant modifications to the published method are described in the SOP. Operations are performed as described in these SOPs. A list of SOPs is included in Table 8.2-6.

Planned changes in procedure which may occur due to expected sample matrix effects or project requirements are documented in nonconformance memos (NCMs), which are kept in project files and/or project-specific case narratives, or may be added to QAPPs. Every effort is made to obtain client written approval prior to implementing the change.

Unplanned deviations in the SOPs, which may occur due to sample matrix or other events, are documented in nonconformance memos (NCMs) and in the project-specific case narratives.

8.3 Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements used to ensure the generation of the type, quantity, and quality of environmental data that will be appropriate for the intended application (EPA 1994)[1]. Typically, DQOs are identified during project scope and the development of sampling and analysis plans. In this LQM however, we refer to only the analytical DQOs, also known as measurement quality objectives (MQOs), because laboratories generally do not have any authority over sample collection, shipment or other field-related activities that may affect the data quality of the environmental sample before the sample is received in the laboratory. The EPA has established six primary analytical DQOs (MQOs) for environmental studies. These include: precision, accuracy, representativeness, completeness, comparability and detectability.

[1] "Guidance for the Data Quality Objectives Process", EPA QA/G-4, EPA 600/R-96/005, August 2000.

The components of analytical variability (uncertainty) can be estimated when QA and QC samples of the right types and quantities are incorporated into measurement procedures at the analytical laboratory. STL Austin incorporates numerous QA and QC samples to obtain data for comparison with the analytical DQOs and to ensure that the measurement system is functioning properly. The QA/QC samples and their applications, described in Section 8.4, are selected on the basis of method- or client-specific requirements. Field blanks, field duplicates and performance evaluation (PE) samples are received from the client as unknown samples. Analytical laboratory QC samples for inorganic, organic, and radionuclide analyses may include calibration or instrument blanks, method blanks, background, duplicates, replicates, laboratory control samples (LCSs), calibration standards, matrix spikes (MSs), matrix spike duplicates (MSDs), surrogate spikes and yield monitors.

8.3.1 Precision and Accuracy

Precision is an estimate of variability, that is, it is an estimate of agreement among individual measurements of the same physical or chemical property, under prescribed similar conditions. The precision of a measurement system is affected by random errors. Precision is expressed either as relative standard deviation (RSD) for replicate measurements greater than two or as relative percent difference (RPD) for duplicate measurements. Table 8.6-1 illustrates the formula used to calculate units of precision (i.e., RSD and RPD).

Accuracy is the degree of agreement between a measurement and the true or expected value, or between the average of a number of measurements and the true or expected value. Systematic errors affect accuracy. For chemical properties, accuracy is expressed either as a percent recovery (R) or as a percent bias (R - 100).

The precision and accuracy DQOs that are to be used in evaluating inorganic and organic constituents at STL Austin are provided in Tables 8.4-5, 8.4-6, 8.4-7, and 8.4-8, method-specific SOPs, and in the documentation for the analytical method of interest.

Precision and accuracy are determined, in part, by analyzing data from matrix spike and matrix spike duplicates, unspiked duplicates, LCSs and single blind audit samples. A description of these QC samples is provided in Section 8.4.

8.3.2 Completeness

Completeness is a measure of the percentage of measurements that are judged to be valid measurements. At a minimum, the objective for completeness of data is 90% for each constituent analyzed.

8.3.3 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, a variation in a physical or chemical property at a sampling point, or an environmental condition. Data representativeness is primarily a function of sampling strategy; therefore, the sampling scheme must be designed to maximize representativeness. Representativeness also relates to ensuring that, through sample homogeneity, the sample analysis result (concentration) is representative of the constituent concentration in the sample matrix. At STL Austin, every effort is made to analyze an aliquot that is representative of the original sample, and to ensure the homogeneity of the sample before subsampling.

8.3.4 Comparability

Comparability is a measure of the confidence with which one data set can be compared to another. To ensure comparability, all laboratory analysts are required to use uniform procedures (i.e., SOPs) and a uniform set of units and calculations for analyzing and reporting environmental data.

8.3.5 Method Detection Limits

It is STL Austin policy to strictly follow the specification in the U.S. EPA 40 CFR Part 136 Appendix B in determining MDLs for chemical tests. The requirement for this procedure is further detailed in corporate SOP S-Q-003 “Method Detection Limit Studies” and STL Austin SOP AUS-QA-0033 “Determination of Method Detection Limits for Chemical Tests.” These procedures require that the MDLs be determined for each analyte of interest representing the aqueous and solid matrices within the capability of the primary analytical methods.

8.3.6 Instrument Detection Limits

Instrument Detection Limits (IDLs) are required to be performed quarterly for metals constituents and cyanide when analyses are performed in support of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) activities, projects adhering to the DOD QSM, or when the USEPA CLP SOW protocol is required. IDLs are not required by the SW-846 methods, except for Method 6020 where the IDLs are a requirement.

When required, IDLs will be performed in accordance with the procedures defined in the applicable USEPA SOW, ILMO3.0 or subsequent versions, and SOP AUS-QA-0032, “Determination of Instrument Detection Limits.”

Prior to acceptance and use for reporting purposes, all data from detection limit studies and reporting limits must undergo technical review and approval by the laboratory management and QA staff.

8.3.7 Reporting Limits

Two reporting limit conventions are used within STL Austin: the Reporting Limit (RL) and the Project-Specific Reporting Limit (PSRL). The Reporting Limit (RL) is the lowest level at which measurements become quantitatively meaningful, also sometimes referred to as the Practical Quantitation Limit (PQL). The RLs/PQLs must be greater than the statistically determined MDLs. In some limited situations, higher RLs may be established based on maximum contaminant level (MCLs), applicable or relevant and appropriate requirements (ARARs), or project-specific data quality objectives (DQOs).

PSRLs are used when project data quality objectives (DQO) require a reporting limit other than the RL. PSRLs tailor STL Austin's product to meet customer requirements. The RLs and PSRLs are maintained in the LIMS.

RLs and PSRLs are established as described in SOP AUS-QA-0034, "Reporting Limits."

8.4 Quality Control Samples

Two types of Quality Control (QC) samples are field QC samples and laboratory QC samples. Field QC samples are collected during the sampling event and are useful in determining sampling precision and accuracy and monitoring for contamination that may occur during collection, transport or storage of environmental samples. Laboratory QC samples are routinely added at the laboratory to the normal sample stream. Successful analysis of these samples demonstrates that the laboratory is operating within prescribed requirements for accuracy and precision. In addition, utilizing matrix-specific laboratory QC samples, information regarding the effect of the matrix or field conditions on the analytical results can be obtained. The following sections describe common field and laboratory QC samples.

8.4.1 Field QC Samples

When field QC sample collection and analysis are required for a project, it is the responsibility of the project sampling supervisor to ensure that this sampling is performed correctly and at the project-required frequencies. Field QC samples may or may not be identified as such to the laboratory and are considered by the laboratory as field samples for the purpose of QC batching, sample preparation and analysis. Field QC sample results are reported in the same manner as actual field samples, unless a specific deliverable is requested by the client. No correction of the analytical data is done in the laboratory based on the analysis of field QC samples.

Field QC sample types, applicability to organic and inorganic analyses, precision and accuracy applications and by whom they are introduced are summarized in Table 8.4-1.

8.4.2 Laboratory QC Samples

Laboratory performance QC is required to ensure the laboratory systems (instrumentation, sample preparation, analysis, data reduction, etc.) are operating within acceptable QC guidelines during data generation as required to meet the client's objectives. Laboratory QC samples consist of method blanks (MB), instrument blanks, laboratory control samples (LCS) and calibration verification samples. In addition to laboratory performance QC, matrix-specific QC is utilized to determine the effect of the sample matrix on the data being generated. Typically, this includes matrix spikes (MS), matrix spike duplicates (MSD), sample duplicates and the use of surrogate compounds. Laboratory- and matrix-spike QC sample types are summarized in Tables 8.4-2, 8.4-3 and 8.4-4. In addition, Tables 8.4-5, 8.4-6 and 8.4-7 list laboratory QC samples, acceptance criteria and corrective actions by reference method for inorganic methods, organic methods and the USEPA CLP Statements of Work, respectively. The following sections provide descriptions of laboratory QC samples and their frequency of use. Non-routine analytes should be spiked at least once every 2 years.

8.4.2.1 Batch

The batch consists of a group of environmental samples that are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of a similar matrix, meeting the above mentioned criteria. Where no preparation method exists (example, volatile organics, water) the batch is defined as environmental samples that are analyzed together with the same process and personnel, using the same lots of reagents, not to exceed 20 environmental samples. An analytical batch is composed of prepared environmental samples, extracts, digestates or concentrates that are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

8.4.2.2 Method Blank

The method blank (MB) is a QC sample (i.e., a blank matrix) that is processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure. The method blank is used to identify any interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false positive data. Potential sources of contamination include solvent, reagents, glassware, other sample processing hardware, or the laboratory environment. In general, the method blank is a volume of deionized laboratory water for water samples, or a purified solid matrix for soil/sediment samples, that is processed as a sample. In the event that no appropriate solid matrix exists, deionized water may be used. The volume or weight of the method blank must be approximately equal to the sample volume or sample weight processed. A method blank shall be prepared with each group of samples processed.

8.4.2.3 Instrument/Calibration Blank

The instrument blank is an unprocessed aliquot of reagent used to monitor the contamination of the analytical system at the instrument. System contamination may lead to the reporting of elevated analyte concentrations or false positive data. The instrument blank does not undergo the entire analytical process and generally consists of an aliquot of the same reagent(s) used for a sample dilution. Instrument blanks are also referred to as continuing calibration blanks (CCBs).

8.4.2.4 Laboratory Control Sample

A laboratory control sample (LCS) is a laboratory-prepared suitable clean matrix sample that is fortified with a known amount of analytes or a solid reference material purchased from an approved vendor, processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure. The LCS contains all target analytes specified in the method, and should contain the same analytes as the matrix spike and matrix spike duplicate.

For certain regulatory or client programs, a LCS may contain a full list of analytes. However, in these cases, a subset of analytes, as defined by the program, is used to determine the acceptability of a batch of sample data. The LCS recovery data are used to monitor the analytical method performance in terms of analytical accuracy. On-going evaluation of the LCS recoveries demonstrates that the laboratory is performing the method within statistical control (*i.e.*, accuracy and precision) in the absence of matrix interference. The LCS results, coupled with MS data, help determine whether the laboratory performed the method correctly or the sample matrix affected the analytical results. When a laboratory control sample duplicate (LCSD) is required, a percent recovery for each target analyte is calculated, as well as a relative percent difference (RPD) between the LCS and the LCSD.

8.4.2.5 Matrix Spike

A matrix spike (MS) is an environmental sample to which known concentrations of target analytes have been added. MS samples are analyzed to evaluate the effect of the sample matrix on the analytical methodology. MS samples are generated by taking a separate aliquot of an actual client sample and spiking it with the selected target analyte(s) prior to sample extraction. The MS sample then undergoes the same extraction and analytical procedures as the unfortified client sample. Due to the potential variability of the matrix of each sample, these results may have immediate bearing only on the specific sample spiked and not on all samples in the QC batch. If the sample volume or amount provided is not sufficient for a MS, then a LCS may be performed.

8.4.2.6 Matrix Spike Duplicate

A matrix spike duplicate (MSD) is a second aliquot of a sample that is spiked with the selected target analyte(s) and analyzed with the associated sample and MS sample. The results of the MS and MSD are used together to determine the effect of a matrix on the accuracy and precision of

the analytical process. Due to the potential variability of the matrix of each sample, the MS/MSD results may have immediate bearing only on the specific sample spiked and not all samples in the QC batch. When a full-analyte spike is required, a selected list of analytes is used to measure statistical control or matrix effects. If the sample volume or amount is not sufficient for a MSD, then a LCSD may be performed.

8.4.2.7 Sample Duplicate

A laboratory sample duplicate is a second aliquot of an environmental sample taken from the same sample container that is processed identically with the first aliquot of that sample. That is, sample duplicates are processed as independent samples within the same QC batch. Compared with other results, such as LCS duplicates, sample duplicates may be used to assess sample homogeneity and the precision of the analytical process. If the sample volume or amount is not sufficient for a sample duplicate, then a LCSD may be performed.

8.4.2.8 Surrogates

Surrogates are organic compounds that are similar in chemical composition and behavior to the target analytes but that are not normally found in environmental samples. Surrogates are added to all appropriate samples and QC samples being tested for organic analytes to monitor the effect of the sample matrix and the procedure on the accuracy of the process.

8.4.2.9 Dilution Test

A dilution test (serial dilution) is performed if the analyte concentration is sufficiently high (minimally, a factor of 10 above the instrumental detection limit after dilution). The analysis of a 1:5 dilution should agree within $\pm$ 10% of the original determination. If not, a chemical or physical interference effect should be suspected. It is most often used in elemental analysis involving various forms of atomic emission or atomic absorption spectroscopy to ensure that neither positive nor negative interferences are operating on any of the analyte elements to distort the accuracy of the reported values.

8.4.2.10 Analytical Spike

An analytical spike is created by spiking target analytes into a prepared portion (i.e., post digestion) of a sample just prior to analysis. It provides information on matrix effects encountered during analysis such as suppression or enhancement of instrument signal levels. It is most often used in elemental analysis involving various forms of atomic emission or atomic absorption spectroscopy to ensure that neither positive nor negative interferences are operating on any of the analyte elements to distort the accuracy of the reported values. A single analytical spike serves as a single point application of the “method of standard additions” or MSA.

8.4.2.11 Interference Check Sample

An interference check sample (ICS) is a solution containing known concentrations of both interfering and analyte elements. Analysis of this sample can be used to verify background and interelement correction factors.

8.4.2.12 Internal Standards

An internal standard (IS) is a compound or element with similar chemical characteristics and behavior in the analysis process to the target analytes, but is not normally found in environmental samples. The internal standard is usually added after sample preparation. The primary function of the internal standard is quantitation, however, it also provides a short-term indication of instrument performance. For isotope dilution methods, internal standards are added during sample preparation and are used for quantitation.

8.5 Data Collection Operations

Laboratory analyses are designed to produce data that are representative of existing conditions present at the time the sample was obtained. The data collection design includes field sampling events, sample handling and custody, analytical operations, data recording procedures, data assessments, data verification, and data reporting requirements and techniques to assess limitations of data use. These operations are discussed in Sections 8.5 through 8.10.

8.5.1 Field Collection and Shipment

In order to provide a sample that most accurately represents the test matrix, field sample collection personnel must abide by the sample collection guidelines and procedures established by involved regulatory agencies. A significant part of the efforts of regulatory agencies include the use of "approved" sample containers, chemical and physical preservation techniques, and observance of specified holding times. It is imperative that all samples be collected and preserved according to the appropriate analytical method specified in the QAPP (if one exists). Although the sampling may be performed by non-STL personnel, the importance of sampling and transportation of the sample to the laboratory is understood and must be considered during data validation.

Sampling requirements must be communicated to the sampling team prior to field collection.

Field personnel are responsible for labeling each individual sample collected with the following information:

- Project name;
- Unique client sample number;
- Sample location (including as appropriate: borehole and depth or grid coordinates);
- Sampling date and time;
- Sample preservation; and
- Analysis required.

An overriding consideration for the resulting analytical data is the ability to demonstrate that the samples have been obtained from the locations stated and that they have reached the laboratory without alteration. Evidence of collection, shipment, laboratory receipt, laboratory custody and disposal must be documented to accomplish this. Figures 8.5-1 and 8.5-2 show example Chain-of-Custody (COC) forms that are used by the STL Austin laboratory to document this evidence. Field personnel are responsible for initiating the COC form.

The prompt shipment of samples to the laboratory is necessary to ensure that required holding times are met. Samples should be shipped by an overnight carrier, be hand-delivered, or transported in a manner that assures prompt delivery to the laboratory. Some sites require an extensive radioactive screening process before a sample may be shipped. In these cases, it is imperative for the Project Manager to maintain good communications with the client to assure proper staffing of the laboratory in response to a decreased holding time.

8.5.2 Sample Containers, Shipping Containers, Preservatives and Holding Times

8.5.2.1 Sample Containers

A sample container is defined as the sealed enclosure, usually made of plastic or borosilicate glass that the sample is collected in and stored in until analysis. All sample containers provided by STL Austin for environmental sampling are new, with the exception of some air sampling canisters, which must be recertified before reuse, and demonstrated to be clean for their appropriate use. All documentation certifying sample container cleanliness must be maintained by the laboratory or the vendor and can be provided to the client upon request. The sample containers to be supplied are listed in Tables 8.5-1 through 8.5-4. Sample containers provided to the client by STL Austin are transmitted under custody.

8.5.2.2 Shipping Containers

Shipping containers are defined as the sealed enclosure in which the sample containers are stored during shipment from the sample collection site to the analytical laboratory. Shipping containers must be of sufficient number and size to accommodate the samples in an upright condition. Shipping containers must also meet all requirements for the shipment of environmental samples.

Packaged samples must be shipped to the analytical laboratory in a safe manner that preserves the integrity of the samples. The most common method of sample shipment employs coolers or ice chests that are sealed with custody tape and shipping tape. These coolers must be durable and resistant to crushing during shipment. All coolers must be well maintained and cleaned to prevent cross-contamination of the samples. It is the ultimate responsibility of the person collecting and packaging the sample for shipment to ensure that the shipping containers are clean and functional.

FIGURE 8.5-1
Example STL Austin Chain-of-Custody Form

Chain of Custody Record

SEVERN TRENT STL

STL4149 (1202)

Client			Project Manager	Date	Page _____ of _____
Address			Telephone Number (Area Code)/Fax Number	Lab Location	Analysis
City	State	Zip Code	Site Contact		
Project Number/Name			Carrier/Waybill Number		
Contract/Purchase Order/Quote Number					

Sample ID. Number and Description	Date	Time	Sample Type	Containers			Preservative	Condition on Receipt/Comments
				Volume	Type	No.		

Special Instructions

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return to Client ☐ Disposal By Lab ☐ Archive For _____ Months
(A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required
☐ Normal ☐ Rush ☐ Other _____

QC Level
☐ I. ☐ II. ☐ III.

Project Specific Requirements (Specify)

1. Relinquished By	Date	Time	1. Received By	Date	Time
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

FIGURE 8.5-2
Example STL Austin Air Chain-of-Custody Form

STL Austin
14050 Summit Drive
Suite A100
Austin, TX 78728
phone 512-244-0855 fax 512-244-0160

Canister Samples Chain of Custody Record

SEVERN TRENT STL

Severn Trent Laboratories, Inc. (STL) assumes no liability with respect to the collection and shipment of these samples.

Client Contact Information	Project Manager:	Samples Collected By:	____ of ____ COCs
Company:	Phone:		
Address:	Email:		
City/State/Zip			
Phone:	Site Contact:		
FAX:	STL Contact:		
Project Name:	Analysis Turnaround Time		
Site:	Standard (Specify)_____		
PO #	Rush (Specify)		

Sample Identification	Sample Date(s)	Time Start	Time Stop	Canister Vacuum in Field, "Hg (Start)	Canister Vacuum in Field, 'Hg (Stop)	Flow Controller ID	Canister ID	TO-15	TO-14A	EPA 3C	EPA 25C	ASTM D-1946	Other (Please specify in notes section)	Sample Type	Indoor Air	Ambient Air	Soil Gas	Landfill Gas	Other (Please specify in notes section)

	Temperature (Fahrenheit)			
		Interior	Ambient	
	Start			
	Stop			

	Pressure (inches of Hg)			
		Interior	Ambient	
	Start			
	Stop			

Special Instructions/QC Requirements & Comments:

Canisters Shipped by:	Date/Time:	Canisters Received by:
Samples Relinquished by:	Date/Time:	Received by:
Relinquished by:	Date/Time:	Received by:

Lab Use Only Shipper Name: Opened by: Condition:

To help prevent sample breakage during shipment, additional consideration must be given to providing shock absorbency to all samples packaged inside the shipping container. Use of bubble-wrap or mesh plastic around each sample container can provide this protection. Foam packing materials and vermiculite are also successfully used.

8.5.2.3 Sample Preservatives

Most analytes have a finite holding time in a given sample matrix. Sample preservation is the chemical or physical means by which samples are treated during and/or following sample collection to aid in the stability of the analytes of interest in that matrix. Sample holding times are also adversely affected when samples are improperly preserved, or shipped unpreserved. The preservation of samples at the time of sample collection will follow the requirements of the analytical methods used. This preservation includes the addition of reagents to deter chemical and biochemical degradation and the maintenance of refrigeration during transit and ultimate storage in the laboratory. The required preservatives for the analysis to be performed on each matrix are included in Tables 8.5-1 through 8.5-4.

8.5.2.4 Sample Holding Times

Holding time is defined as the maximum allowable time a sample can be stored after sample collection and preservation until appropriate processing occurs (preparation or analysis). The holding time may vary according to method or client requirements. Tests designated with holding times as “analyze immediately or ASAP” are considered parameters that should be tested by field personnel or on-site. Each operation has a system in place to ensure that holding times are monitored by each group within the operating unit. It is the responsibility of each STL Austin associate processing the sample to assure that holding times are met. The STL Austin laboratory is responsible for meeting all holding times for properly preserved samples received within 48 hours of collection or if less than half the holding time has passed. If these conditions are not met, the PM will confer with the client regarding the recommended course of action. STL Austin will attempt to expedite sample analysis as soon as possible. Sample holding times are listed in Tables 8.5-1 through 8.5-4.

8.5.3 Sample Handling

The STL Austin laboratory SOP AUS-SC-0001, "Sample Receipt and Initialization of Testing," describes the receipt, log-in, distribution, and storage of samples. The following sections describe the general policies followed by the STL Austin laboratory.

8.5.3.1 Sample Receipt

Samples shall be received and logged in at STL Austin by a designated sample custodian or other properly trained associate. Upon sample receipt, the sample custodian shall perform the following, as appropriate:

- Wear appropriate personal protective equipment. At a minimum, this consists of gloves, a lab coat, and safety glasses;
- Examine the shipping containers to verify that the custody tape is intact;
- Examine all sample containers for damage;
- Open shipping containers in adequately ventilated areas to assure worker safety; depending on sample origin and nature, containers may need to be opened under a fume hood;
- Determine if the temperature required by the requested testing program has been maintained during shipment. Document the shipping container temperature on the COC or COC Addendum;
- Compare samples received against those listed on the COC;
- Verify that sample holding times have not been exceeded;
- Examine all shipping records for accuracy and completeness;
- Determine sample pH, residual chlorine, etc. (as required for the scheduled analysis) (except VOA samples) and record on the COC or COC Addendum;
- Sign and date the COC immediately (only after shipment is accepted) and attach the waybill;
- Note any problems associated with the coolers and samples on the COC, immediately initiate a COC Addendum, and notify the PM who in turn notifies the client,
- Attach durable (water-resistant) laboratory sample container labels with unique laboratory identification number and test; and
- Place the samples in proper laboratory storage.

A COC Addendum is generated by sample control during the sample log-in process to document condition upon receipt anomalies identified upon the receipt of samples in the laboratory. These anomalies are outside of laboratory control and do not require corrective actions to be taken within the laboratory. The affected client shall be notified by the PM or designee of all anomalies generated for their samples. The PM is responsible for resolving with the client how to proceed with the samples and documenting the decision to proceed with the analysis of compromised samples. Condition upon receipt anomalies must be resolved prior to sample preparation and analysis. The completed COC Addendum form shall be stored in the project file. An example COC Addendum is shown in Figure 8.5-3. The report narrative will include an explanation of sample receiving related anomalies.

8.5.3.2 Exceptions or Discrepancies

STL Austin reserves the right to reject samples for any of the following reasons.

- No custody seals as required by project and/or broken custody seals;
- No chain of custody (COC) documentation provided or COC not properly completed;
- Improper sample labeling, including non-unique identification and non-durable labels (non-water resistant) and/or the use of non-permanent ink;
- Cooler and/or samples received outside of temperature specification;
- Preservation inappropriate for analysis requested;
- Sample container inappropriate for analysis requested;
- Headspace in volatile samples;

- Sample received out of holding time for analysis requested, or with less than half of the hold time left to do the analysis;
- Incomplete sample information provided;
- Discrepancies between COC and sample labels;
- Inadequate sample volume;
- Samples show signs of damage or contamination;
- Seepage of extraneous water or materials into samples;
- Samples have high levels of polychlorinated dibenzo-p-dioxins/dibenzo furans (PCDD/PCDFs);
- Samples have a high level gross alpha or beta radiation; and
- Samples from a site known to contain chemical warfare agents (CWAs) and the samples have not been screened for them.

These or any other project exceptions or discrepancies are discussed with the client and agreed upon action taken. If the client decides to proceed with analysis, the project report shall clearly indicate any of the above conditions and the resolution.

8.5.3.3 Sample Log-in

Sample log-in activities at STL Austin are fully documented. The following is a general description of the log-in process:

- Enter the samples in the LIMS which contains the following information at a minimum:
  - Project name or identification number;
  - Unique sample numbers (both client and internal laboratory);
  - Type of samples;
  - Required tests;
  - Date and time of laboratory receipt of samples; and
  - Field ID supplied by field personnel.
- Notify the PM and appropriate Group/Team Leader(s) of sample arrival.
- Place the completed COCs, waybills, and any additional documentation in the project file.

FIGURE 8.5-3
Example STL Austin COC Addendum
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SEVERN TRENT STL

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CHAIN–OF–CUSTODY ADDENDUM

Lot No: _____

RECEIVED BY: _____ COC NUMBER: _____

DATE/TIME RECEIVED: _____ QUOTE/PROFILE: _____

UNPACKED DATE/TIME: _____

CLIENT/PROJECT: _____ SAMPLES LOGGED IN: LOG-IN REVIEWED:

Number of Shipping Containers Received with Chain of Custody _____ _____ _____

VOC AIR / FILTER SAMPLES ☐ **YES** **SEE SECTIONS 1.0, 2.0, & 6.0**

1.0 CONTAINERS EXAMINED UPON RECEIPT: _____

Container Sealed: ☐ YES ☐ NO Custody Seal Signed/Dated: ☐ YES ☐ NO

Custody Seal Present: ☐ YES ☐ NO Containers checked for radioactivity: ☐ YES ☐ NO ☐ N/A

If seal not intact or Geiger counter reading >0.5 mR/hr, list air bill number of that container(s): _____

2.0 VOC CANISTERS EXAMINED UPON RECEIPT: _____

Canister Valves Closed: ☐ YES ☐ NO Samples Received Match Chain: ☐ YES ☐ NO

Canister Valves Capped: ☐ YES ☐ NO Other Equipment Received: ☐ YES ☐ NO

Valve Cap Tightened Properly: ☐ YES ☐ NO See Additional Comments (Section 5.0 and / or 7.0) ☐ YES ☐ NO

Packing Material Used: (circle) Chain-of-Custody form properly maintained: ☐ YES ☐ NO

None / Absorbent / Paper / Bubble Wrap Can Size: ☐ 6L ☐ 15L Other _____

3.0 SAMPLE TEMPERATURE UPON RECEIPT BY: _____ **IR THERMOMETER #:** _____

Temperature of the container(s):

Circle selection: TB = Temp. Blank and/or SC = Sample Container *[acceptable tolerance 4.0°C ± 2.0°; (NC, WI: 1-4.4°C)]*

TB SC	TB SC	TB SC	TB SC	TB SC	TB SC	TB SC	TB SC	TB SC	TB SC

If temperature is outside acceptable tolerance, Project Manager was notified (_____PM). Date: _____ Time: _____

Samples received do not require cooling _____ OK to analyze samples: ☐ YES ☐ NO

PRESERVATION OF SAMPLES REQUIRED: ☐ NA ☐ YES **VERIFIED BY:** _____

Base samples are>pH 12: ☐ YES ☐ NO Acid preserved are<pH 2: ☐ YES ☐ NO

Cyanide samples checked for sulfides: ☐ YES Sulfide samples appear to be preserved with zinc acetate: ☐ YES ☐ NO

Samples checked for chlorine per specification (N.C.) ☐ YES Free chlorine present: ☐ YES ☐ NO

If sample preservation is outside acceptable tolerance, Project Manager was notified (_____PM)

Date: _____ Time: _____ ☐ see pH adjustment form

VOLATILE SAMPLES FILLED COMPLETELY, IF NOT, LIST ID AND HEADSPACE OF VOA's CONTAINING BUBBLES EXCEEDING 6MM IN DIAMETER:

Sample ID	mm Headspace	Sample ID	mm Headspace

Revised 07/01/05

FIGURE 8.5-3
Example STL Austin COC Addendum
Page 2 of 2

4.0 CONDITION OF BOTTLES/CONTAINERS **VERIFIED BY:**_____

Samples received match COC: ☐ YES ☐ NO Bottles received intact: ☐ YES ☐ NO
See additional discrepancies/comments section: ☐ YES ☐ NO Samples received from USDA restricted area: ☐ YES ☐ NO
Chain-of-Custody form properly maintained: ☐ YES ☐ NO VOA trip blanks included: ☐ YES ☐ NO ☐ N/A

5.0 ADDITIONAL DISCREPANCIES

Appears on COC		Appears on Label		
Sample ID	Date/Time	Sample ID	Date/Time	Comments

6.0 SHIPPING DOCUMENTATION:
Air/freight bill is available and attached to COC: ☐ YES ☐ NO Air bill #: _____
Hand-delivered Carrier:_____ Date: _____ Time: _____

7.0 OTHER COMMENTS:

CORRECTIVE ACTION:
Client's Name: _____ Informed verbally on: _____ By: _____
Client's Name: _____ Informed verbally on: _____ By: _____
Sample(s) processed "as is" comments: _____

Samples(s) on hold until: _____ If released, notify: _____

REVIEW:
Project Management: _____ Date: _____

SIGNED ORIGINAL MUST BE RETAINED IN THE PROJECT FILE

8.5.3.4 Sample Storage

The primary considerations for sample storage are the following:

- Maintenance at the method prescribed temperature, if required.
- Maintenance of sample integrity through adequate protection from contamination from outside sources or from cross-contamination of samples. Low-level and high-level samples, when known, must be stored separately. Samples and standards must be stored in separate refrigerators or freezers. Storage areas for volatile organic test requests should be monitored twice per month by the analysis of a holding (refrigerator) blank (an aliquot of contaminant-free water stored in a VOA vial).
- Security of samples within the laboratory.

The requirements listed in Tables 8.5-1 through 8.5-4 for temperatures and holding times shall be used. Placing of samples in the proper storage environment is the responsibility of sample control personnel. The STL Austin laboratory will assign individuals the responsibility of notifying the Operations Manager and Laboratory Managers if there are any samples that must be analyzed immediately because of holding time requirements.

8.5.3.5 Internal Sample Chain-of-Custody and Interlaboratory Transfers

Access to the STL Austin facility is restricted to prevent any unauthorized contact with samples, extracts, or documentation. Sample custody within the STL Austin laboratory is described in SOPs.

Documented internal COC is only necessary when legal chain-of-custody is required or if required by a client for a specific project. Internal COC may be required for some programs defined by state or federal agencies. The sample custody documentation shall include the following minimum requirements:

- Name of associate taking custody of the sample from the sample storage area for preparation or analysis;
- Dates sample removed from and returned to the sample storage area;
- Identification of tests to be performed on the sample aliquot(s) selected by the associate;
- Sample matrix;
- Laboratory sample numbers; and
- Sample storage location.

Additional custody records can be provided by a facility at the specific request of the client.

Samples transferred to a different laboratory than the original receiving facility are transferred under chain-of-custody (COC). The COC is maintained whether the laboratory is another STL facility or a subcontracted laboratory. If the entire sample volume is transmitted, the original copy of the client's COC form will be used to document the relinquishing of the sample and will accompany the sample to its destination. A copy of the completed COC form shall be retained in

the laboratory project file. In the case where an aliquot of a sample is shipped from the laboratory, a new COC will be generated by the laboratory and shipped with the sample aliquot. The original COC will be retained in the project file at the site holding the original sample container.

Samples are not transferred to other STL facilities or to subcontracted laboratories without prior approval of the client.

8.5.3.6 Sample Disposal and Return Chain-of-Custody

After the requested analyses on the samples have been completed, any remaining portions of the samples will be maintained by the sample custodian until the samples are disposed of or returned to the client. The disposal of each sample is recorded on the client's COC form, in the LIMS, or referenced in the project file. Sample disposal procedures and documentation are described in operation-specific SOPs. STL Austin's routine sample retention period is at least thirty days after the analytical report is issued to the client, unless otherwise specified by the client.

If samples are returned to the client rather than disposed of by the laboratory, the original COC or a new COC is used to document custody transfer back to the client from the laboratory. A copy of the completed COC is retained in the laboratory project file.

8.5.4 Calibration Procedures and Criteria

The STL Austin laboratory is equipped with state-of-the-art instrumentation to provide the highest quality analytical data to clients. Table 8.5-5 of this LQM lists major analytical instrumentation in place in each laboratory area.

All equipment and instruments used at STL Austin for quantitative measurements are controlled by a formal calibration program. Calibrations may be periodic or operational. These are described in SOPs. The corporate policy P-T-001, "Selection of Calibration Points," is applicable when the number of data points is not described in the method. At a minimum, these procedures shall include the following:

- Instrument to be calibrated;
- Reference standards used for calibration;
- Calibration technique (e.g., linear, quadratic);
- Acceptable performance tolerances and corrective actions required if specifications are not met;
- Frequency of calibration; and
- Calibration documentation requirements.

Whenever possible, recognized procedures such as those published by ASTM or the USEPA or procedures provided by manufacturers shall be adopted. If established procedures are not available, a procedure shall be developed considering the type of equipment, stability characteristics of the equipment, required accuracy and the effect of operation error on the quantities measured.

8.5.4.1 Physical Reference Standards

Physical reference standards associated with periodic calibrations include weights for calibrating balances and certified thermometers for calibrating working thermometers. Whenever possible, physical reference standards shall be calibrated by a body that can provide traceability to nationally or internationally recognized standards. If these standards are not available, the basis for the reference standard shall be documented.

Physical reference standards shall be used only for calibration procedures and shall be stored separately from equipment used for analysis.

8.5.4.2 Chemical Reference Standards and Reagents

Chemical reference standards are generally associated with operational calibration. These standards include reference materials traceable to recognized standards suppliers. This may include vendor-certified materials traceable to national or international standard reference materials (*e.g.*, NIST).

All chemical reference standards maintained in the laboratory for use in calibrations (or as QC spiking solutions) and reagents prepared in the laboratory shall be labeled or referenced to appropriate documentation (hard copy or electronic) with the following information at a minimum:

- A unique identification including concentration (solutions containing several analytes can be identified such that the solution constituents and concentrations can be referenced to a logbook);
- Medium prepared in;
- Preparation date;
- Expiration date; and
- Initials of preparer.

Vials containing standard solutions that are not large enough to accommodate labels listing the above information may be referenced to a laboratory logbook/notebook entry or standards software. The expiration date of the working standard and reagent must not exceed the expiration date of the original material. These records should provide sufficient detail to allow one to reproduce the standard or reagent.

Records for all purchased standards and reagents shall include the date of receipt, the date opened and, where applicable, the expiration date.

8.5.4.3 Standards Verification

When possible, reference standards are purchased from a STL pre-approved vendor. Standards are verified by quantitation against a second known standard before reporting data. The standard for verification must meet the laboratory's criteria for the independent/second source ICV verification. Therefore, the verification of a new standard initial calibration with a second source ICV meets this verification requirement. Realizing that some "bad acting" analytes may not meet these criteria, they must be approved by the QAM and/or Technical Director before use. Standard spiking solutions and surrogates shall be verified by analyzing an LCS with the new standards and verifying against historical criteria limits. Special standards that are obtained from another source must also be independently verified at the lab. Verification by the laboratory of a reference standard from neat materials is also necessary.

To extend the use of an expired standard, re-verification is necessary provided that new analysis produces acceptable data. The verification of an expired standard is performed against a current, independent standard reference material by analyzing within a valid calibration and QC. See SOP AUS-QA-0019, "Receipt, Inventory, Preparation, Traceability, Shelf Life and Documentation of Laboratory Standards and Reagents."

Stock and working standards and reagents are checked regularly for signs of deterioration, such as discoloration, formation of precipitates, or change in concentration. Care is exercised in the proper storage and handling of standard and reagent solutions. Standards and reagents are always stored separately from samples.

An independent or second source standard is used to verify initial calibrations. An independent/second source standard is defined as a standard composed of the same target constituents as, but from a different source than those used in the standards for the initial calibration. An independent standard may be a laboratory-prepared or a certified independent standard solution(s). Independence of reference material can be achieved by: (1) purchasing reference materials from two separate vendors, (2) using a different lot from the same vendor that is certified by the vendor as an independent standard, or (3) having two separate individuals prepare the calibration and verification standard solutions if independent sources are not available.

8.5.4.4 Periodic Calibration

Periodic calibration is performed at prescribed intervals. In general, equipment which can be calibrated periodically is a distinct, singular purpose unit and is relatively stable in performance. These include balances, micropipettors, thermometers, refrigerators, freezers and ovens. Equipment employed at STL Austin requiring periodic calibration are listed along with their respective calibration requirements in Table 8.5-6. NELAP requires that mechanical volumetric dispensing devices (except Class A glassware) to be checked for accuracy on at least a quarterly basis if in use. See SOP AUS-QA-0001, "Use and Calibration Verification of Pipet Dispenser Apparatus."

8.5.4.5 Operational and Continuing Calibration

Operational calibration is routinely performed as part of instrument usage, such as the development of a standard calibration curve. The accuracy of initial calibrations is to be verified prior to sample analysis through the use of an independent standard in situations where the source method requires calibration verification. Detailed requirements for operational calibration are contained in method-specific SOPs. A summary of the various operational calibrations performed at STL Austin is shown in Tables 8.5-7 through 8.5-9.

When an initial calibration is not performed on the day of analysis, the validity of the initial calibration verification must be verified prior to sample analyses by a continuing instrument calibration verification with each analytical batch. The following items are essential elements of continuing instrument calibration verification:

- The details of the continuing instrument calibration procedure, calculations and associated statistics are referenced in the laboratory method SOPs.
- A continuing instrument calibration verification must be repeated at the beginning and end of each analytical batch. The concentrations of the calibration verification shall be varied within the established calibration range on an annual basis for each NELAC accredited analytical method. If an internal standard is used, only one continuing instrument calibration verification must be analyzed per analytical batch.
- Sufficient raw data records must be retained to permit reconstruction of the continuing instrument calibration verification, *e.g.*, test method, instrument, analysis date, each analyte name, concentration and response, and calibration curve or response factor.
- Criteria for the acceptance of a continuing instrument calibration verification such as the percent difference must be established.
- If the continuing instrument calibration verification results obtained are outside the established acceptance criteria, corrective actions must be performed. If routine corrective action procedures fail to produce a second consecutive (immediate) calibration verification within acceptance criteria, then either the laboratory has to demonstrate performance after corrective action with two consecutive successful calibration verifications or a new initial instrument calibration must be performed. If the laboratory has not demonstrated acceptance performance, sample analyses must not occur until a new initial calibration curve is established and verified. However, sample data associated with an unacceptable calibration verification may be reported as qualified data under the following special conditions:
  - When the acceptance criteria for the continuing calibration verification is exceeded high, *i.e.*, high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

- When the acceptance criteria for the continuing calibration verification is exceeded low, *i.e.*, low bias, those sample results may be reported if they exceed a maximum regulatory limit. Otherwise the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

8.5.4.6 Calibration Failure

Equipment or instruments that fail calibration or become inoperable during use shall be tagged to indicate they are out of calibration. Such instruments or equipment shall be repaired and successfully recalibrated before reuse. Following recalibration or verification, "back to control" will be documented in the injection/run log and/or maintenance logbook through the routine identification of the required calibration runs specified by the standard operating procedure. The procedure for tagging out such instruments or equipment is described in the SOP Number AUS-QA-0013, "Nonconformance and Corrective Action."

Recalibration may occur more frequently than scheduled. At any time, if equipment calibration becomes suspect, it shall undergo a calibration check to determine whether the current calibration is still acceptable or if recalibration is required.

8.5.4.7 Calibration Records

Calibration shall be documented for each piece of equipment subject to calibration. All calibration records (periodic and operational) directly affect data and may not be limited to one project. These records shall be stored in either the quality records or the associated project files. Project files that include sample data shall either include the calibration records or include reference to them.

8.6 Quality Assessment

The effectiveness of the QA practices at a laboratory is measured by the quality of data generated by the laboratory. The STL Austin laboratory has established, implemented and documented procedures to detect, prevent and correct quality problems, and to ensure quality improvement. Items and processes that do not meet established requirements must be investigated to determine their cause. Improvements must be implemented in the operations which will prevent a recurrence of these quality problems and provide overall quality performance. All phases of laboratory work should be designed with the objective of preventing problems and improving quality on a continuous basis.

8.6.1 Data Quality Assessment

Data quality is judged in terms of precision, accuracy, representativeness, completeness and comparability. The areas of representativeness, comparability and completeness for an overall project, inclusive of sampling issues, may be beyond the control of the laboratory. The elements over which the laboratory has direct control are precision, accuracy and completeness relative to analytical testing results.

Precision and accuracy assessments are made as part of the evaluation of laboratory QC data generated during sample preparation and analysis. The QC samples employed at STL Austin as part of routine sample analysis are summarized in Section 8.4 of this document. Table 8.6-1 shows the precision and accuracy measurements employed by STL Austin. Analytical method SOPs include information on requirements for the type of QC samples, frequencies and acceptance criteria. Additionally, the SOPs describe the appropriate actions to be taken when a QC sample result does not meet acceptance criteria.

8.6.2 Statistical Evaluation of Data

In-house limits for all QC data must be evaluated at least annually and compared to the limits published in the methods for applicable matrices. Method limits will be employed until sufficient QC data are acquired. A minimum of 20 to 30 data points are recommended to establish the in-house QC limits. Calculated results of the QC (LCS) samples are evaluated by comparing against control limits (3-sigma).

Program-specific data analysis requirements for control charts are followed as required for data generated under those programs. These additional requirements shall be documented in a QAPP or QAS.

Precision and accuracy measurements employed by STL Austin are shown in Table 8.6-1. Calculated results of these QC samples are evaluated using statistical tables or control charts.

8.7 Data Recording Procedures

To ensure data integrity, all documentation of data and records generated or used during the process of data generation must be performed in compliance with SOP AUS-QA-0017, “Data Recording Requirements.” The STL Austin record system produces accurate records that document all laboratory activities. STL Austin retains on record all original observations, calculations and derived data, calibration records and a copy of the test report. The record keeping system allows for historical reconstruction of all laboratory activities that produced the resultant sample analytical data. The history of the sample is readily understood through the documentation. This includes interlaboratory transfers of samples and/or extracts.

Records include the identity of personnel involved in sampling, preparation, calibration or testing; information relating to the laboratory equipment; analytical test methods; and related laboratory activities, such as sample receipt, sample preparation or data verification. The system facilitates the retrieval of working files and archived records for inspection and verification purposes. Documentation entries shall be signed or initialed by responsible staff. All manually generated data shall be recorded directly, promptly and legibly in permanent ink. Entries in records shall not be obliterated.

8.8 Data Reduction and Verification Procedures

Data review procedures, defined as a set of computerized and manual checks applied at appropriate levels of the measurement process, will be clearly defined for all measurement systems in SOPs. Data review begins with the reduction or processing of data and continues through verification of the data and the reporting of analytical results. Calculations are checked from the raw data to the final value prior to reporting results for each group of samples. Data reduction can be performed by the analyst who obtained the data or by another analyst. Data verification starts with the analyst who performs a 100 percent review of the data to ensure the work was done correctly the first time. Data verification continues with review by a second reviewer who verifies that data reduction has been correctly performed and that the analytical results correspond to the data acquired and processed. This procedure is outlined in Figure 8.8-1.

8.8.1 Data Reduction and Initial Verification

Data reduction and initial verification may be performed by more than one analyst depending upon the analytical method employed. The preparation and analytical data may be reviewed independently by different analysts. In these instances, each item may not be applicable to the subset of the data verified or an item may be applicable in both instances. It is the responsibility of the analyst to ensure that the verification of data in his or her area is complete. The data reduction and initial verification process must ensure the following:

- Sample preparation information is correct and complete including documentation of standard identification, solvent lot numbers, sample amounts, etc.;
- Analysis information is correct and complete including proper identification of analysis output (charts, chromatograms, mass spectra, etc.);
- Analytical results are correct and complete including calculation or verification of instrument calibration, QC results, and qualitative and quantitative sample results with appropriate qualifiers;
- Manual integrations are appropriate, data flags to indicate manual integrations are recorded, and manual integrations are authorized by a date and signature or initials of primary analyst;
- The appropriate SOPs have been followed and are identified in the project records;
- Proper documentation procedures have been followed;
- All nonconformances have been documented;
- Special sample preparation and analytical requirements and client specific requirements have been met; and
- The data generated have been reported with the appropriate number of significant figures as

defined by the analytical method in the LIMS or otherwise specified by the client.

In general, data will be processed by an analyst in one of the following ways:

- Manual computation of results directly on the data sheet or on calculation pages attached to the data sheets;
- Input of raw data for computer processing; or
- Direct acquisition and processing of raw data by a computer.

If data are manually processed by an analyst, all steps in the computation shall be provided including equations used and the source of input parameters such as response factors (RFs), dilution factors and calibration constants. If calculations are not performed directly on the data sheet, they may be attached to the data sheets.

Manual integrations are sometimes necessary to produce good chromatography, but must only be performed when necessary. Further discussion of manual integrations and the required documentation is given in SOP AUS-QA-0027, “Acceptable Manual Integration Practices.”

For data that are input by an analyst and processed using a computer, a copy of the input shall be kept and uniquely identified with the project number and other information as needed. The samples analyzed must be clearly identified.

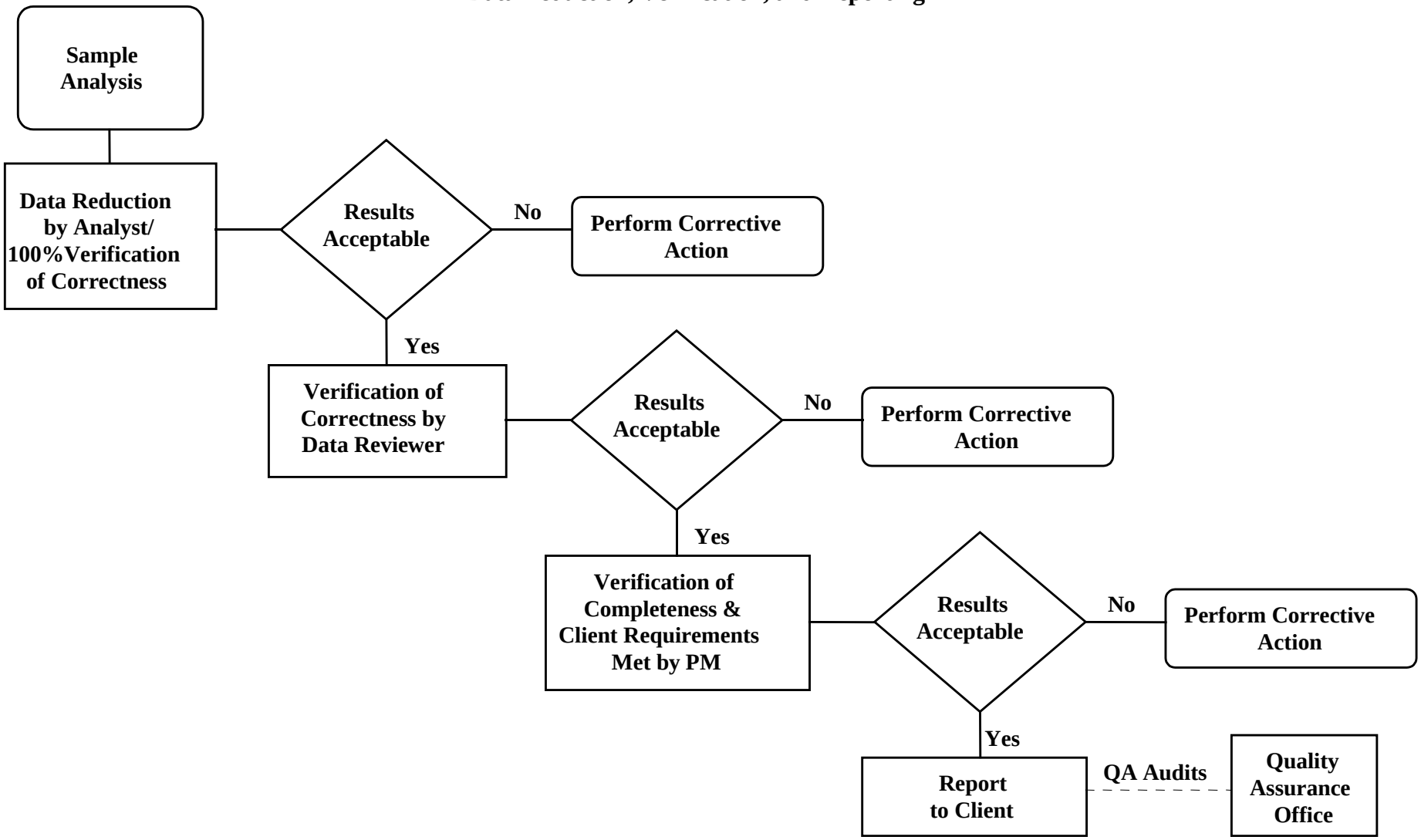
If data are directly acquired from instrumentation and processed, the analyst must verify that the following are correct:

- Project and sample numbers;
- Calibration constants and RFs;
- Units; and
- Numerical values used for reporting limits.

Analysis-specific calculations for methods are provided in SOPs. In cases where computers perform the calculations, software must be validated or verified, as described in Section 6.0 of this document, before it is used to process data.

The data reduction is documented, signed and dated by the analyst completing the process. Initial verification of the data reduction by the same analyst is documented on a data review checklist, signed and dated by the analyst. Data review requirements are described in SOP AUS-QA-0028, “Data Review Requirements.”

FIGURE 8.8-1
Data Reduction, Verification, and Reporting



8.8.2 Data Verification

Following the completion of the initial verification by the analyst performing the data reduction, a systematic check of the data that has been fully reduced and checked through Level 1 review is performed by an experienced peer, supervisor or designee. This secondary review is a complete technical review of a data set. This check is performed to ensure that Level 1 review has been completed correctly and thoroughly. The second level reviewer examines the data signed by the analyst. This review includes an evaluation of all items required in the raw data package. Any exceptions noted by the analyst must be reviewed. Included in this review is an assessment of the acceptability of the data with respect to the following:

- Adherence of the procedure used to the requested analytical method SOP;
- Acceptable manual integration practices, as verified by date and initials or signature of secondary data reviewer;
- Correct interpretation of chromatograms, mass spectra, etc.;
- Correctness of numerical input when computer programs are used (checked randomly);
- Correct identification and quantitation of constituents with appropriate qualifiers;
- Numerical correctness of calculations and formulas (checked randomly);
- Acceptability of QC data;
- Documentation that instruments were operating according to method specifications (calibrations, performance checks, etc.);
- Documentation of dilution factors, standard concentrations, etc.; and
- Sample holding time assessment.

This review also serves as verification that the process the analyst has followed is correct in regard to the following:

- The analytical procedure follows the methods and specific instructions given on the project QAS or equivalent summary form.
- Nonconforming events have been addressed by corrective action as defined on a nonconformance memo.
- Valid interpretations have been made during the examination of the data and the review comments of the initial reviewer are correct.
- The package contains all of the necessary documentation for data review and report production and results are reported in a manner consistent with the method used for preparation of data reports.

The specific items covered in the second stage of data verification may vary according to the analytical method, but this review of the data must be documented by signing the same checklist. Data review requirements are described in SOP AUS-QA-0028, “Data Review Requirements.”

8.8.3 Completeness Verification

A third-level review is performed by the PM. This review is required before results are submitted to clients. This review serves to verify the completeness of the data report and to ensure that project requirements are met for the analyses performed. This completeness review includes the generation of a project narrative and/or cover letter that outlines anomalous data and nonconformances using project narrative notes and nonconformance reports generated during the primary and secondary review. The completeness review addresses the following items:

- The project report is complete, *e.g.*,
  - Analysis results are present for every sample in the analytical batch, reporting group, or sample delivery group (SDG);
  - Every parameter or target compound requested is reported with either a value or reporting limit;
  - The final report is legible, contains all the supporting documentation required by the project, and is in either the standard STL Austin format or in the client-required format;
- The data meet with the client's expectations;
- The data quality objectives of the project were met; and
- All nonconformances, including holding time violations, and data evaluation statements that impact the data quality are approved, accompanied by clearly expressed comments from the laboratory, and appropriately explained in the narrative notes.

8.9 Data Reporting

8.9.1 Data Reports

STL Austin is capable of developing a variety of data deliverable reports. Reports will contain the following:

- Cover Letter/Narrative - Information on sample types, tests performed, any problems encountered, and general comments are provided.
- Analytical Data - Data are reported by sample or by test with the appropriate significant figures and reporting limits, and have been adjusted for dilution, if appropriate. Pertinent information including dates sampled, received, prepared, extracted and analyzed are provided.
- Laboratory Performance QC Information - The results of LCSs and method blanks analyzed with the project are listed. Any data or QC anomalies are discussed in the narrative.
- Matrix-Specific QC Information - Results of any sample duplicates and MS/MSDs analyzed with the samples as batch QC are reported. Other project-specific QC requested by the client are also reported. The results include supporting information such as amount spiked, percent recovery or percent difference/RPD.
- Methodology - Reference for analytical methodology used is cited.

- Other Deliverables - Other deliverables available include disk deliverables, electronic data transfer, sample raw data packages, complete deliverable packages and custom report formats. Requirements for electronic reporting are defined in SOP AUS-PM-0004, "Electronic Reporting."

The Laboratory Director or his/her designee must authorize the release of the project report with a signature. STL Austin Project Managers are designees and authorized to sign and release project reports.

8.9.2 Final Report Details

STL Austin will provide paginated reports or a uniquely defined, identifiable certificate/report (*i.e.*, electronic file, CD). The report will include the following:

a) Report title, name, address and phone number of the laboratory;
b) Name and address of client/project name/client identification number;
c) Description (lab ID of sample);
d) Dates and Time of sample collections (if known), receipt, preparation and analysis;
e) If the required holding time is 48 or less, time of sample preparation and analysis;
f) Method identifiers traceable to all procedures used;
g) Reporting limit;
h) Test result with appropriate units and how reported (wet weight/dry weight). Also identify any results outside of quantitation limits. When required, a statement of the estimated uncertainty of the test result should be added;
i) If appropriate, description of any QC failures or deviations from SOPs;
j) Signature and title of the individual responsible for the report. Electronic signature is acceptable;
k) Date of issue;
l) All subcontract work must be clearly identified, and the name and address of outside subcontractor noted;
m) Where relevant, a statement to the effect that the results relate only to the items tested or to the sample as received by the laboratory; and
n) Where relevant, a statement that the certificate or report shall not be reproduced except in full, without the written approval of the laboratory.

After final report any correction, addition, or deletion must clearly identify its purpose and meet the above reporting requirements as appropriate.

All applicable elements from above should be available for review if not issued in a formal report by an in-house or captive laboratory.

8.9.3 Verbal Results

It is the policy of STL Austin to discourage the release of data verbally or without full data review. If however, the client requests analytical results to be communicated verbally or by facsimile prior to final review, they must be clearly identified as “Preliminary” results. The client must understand that the data have not undergone the required levels of review and may potentially change.

8.9.4 Reporting Analytical Results

Sample results are reported according to analytical method SOPs or client specifications. Normally, the laboratory uses the STL Austin Reporting Limit (RL) at which any analyte of interest detected at or above that level is reported as a positive value and any analyte of interest not detectable or detected below that level is reported as “not detected” at the RL.

The laboratory will normally report results within the calibration, however, any reported results outside of the calibration range will be documented in the final report. If a QC measurement is out of control and the data are to be reported, data qualifiers are reported with samples associated with failed QC measurements.

In some cases, a contract, QAPP, or documented client request may require the laboratory to report sample results in a specified manner. Some examples are given below:

- The laboratory may be requested to report all analytes of interest that are less than the laboratory's RL but are greater than the MDL. This data will be flagged with an appropriate qualifier or noted in the report case narrative.
- The laboratory may be requested to report any tentatively identified compounds (TICs). This data will be flagged with an appropriate qualifier, or otherwise identified.
- The laboratory may be requested to report sample results using an RL that is higher than their normal level. In this case, only the analytes of interest found at or above that level would be reported as positive values. In this case, the laboratory will state the PSRL rather than the RL. All analytes of interest not detected or detectable below that level would be reported as “not detected” at the PSRL.

In these types of cases, the laboratory must include documentation in the project file that supports the reporting procedure employed.

It is the responsibility of the laboratory to provide for a reporting system that assures that any problems associated with an analysis are properly documented on a nonconformance memo, communicated to the appropriate STL associates, and addressed appropriately in the data report.

For projects requiring NELAC accreditation, the laboratory must certify that the test results meet all NELAC requirements or provide reasons and/or justification if they do not.

8.9.5 Reissued Deliverables

If, after issuance of a report, STL Austin observes any mistake that affects the results reported or the QC interpretation of those results, the client will be notified. After issuance of the report, the laboratory report remains unchanged. Any material amendments to a report after issue made only in the form of a further document, or data transfer must include the statement “Supplement to Test Report”, “Revised”, “Reissued” or otherwise identified.

8.9.6 Client Confidentiality

Data and sample materials provided by the client or at the client’s request, and the results obtained by STL, shall be held in confidence, unless such information is generally available to the public or is in the public domain. STL’s reports, and the data and information provided therein, are for the exclusive use and benefit of our clients, and are not released to a third party without written consent from the client. Data confidentiality is also discussed Section 5.7.

8.10 Data Validation

Data validation for STL Austin refers to data reviews conducted in accordance with specifications, such as described in the USEPA CLP “Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses” and “Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses,” or modifications thereof, for non-CLP type analyses.

STL Austin can provide complete data packages to support data validation. This form of data validation provides an impartial evaluation of the laboratory's results. Data validation may be requested by the client for a percentage of data and is usually performed by a third party, one that was not involved with the sample analysis. Qualifiers are assigned to data, when required, according to the requirements of the data validation protocol being used.

8.11 Preventive Maintenance and Service

Facilities, instruments, equipment, and parts are subject to wear, deterioration or change in operational characteristics. Within STL Austin, preventive maintenance, coupled with vendor service agreements, is an organized program of actions taken to maintain facilities and equipment in control.

8.11.1 Analytical Instrumentation and Equipment

The primary purpose of the maintenance program is to prevent instrument and equipment failure and to minimize down time. A properly implemented maintenance program increases the reliability of a measurement system.

STL Austin has uniquely identified each instrument or piece of equipment. The laboratory maintains the following:

- Instrument/equipment inventory list;
- Instrument/equipment major spare parts list or inventory;
- External service agreement documents (if applicable); and
- Instrument-specific preventive maintenance logbook or file for each functional unit.

The records of routine maintenance and non-routine maintenance includes at a minimum:

- Name and serial number of the item or equipment;
- Details of maintenance performed;
- Dates and results of recalibrations/reverifications indicating back to control; and
- Analyst initials and the date maintenance was performed whether by the analyst or a contracted service representative.

Any item or equipment that does not perform to specifications or is defective shall be taken out of service, clearly identified and segregated until it has been repaired and shown by calibration/ verification to perform satisfactorily. STL Austin documents and describes in detail instrument and equipment preventive maintenance procedures and requirements in SOPs.

8.11.2 Facilities

Another important aspect of the laboratory operation is the existence and maintenance of adequate, safe, and clean facilities including appropriate engineering controls such as proper ventilation, lighting, dust control, hoods, air flow, protection from extreme temperatures, waste disposal, and a source of stable power.

The maintenance and use of these facilities and proper operations are described in the Corporate Safety Manual (CSM). The Laboratory Director has the responsibility for ensuring a properly maintained facility. The Laboratory Director also has the responsibility for ensuring that samples are stored properly without contamination, work areas are equipped with adequate bench, hood and operational space, and the areas are free from chemical and radiological contamination that may affect analytical results.

8.11.3 Frequency of Maintenance

The frequency of maintenance must consider manufacturer's recommendations and previous experience. Frequency of preventive maintenance along with the recommended preventive maintenance schedules are given in Tables 8.11-1 through 8.11-23 for analytical instrumentation and equipment or defined in laboratory routine maintenance SOPs. These schedules are the recommended default if not otherwise specified by the manufacturer or laboratory SOP. Frequency of maintenance for the facility systems is documented in the CSM.

8.12 Other Requirements

8.12.1 Water

High purity water (*i.e.*, reagent grade or equivalent water) will be used in all metals, wet chemistry, and organic analyses. Demonstration of contaminant-free water is shown through the analysis of method blanks consisting of the reagent water on a daily basis for the analyte of interest. This water is obtained by the use of either a commercial ion-exchange deionizing, distillation, or reverse osmosis unit plus an appropriate polishing unit. The resulting water has a maximum conductivity of 1.0 umho-cm at 25°C or a minimum resistivity of 1.0 Mohm at 25°C. Conductivity or resistivity will be monitored and documented daily or on each day that water is dispensed for analytical use.

For volatile analyses the water may be further purified by purging with an inert gas before use to remove potential traces of organic solvents.

Water monitoring procedures used by STL Austin are detailed in SOP AUS-QA-0016, "Water Purification Systems Monitoring."

8.12.2 Compressed Air and Gases

Ultra high-purity compressed gases from preapproved vendors or in-house gas generators will be used when required for instrumentation. These air and gases must meet the requirements and specifications of the analytical methods performed. In-line filters will be used when appropriate to minimize contamination and moisture from the gases.

8.12.3 Glassware Preparation

Glassware preparation procedures implemented at STL Austin are designed to ensure that contaminants are not introduced during sample analysis. Procedures describing glassware preparation are detailed in SOP AUS-QA-0003, "Cleaning of Laboratory Glassware."

8.12.4 Chemical Storage

Storage of chemicals shall be conducted in a manner to minimize the potential for fire or release of hazardous material resulting from an unplanned chemical reaction. Refrigerators used for storing flammable liquids must have spark-free interior construction. Flammable solvents shall be stored in appropriate cabinets meeting all necessary codes. All chemicals are stored according to chemical compatibility. Further details regarding chemical storage are provided in the CSM.

8.12.5 Waste Disposal

Laboratory wastes shall be disposed of safely and in a manner consistent with applicable regulations. The Laboratory Director or designee is responsible for the development, implementation, and maintenance of site-specific procedures that will document all aspects of the disposal program.

8.12.6 Facility Security

The STL Austin laboratory is a limited access, secure facility. To ensure that only authorized personnel are able to enter the building from an entrance that is not monitored, entry into each building is limited in one or more of the following ways at a minimum:

- Locking doors and issuing keys only to authorized personnel; and
- During business hours, entry is possible only through the main entrance. This entrance is monitored at all times, usually by a receptionist. All guests are required to sign in by using a visitor logbook.

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TABLE 8.2-1

STL Austin Laboratory
Organic Preparation and Cleanup Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Volatile Organics (VOAs)	Aqueous		EPA 624 EPA 602	SW846 5030B SW846 1311 SW846 1312	
	Solid			SW846 5030B SW846 5035 SW846 1311 SW846 1312	
	Waste			SW846 5030B SW846 1311 SW846 1312	
	Biological				
	Air				
Base Neutrals and Acids (BNAs)	Aqueous		EPA 625	SW846 3510C SW846 3520C SW846 1311 SW846 1312	
	Solid			SW846 3550B SW846 1311 SW846 1312	
	Waste			SW846 3580A SW846 1311 SW846 1312	
	Biological				
	Air				
Organochlorine Pesticides	Aqueous		EPA 608	SW846 3510C SW846 3520C SW846 1311 SW846 1312	
	Solid			SW846 3540C SW846 3550B SW846 1311 SW846 1312	
	Waste			SW846 3580A SW846 1311 SW846 1312	
	Biological				
	Air				

TABLE 8.2-1
(continued)
STL Austin Laboratory
Organic Preparation and Cleanup Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
PCBs	Aqueous		EPA 608	SW846 3510C SW846 3520C SW846 3665A SW846 1311 SW846 1312	
	Solid			SW846 3540C SW846 3550B SW846 3665A SW846 1311 SW846 1312	
	Waste			SW846 3580A SW846 3665A SW846 1311 SW846 1312	
	Biological				
	Air				
Polynuclear Aromatic Hydrocarbons	Aqueous			SW846 3510C SW846 3520C SW846 1312	
	Solid			SW846 3540C SW846 3550B SW846 1312	
	Waste			SW846 3580A	
	Biological				
	Air				
Petroleum Hydrocarbons	Aqueous			SW846 5030B SW846 3510C SW846 3520C	TX 1005 TX 1006
	Solid			SW846 5030B SW846 5035 SW846 3540C SW846 3550B	TX 1005 TX 1006
	Waste			SW846 3580A	
	Biological				
	Air				
Dissolved Gases in Water	Aqueous				RSK-175 AUS-GC-0002
	Solid				
	Waste				
	Biological				
	Air				

TABLE 8.2-2

STL Austin Laboratory
Organic Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	**CWA**	**RCRA/CERCLA**	**Other**
Volatile Organics (VOAs)	Aqueous		EPA 624 EPA 602	SW846 8260B SW846 8021B SW846 8260B SIM	
	Solid			SW846 8260B SW846 8021B	
	Waste			SW846 8260B SW846 8021B	
	Biological				
	Air				
Volatile Organic Canister (VOCs) Ambient	Aqueous				
	Solid				
	Waste				
	Biological				
	Air				TO15 TO12 Exhibit D(1)
Volatile Organic Canister (VOCs) Source	Aqueous				
	Solid				
	Waste				
	Biological				
	Air				TO14A TO12 ASTM D1946-90
Base Neutrals and Acids (BNAs)	Aqueous		EPA 625	SW846 8270C	
	Solid			SW846 8270C	
	Waste			SW846 8270C	
	Biological				
	Air				
Organochlorine Pesticides	Aqueous		EPA 608	SW846 8081A	
	Solid			SW846 8081A	
	Waste			SW846 8081A	
	Biological				
	Air				
PCBs	Aqueous		EPA 608	SW846 8082	
	Solid			SW846 8082	
	Waste			SW846 8082	
	Biological				
	Air				

TABLE 8.2-2
(continued)
STL Austin Laboratory
Organic Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Polynuclear Aromatic Hydrocarbons	Aqueous			SW846 8270C SIM	
	Solid			SW846 8270C SIM	
	Waste			SW846 8270C SIM	
	Biological				
	Air				
Petroleum Hydrocarbons	Aqueous			SW846 8015B	TX 1005 TX 1006
	Solid			SW846 8015B	TX 1005 TX 1006
	Waste			SW846 8015B	TX 1005 TX 1006
	Biological				
	Air				
Direct Aqueous Injection	Aqueous			SW846 8015B	
	Solid			SW846 8015B	
	Waste				
	Biological				
	Air				
Dissolved Gases in Water	Aqueous				RSK-175 AUS-GC-0002
	Solid				
	Waste				
	Biological				
	Air				

Footnotes for Table 8.2-2 Organic Methods

(1) Exhibit D, "Draft Statement of Work for Analysis of Ambient Air", US EPA CLP, June 1990

TABLE 8.2-3

STL Austin Laboratory
Metals Preparation Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	**CWA**	**RCRA/CERCLA**	**Other**
ICP Metals	Aqueous		EPA 200.7 SM18 3030C	SW 846 3005A SW846 3010A SW846 1311 SW846 1312	
	Solid			SW846 3050B SW846 1311 SW846 1312	
	Waste			SW846 3050B SW846 1311 SW846 1312	
	Biological				
	Air				
ICP/MS Metals	Aqueous		EPA 200.8	SW846 3020A	
	Solid			SW846 3050B	
	Waste			SW846 3050B	
	Biological				
	Air				
Organic Lead (GFAA)	Aqueous				HML 939-M
	Solid				
	Waste				
	Biological				
	Air				
Mercury	Aqueous		EPA 245.1	SW 846 7470A SW846 1311 SW846 1312	
	Solid		EPA 245.5	SW 846 7471A SW846 3051 SW846 3052 SW846 1311 SW846 1312	
	Waste			SW 846 7471A SW846 3051 SW846 3052 SW846 1311 SW846 1312	
	Biological				
	Air				

TABLE 8.2-4

STL Austin Laboratory
Metals Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Aluminum	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Antimony	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Arsenic	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Barium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Beryllium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Bismuth	Aqueous		EPA 200.7	SW846 6010B	
	Solid			SW846 6010B	
	Waste			SW846 6010B	
	Biological				
	Air				
Boron	Aqueous		EPA 200.7	SW846 6010B	
	Solid			SW846 6010B	
	Waste			SW846 6010B	
	Biological				
	Air				

TABLE 8.2-4
(continued)
STL Austin Laboratory
Metals Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Cadmium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Calcium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Chromium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Cobalt	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Copper	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Gold	Aqueous		EPA 200.7	SW846 6010B	
	Solid			SW846 6010B	
	Waste			SW846 6010B	
	Biological				
	Air				
Hardness	Aqueous		EPA 200.7 SM 2340B	SW846 6010B SM 2340B	SW846 6020 SM 2340B
	Solid				
	Waste				
	Biological				
	Air				

TABLE 8.2-4
(continued)
STL Austin Laboratory
Metals Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Iron	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Lead	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Lithium	Aqueous		EPA 200.8		SW846 6020
	Solid				
	Waste				
	Biological				
	Air				
Magnesium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Manganese	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Mercury	Aqueous		EPA 245.1	SW846 7470A	
	Solid		EPA 245.5	SW846 7471A	
	Waste			SW846 7471A	
	Biological				
	Air				
Molybdenum	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	
	Waste			SW846 6010B	
	Biological				
	Air				

TABLE 8.2-4
(continued)
STL Austin Laboratory
Metals Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Nickel	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Organic Lead	Aqueous				HML 939-M
	Solid				
	Waste				
	Biological				
	Air				
Palladium	Aqueous		EPA 200.7		
	Solid			SW846 6010B	
	Waste			SW846 6010B	
	Biological				
	Air				
Phosphorus	Aqueous		EPA 200.7	SW846 6010B	
	Solid			SW846 6010B	
	Waste			SW846 6010B	
	Biological				
	Air				
Platinum	Aqueous		EPA 200.8		SW846 6020
	Solid				SW846 6020
	Waste				SW846 6020
	Biological				
	Air				
Potassium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Selenium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				

TABLE 8.2-4
(continued)
STL Austin Laboratory
Metals Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Silicon	Aqueous		EPA 200.7	SW846 6010B	
	Solid			SW846 6010B	
	Waste			SW846 6010B	
	Biological				
	Air				
Silver	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Sodium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Strontium	Aqueous		EPA 200.8	SW 846 6010B	SW846 6020
	Solid			SW 846 6010B	SW 846 6020
	Waste			SW 846 6010B	SW846 6020
	Biological				
	Air				
Sulfur	Aqueous		EPA 200.7		
	Solid			SW846 6010B	
	Waste			SW 846 6010B	
	Biological				
	Air				
Tellurium	Aqueous		EPA 200.7		
	Solid			SW846 6010B	
	Waste			SW 846 6010B	
	Biological				
	Air				
Thallium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				

TABLE 8.2-4
(continued)
STL Austin Laboratory
Metals Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Tin	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Titanium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Tungsten	Aqueous		EPA 200.7	SW846 6010B	
	Solid			SW846 6010B	
	Waste			SW846 6010B	
	Biological				
	Air				
Uranium	Aqueous		EPA 200.7		
	Solid			SW846 6010B	
	Waste			SW846 6010B	
	Biological				
	Air				
Vanadium	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				
Zinc	Aqueous		EPA 200.7 EPA 200.8	SW846 6010B	SW846 6020
	Solid			SW846 6010B	SW846 6020
	Waste			SW846 6010B	SW846 6020
	Biological				
	Air				

TABLE 8.2-5

STL Austin Laboratory
Wet Chemistry Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	**CWA**	**RCRA/CERCLA**	**Other**
Acetate	Aqueous		EPA 300.0A MOD		
	Solid				
	Waste				
	Biological				
	Air				
Alkalinity (carbonate, bicarbonate, total)	Aqueous		EPA 310.1		
	Solid				
	Waste				
	Biological				
	Air				
Bromide	Aqueous		EPA 300.0	SW 846 9056	
	Solid		EPA 300.0	SW 846 9056	
	Waste				
	Biological				
	Air				
Carbon, Total Carbon	Aqueous		EPA 415.1	EPA 9060	
	Solid			Walkley-Black	
	Waste				
	Biological				
	Air				
Chloride	Aqueous		EPA 300.0 EPA 325.3	SW 846 9056	
	Solid		EPA 300.0	SW 846 9056	
	Waste				
	Biological				
	Air				
Chromium, Hexavalent	Aqueous			SW846 7196A	SM 3500-Cr D
	Solid			SW846 7196A	
	Waste				
	Biological				
	Air				
Conductivity	Aqueous		EPA 120.1	SW846 9050A	
	Solid				
	Waste				
	Biological				
	Air				
Corrosivity	Aqueous			SW846 9040B	
	Solid			SW846 9040B	
	Waste			SW846 9040B	
	Biological				
	Air				

TABLE 8.2-5
(continued)
STL Austin Laboratory
Wet Chemistry Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Cyanide, Amenable	Aqueous		EPA 335.1	SW846 9012A	
	Solid				
	Waste				
	Biological				
	Air				
Cyanide, Total	Aqueous		EPA 335.3	SW846 9012A	
	Solid			SW846 9012A	
	Waste				
	Biological				
	Air				
Demand, Chemical Oxygen	Aqueous		EPA 410.4		
	Solid				
	Waste				
	Biological				
	Air				
Fluoride	Aqueous		EPA 300.0 EPA 340.2 without distillation	SW846 9056	
	Solid		EPA 340.2 without distillation	SW846 9056	
	Waste				
	Biological				
	Air				
Formate	Aqueous		EPA 300.0		
	Solid				
	Waste				
	Biological				
	Air				
Hardness	Aqueous		EPA 130.2		SM 3500-Ca D
	Solid				
	Waste				
	Biological				
	Air				
N-Hexane Extractable Material	Aqueous		EPA 1664A		
	Solid				
	Waste				
	Biological				
	Air				

TABLE 8.2-5
(continued)
STL Austin Laboratory
Wet Chemistry Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Ignitability	Aqueous			SW846 1020A	
	Solid			SW846 7.1.2	
	Waste			SW846 1020A	
	Biological				
	Air				
Moisture	Aqueous				
	Solid				ASTM D2216-90 AFCEE mod
	Waste				
	Biological				
	Air				
Nitrate (NO_3)	Aqueous		EPA 300.0 EPA 353.2	SW846 9056	
	Solid		EPA 300.0	SW846 9056	
	Waste				
	Biological				
	Air				
Nitrate-Nitrite	Aqueous		EPA 353.2		
	Solid				
	Waste				
	Biological				
	Air				
Nitrite (NO_2)	Aqueous		EPA 300.0 EPA 353.2	SW846 9056	
	Solid		EPA 300.0	SW846 9056	
	Waste				
	Biological				
	Air				
Nitrogen, Ammonia	Aqueous		EPA 350.1 EPA 350.2 Mod.		
	Solid				
	Waste				
	Biological				
	Air				

TABLE 8.2-5
(continued)
STL Austin Laboratory
Wet Chemistry Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Nitrogen, Organic	Aqueous		Calculation 351.2 – 350.1		
	Solid				
	Waste				
	Biological				
	Air				
Nitrogen, Total Kjeldahl	Aqueous		EPA 351.2		
	Solid				
	Waste				
	Biological				
	Air				
Orthophosphate	Aqueous		EPA 300.0 EPA 365.1	SW846 9056	
	Solid		EPA 300.0	SW846 9056	
	Waste				
	Biological				
	Air				
Paint Filter Test	Aqueous				
	Solid			SW846 9095A	
	Waste			SW846 9095A	
	Biological				
	Air				
pH	Aqueous		EPA 150.1 SM 4500-H B	SW846 9040B	
	Solid			SW846 9045C	
	Waste			SW846 9040B SW846 9041A SW846 9045C	
	Biological				
	Air				
Phenolics	Aqueous		EPA 420.2	SW846 9066	
	Solid			SW846 9066	
	Waste				
	Biological				
	Air				

TABLE 8.2-5
(continued)
STL Austin Laboratory
Wet Chemistry Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Phosphorus, Total	Aqueous		EPA 365.1		
	Solid				
	Waste				
	Biological				
	Air				
Solids, Total Dissolved	Aqueous		EPA 160.1		
	Solid				
	Waste				
	Biological				
	Air				
Solids, Total Suspended	Aqueous		EPA 160.2		
	Solid				
	Waste				
	Biological				
	Air				
Solids, Total	Aqueous		EPA 160.3		
	Solid				
	Waste				
	Biological				
	Air				
Solids, Settleable	Aqueous		EPA 160.5		
	Solid				
	Waste				
	Biological				
	Air				
Solids, Volatile	Aqueous		EPA 160.4		
	Solid				
	Waste				
	Biological				
	Air				
Sulfate	Aqueous		EPA 300.0	SW846 9056	
	Solid			SW846 9056	
	Waste				
	Biological				
	Air				
Sulfide	Aqueous		EPA 376.1	SW 9034	
	Solid			SW846 9030B modified / SW846 9034	
	Waste				
	Biological				
	Air				

TABLE 8.2-5
(continued)
STL Austin Laboratory
Wet Chemistry Methods

Parameter	Matrix	NELAP Field of Testing			
		SDWA	CWA	RCRA/CERCLA	Other
Sulfite	Aqueous		EPA 377.1		
	Solid				
	Waste				
	Biological				
	Air				
Terephthalic acid	Aqueous		EPA 300.0A MOD		
	Solid				
	Waste				
	Biological				
	Air				

TABLE 8.2-6
STL Austin Laboratory
Standard Operating Procedures

Document #	Rev #	Title	Date Active
AL/QMP003	1	Quality Traveler	09/01/98
AUS-GC-0002	4	Analysis of Dissolved Gases in Water (RSK-175)	08/31/04
AUS-GC-0003	2	Total Petroleum Hydrocarbons - TNRCC Method 1005	03/01/06
AUS-GC-0004	2	Hexamethylphosphoramide (HMPA) by GC/NPD	01/13/06
AUS-GC-0005	1	Analysis of Alcohols and Glycols by Method 8015B, Direct Aqueous Injection (DAI)	10/27/03
AUS-GC-0006	1	GC Determination of BTEX and Gasoline by EPA Methods 602, 8021B, 8015B GRO, Iowa OA-1 and Tennessee GRO	10/27/03
AUS-GC-0007	2	GC Analysis of Organochlorine Pesticides and PCBs by EPA Methods 608 and SW-846 8081A, 8082	2/20/04
AUS-GC-0016	1	Analysis of Extractable Total Petroleum Hydrocarbons by SW-846 Method 8015B (including CA LUFT, Iowa OA-2, OK DRO, and TN EPH)	10/27/03
AUS-HS-0017	2	Facility Contingency Plan	08/12/03
AUS-HS-0018	2	Site-Specific Waste Management Plan	08/19/05
AUS-IP-0002	1	Acid Digestion of Soil and Sludge Samples by SW-846 Method 3050B	6/21/05
AUS-IP-0003	2	Preparation of Aqueous Samples for Acid-Extractable Metals (3030C)	04/08/05
AUS-IP-0004	1	Toxicity Characteristic Leaching Procedure and Synthetic Precipitation Leaching Procedure	03/19/04
AUS-IP-0006	1	Waste Extraction Test (WET) Using CCR Title 22 and 26 Methods	08/02/05
AUS-IP-0007	0	Gravimetric Determination of pM10 Mass Concentration of Particulate Filters	08/16/04
AUS-IP-0010	0	Acid Digestion of Aqueous Samples by SW846 Methods 3005A, 3010A, 3020A and MCAWW 200 Series Methods	10/24/03
AUS-IP-0011	0	Hot Extraction Procedure	3/31/06
AUS-IT-0002	2	Data Backup Procedures	12/15/05
AUS-IT-0003	1	Computer Security	06/15/05
AUS-MS-0001	0	Screening Procedures for Volatile Analyses	3/31/06
AUS-MS-0004	1	GCMS Determination of Volatile Organic Compounds by EPA Methods 624, SW-846 8260B and 8260B SIM	10/27/03
AUS-MS-0005	1	GC/MS Analysis by EPA Methods 625 and SW-846 8270C	10/17/03

TABLE 8.2-6
STL Austin Laboratory
Standard Operating Procedures

Document #	Rev #	Title	Date Active
AUS-MT-0001	1	Inductively Coupled Plasma -Atomic Emission Spectroscopy, Spectrophotometric Method for Trace Element Analyses, SW-836 Method 6010B and EPA Method 200.7	12/03/03
AUS-MT-0005	1	Preparation and Analysis of Mercury in Aqueous Samples by Cold Vapor Atomic Absorption, SW-846 7470A and MCAWW 245.1	01/30/04
AUS-MT-0007	2	Preparation and Analysis of Mercury in Solid Samples by Cold Vapor Atomic Absorption, SW-846 7471A and MCAWW 245.5	3/17/06
AUS-MT-0008	3	Hardness by Calculation (SM2340B)	06/20/05
AUS-MT-0011	2	Determination of Organic Lead Compounds by GFAAS	01/06/06
AUS-MT-0012	1	ICP/MS by EPA Method SW-846 6020	01/13/06
AUS-OP-0001	1	Preparation of Samples in Encore Samplers for SW846 Method 5035	10/27/03
AUS-OP-0002	0	Sonicator Tuning and Maintenance	10/28/05
AUS-OP-0003	0	Extraction & Cleanup of Organic Compounds from Waters and Soils, Based on SW-846 3500 Series, 3600 Series, 8151A and 600 Series Methods (Change Form 8/27/03)	08/18/03
AUS-PM-0002	4	Procedures to Address Customer Complaints and Erroneous Reports	3/28/06
AUS-PM-0004	1	Electronic Reporting	11/04/05
AUS-PM-0005	0	Data Package Preparation	01/25/03
AUS-PM-0006	1	Invoicing (Reviewed 3/22/06)	02/07/05
AUS-QA-0001	2	Use and Calibration Verification of Pipet Dispenser Apparatus	11/10/05
AUS-QA-0002	7	Maintenance and Calibration of Balances and Class 1 Weights	02/08/06
AUS-QA-0003	4	Cleaning of Laboratory Glassware	11/23/05
AUS-QA-0006	6	Calibration Verification of Laboratory Thermometers	12/28/05
AUS-QA-0007	5	VOA Storage Blanks	06/20/05
AUS-QA-0008	3	Chromatography Column Identification	06/20/05
AUS-QA-0011	1	Preventative Maintenance and Repair Procedures for Organic Instrumentation	09/10/04
AUS-QA-0012	4	Preventing Sample Contamination	12/12/05

TABLE 8.2-6
STL Austin Laboratory
Standard Operating Procedures

Document #	Rev #	Title	Date Active
AUS-QA-0013	2	Nonconformance and Corrective Action System	03/17/06
AUS-QA-0017	3	Data Recording Requirements	06/21/05
AUS-QA-0018	4	Temperature Monitoring & Temperature Requirements of Sample Storage Area, Refrigerators, Freezers, Incubators, and Ovens	06/15/05
AUS-QA-0019	1	Receipt, Inventory, Preparation, Traceability, Shelf Life and Documentation of Laboratory Standards and Reagents	05/16/05
AUS-QA-0020	3	Definitions and Procedures for Determination of Matrices, Phases, Compositing, and Subsampling	01/18/06
AUS-QA-0021	2	Rounding and Significant Figures	09/23/05
AUS-QA-0022	3	Quality and Operations Records Management	05/21/04
AUS-QA-0023	2	Audits, Internal Surveillances, and Assments	02/01/03
AUS-QA-0024	3	Naming Conventions for Instrumentation	11/12/05
AUS-QA-0026	3	Document Control and Distribution	11/19/04
AUS-QA-0027	32	Acceptable Manual Integration Practices	11/10/05
AUS-QA-0028	2	Data Review Requirements	11/15/05
AUS-QA-0029	3	Preparation and Management of Standard Operating Procedures	06/15/05
AUS-QA-0030	1	Employee Orientation and Training	11/11/05
AUS-QA-0031	1	Data Handling and Archiving	05/25/05
AUS-QA-0032	1	Determination of Instrument Detection Limits	08/04/03
AUS-QA-0033	2	Determination of Method Detection Limits for Chemical Tests	1/31/06
AUS-QA-0034	1	Reporting Limits	03/12/04
AUS-QA-0035	2	STL Austin Quality Control Program	11/23/05
AUS-QA-0036	2	Maintaining Time Integrity	06/20/05
AUS-QA-0037	0	Measurement Uncertainties	10/21/05
AUS-SC-0001	6	Sample Receipt and Initialization of Testing	01/30/04
AUS-SC-0002	4	Ice Chest Preparation and Shipment	07/01/05
AUS-SC-0003	2	Internal Chain-of-Custody	08/15/03
AUS-SC-0004	2	Receipt and Handling of Canister Samples for the VOC Laboratory	07/01/05
AUS-SC-0005	2	Handling of USDA Restricted Soils for Analysis	02/15/05
AUS-VA-0001	2	Cleaning of SUMMA Canisters	08/18/05

TABLE 8.2-6
STL Austin Laboratory
Standard Operating Procedures

Document #	Rev #	Title	Date Active
AUS-VA-0002	1	Evacuation and Shipping of Summa Canisters	0715/05
AUS-VA-0003	1	Calibration of Pressure and Vacuum Gauges	08/19/05
AUS-VA-0004	1	Gaseous Standards Preparation	07/15/05
AUS-VA-0005	0	Canister Dilutions	12/01/04
AUS-VA-0007	1	GC/MS Analysis of Volatile Organic Compounds in an Ambient Air Matrix by Methods TO-14A and TO-15	11/17/05
AUS-VA-0008	0	Analysis for Percent-level Permanent Gases by Thermal Conductivity Gas Chromatography	09/17/04
AUS-VA-0009	1	Determination of TNMHC by Method TO-12	08/15/05
AUS-VA-0010	0	Field Equipment Calibration and Handling	02/23/05
AUS-VA-0011	1	Leak Check and Repair of Canisters	08/15/05
AUS-VA-0012	0	05Detemination of C1-C3 Hydrocarbons (light Gases) by EPA Compendium TO-14A, GC-FID	11/18/15
AUS-VA-0013	0	Gas Chromatography/Mass Spectrometry Analysis of Volatile Organic Compounds in a Source Air Matrix by EPA Compendium Method TO-15	12/28/05
AUS-WC-0001	2	Method for the Determination of % Solids, % Moisture and Water Content in Soils, Sediments, and Solids	05/01/05
AUS-WC-0003	1	COD, Colorimetric by EPA 410.4 and SM 5220D	06/24/05
AUS-WC-0004	2	n-Hexane Extractable Material (HEM) by EPA Method 1664A and SW-846 Method 9070A (Formerly Oil and Grease)	12/16/05
AUS-WC-0005	2	Hexavalent Chromium by SW-846 7196A and Standard Methods 3500-Cr D	12/28/05
AUS-WC-0006	3	Sulfide, Distillation andTitration (Iodine) by EPA 376.1 and SW-846 9030B and 9034	3/28/06
AUS-WC-0007	2	Determination of Solids in Waters and Wastes (TS by 160.3 & 2540B, TDS by 160.1 & 2540C, TSS by 160.2 & 2540D)	12/09/05
AUS-WC-0008	1	Specific Conductance Determination by 120.1 and SW-846 9050A	12/09/05
AUS-WC-0009	2	Determination of pH (EPA 150.1/9040B/9045C/9041)	12/30/05
AUS-WC-0010	1	Hardness by EPA 130.2 and Standard Methods 2340C	12/07/05
AUS-WC-0011	2	Settleable Solids Determination by 160.5 and SM 2540 F	12/30/04
AUS-WC-0016	2	Alkalinity (Total/Carbonate/Bicarbonate/Hydroxide) by EPA Method 310.1 and SM 2320B (Titration)	05/09/05

TABLE 8.2-6
STL Austin Laboratory
Standard Operating Procedures

Document #	Rev #	Title	Date Active
AUS-WC-0017	3	Analysis of Anions by Ion Chromatography by 300.0 and SW-846 9056	08/19/05
AUS-WC-0018	2	Ignitability of Solids for Waste Characterization by EPA SW-846 Chapter 7, Section 7.1	11/16/05
AUS-WC-0023	0	Phosphorus, All Forms by EPA Method 365.1 (Colorimetric, Automated, Ascorbic Acid)	09/16/02
AUS-WC-0024	2	Nitrate + Nitrite, Nitrite, Nitrate by EPA Method 353.2 (LACHAT Autoanalyzer)	02/20/04
AUS-WC-0026	3	Paint Filter Liquids Test (SW-846, Method 9095)	10/08/04
AUS-WC-0028	0	Determination of Ammonia Nitrogen by Semi-Automated colorimetry, EPA Method 350.1	02/08/06
AUS-WC-0029	2	Method for Extraction of Water Leachable Anions	12/09/05
AUS-WC-0030	0	Total Kjeldahl Nitrogen by EPA Method 351.2 and Total Organic Nitrogen by Calculation (351.2-350.1)	10/22/03
AUS-WC-0033	4	Total Oxidizable Carbon (TOC) Analysis in Soils, Walkley-Black Procedure	3/31/06
AUS-WC-0034	2	TOC and TIC by 415.1, SW-846 9060 and SM 5310D	01/11/06
AUS-WC-0035	0	Phenols (automated) by EPA Methods 420.2 and SW-846 9066	01/02/04
AUS-WC-0036	4	Total Cyanide by EPA Methods 335.3 and 9012A and Cyanide Amenable to Chlorination by EPA Methods 335.1 and 9012A	10/27/03
AUS-WC-0037	1	Sulfite, Titrimetric (EPA 377.1)	12/14/05
AUS-WC-0038	1	Ignitability/Flashpoint of Liquids by SW846 Method 1020A	12/01/05
AUS-WC-0043	1	Fluoride, ISE by EPA Method 340.2 and SM 4500-F C	3/21/06
AUS-WC-0044	0	Ferrous Iron by Method 3500D	03/07/05
STL Corporate Policies			
STL P-ITQ-013	1	Software Quality Assurance Policy	02/05/03
STL P-E-003	1	STL Policy on Annual Assessment of Operations	2/28/05
STL P-I-001	2	Internet Use Policy	05/25/04
STL P-I-002	2	Electronic Mail (Email) Use	05/25/04
STL P-I-003	2	Computer Systems Account and Naming Policy	05/25/04
STL P-I-004	2	Computer Systems Password Policy	05/25/04
STL P-I-005	2	Software Licensing Policy	10/11/04

TABLE 8.2-6
STL Austin Laboratory
Standard Operating Procedures

Document #	Rev #	Title	Date Active
STL P-I-006	2	Virus Protection Policy	10/11/04
STL P-I-007	2	Databackup Policy	10/11/04
STL P-I-008	2	Internet Security Policy	01/20/04
STL-P-I-009	1	Cellular Phone Policy	06/17/04
STL-P-L-001	1	Record Retention	09/17/04
STL P-L-002	2.1	Subponeas Policy	10/06/05
STL P-L-003	1.1	Internal Investigations	12/15/05
STL P-L-004	1	Organizational Conflicts of Interest	09/17/02
STL P-L-006	4.1	Ethics Policy	12/15/05
STL P-T-001	3	Selection of Calibration Points	10/06/04
STL P-T-002	1	Establishment and Utilization of Technical Experts	04/11/01
STL P-T-003	1	Qualified Product List	08/06/02
STL Corporate SOPs			
STL S-ITQ-0001	1	Software and Hardware Change Management	02/05/03
STL S-ITQ-0005	1	QuantIMS User Profile Setup and Maintenance	02/05/03
STL S-ITQ-0007	1	Software Testing, Validation and Verification	02/05/03
STL S-Q-001	4	Official Document Control and Archive	11/24/04
STL S-Q-002	3.1	Systems Audits	12/15/05
STL S-Q-003	2	Method Detection Limit Studies	11/24/04
STL S-Q-004	2	Acceptable Manual Integration Practices	09/24/04
STL S-Q-005	1.1	Data Recall Process	12/15/05
STL S-Q-007	1	Data Authenticity Audits	12/15/05
STL S-T-001	2	Quality Testing of Solvents, Acids, and Reagents	12/07/04
STL S-T-002	2	Reporting Limits QuantIMS	12/07/04

TABLE 8.4-1
Field Quality Control Samples

Type	Applicability		Accuracy and Precision Application	Introduced By
	Inorganic	Organic		
Trip Blank (volatiles)	No	Yes	Accuracy	Supplier of Containers
Field Blank	Yes	Yes	Accuracy	Field Sampler
Rinsate Blank	Yes	Yes	Accuracy	Field Sampler
Collocated Sample	Yes	Yes	Precision	Field Sampler
Split Sample	Yes	Yes	Precision	Field Sampler
Field Duplicate	Yes	Yes	Precision	Field Sampler
Field Matrix Spike	Yes	Yes	Accuracy	Field Sampler

TABLE 8.4-2
Laboratory Quality Control Samples

Type	Frequency	Applicability		Accuracy and Precision Application	Introduced By
		Inorganic	Organic		
Analytical Spike	As specified in methods, or as needed	Yes	No	Accuracy	Analyst/ Prep
Serial Dilution	As specified in methods, or as needed	Yes	No	Precision	Analyst
Duplicate	1 out of 20 or at least 1/month/run	Yes	Yes	Precision	Analyst/ Prep
Instrument Blank	As specified in methods, or as needed	Yes	Yes	Accuracy	Analyst
Interference Check Sample	As specified in methods	Yes	No	Accuracy	Analyst
Internal Standard	Each sample and standard, as specified in methods.	Yes	Yes	Both	Analyst/Prep
Laboratory Control Sample	1 per each group of samples processed up to 20 samples.	Yes	Yes	Accuracy	Analyst/Prep
Laboratory Control Sample Duplicate	1 per each group of samples processed up to 20 samples.	Yes	Yes	Both	Analyst/Prep
Matrix Spike	1 per each group of samples processed up to 20 samples.	Yes	Yes	Accuracy	Analyst/Prep
Matrix Spike Duplicate	1 per each group of samples processed up to 20 samples.	Yes	Yes	Both	Analyst/Prep
Method Blank	1 per each group of samples processed up to 20 samples.	Yes	Yes	Accuracy	Analyst/Prep
Surrogate	All standards, method blanks, LCS, and samples; as specified in methods.	No	Yes Method Dependent	Accuracy	Analyst/Prep

TABLE 8.4-3
Laboratory Performance Quality Control Samples

Sample/Measurement	Purpose
Method Blank	Demonstrates that the laboratory systems (e.g., glassware cleaning procedures) and laboratory reagents used for the preparation and analysis of samples have not contributed to a false positive or negative measurement.
Instrument Blank	Demonstrates that the analytical system has not contributed to a false positive or negative measurement.
Laboratory Control Sample	Demonstrates the laboratory's ability to perform an analysis within the performance requirements of the method.
Laboratory Control Sample Duplicate	Demonstrates the laboratory's ability to perform an analysis within established precision limits.

TABLE 8.4-4
Matrix Specific Quality Control Samples

Quality Control Sample	Purpose
Duplicate Samples	Estimates the ability of the laboratory to obtain precise measurements on a sample. This measure is dependent on the homogeneity of the sample being duplicated. Solid samples often portray poor sample homogeneity and therefore often have poor duplication with regards to the sample result.
Matrix Spike Sample	Estimates the ability of the laboratory to obtain accurate measurements on a sample. The measure is dependent on the bias a sample matrix may cause regarding a given analyte.
Matrix Spike Duplicate Sample	In addition to verifying the accuracy of the matrix spike sample, the matrix spike duplicate can be used with the matrix spike sample as a measure of precision by calculating the relative percent difference (RPD).
Analytical/Post Digestion Spike	Estimates the relative bias of the laboratory’s measurements in a given matrix. This measurement is independent of the homogeneity of the sample.

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Alkalinity	Method Blank	310.1 2320B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	—	Not Applicable
	Laboratory Control Sample / Laboratory Control Sample Duplicate	310.1 2320B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	Not Applicable
	Matrix Spike	310.1	Not Applicable	—	Not Applicable
	Matrix Spike Duplicate	310.1	Not Applicable	—	Not Applicable
	Duplicate	310.1 2320B	Frequency: 1 per batch of 10 samples Criteria: ≤20 % RPD[3] Corrective Action: Flag data outside of limit.	—	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Ammonia	Method Blank	350.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	—	Not Applicable
	Laboratory Control Sample / Laboratory Control Sample Duplicate	350.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD(3) within lab limits Corrective Action: If not within control limits, rerun all associated samples	—	Not Applicable
	Matrix Spike	350.1	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	—	Not Applicable
	Matrix Spike Duplicate	350.1	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data outside of limit	—	Not Applicable
	Duplicate	350.1	Not Applicable	—	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Ammonia (TKN)	Method Blank	351.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	—	Not Applicable
	Laboratory Control Sample / Laboratory Control Sample Duplicate	351.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within control limits, rerun all associated samples	—	Not Applicable
	Matrix Spike	351.2	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	—	Not Applicable
	Matrix Spike Duplicate	351.2	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data outside of limit	—	Not Applicable
	Duplicate	351.2	Not Applicable	—	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Bromide	Method Blank	300.0[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	300.0[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: If not within control limits, rerun all associated samples	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within control limits, rerun all associated samples
	Matrix Spike	300.0[5]	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: 90-110% recovery Corrective Action: Flag data associated with unacceptable MS	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with MS outside of limit
	Matrix Spike Duplicate	300.0[5]	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: Flag data associated with unacceptable MSD	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	300.0[5]	Not Applicable	9056	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Chemical Oxygen Demand (COD)	Method Blank	410.4	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	—	Not Applicable
	Laboratory Control Sample / Laboratory Control Sample Duplicate	410.4	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	Not Applicable
	Matrix Spike	410.4	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	—	Not Applicable
	Matrix Spike Duplicate	410.4	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data outside of limit	—	Not Applicable
	Duplicate	410.4	Not Applicable	—	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Chloride	Method Blank	300.0[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	300.0[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: If not within control limits, rerun all associated samples	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within control limits, rerun all associated samples
	Matrix Spike	300.0[5]	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits 300.0 Criteria: 90-110% recovery Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with MS outside of limit
	Matrix Spike Duplicate	300.0[5]	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable MSD

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Chloride (continued)	Duplicate	300.0[5]	Methods 300.0: Not Applicable Method 4500-Cl E: Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: ≤ 20 % RPD[3] Corrective Action: Flag data outside of limit.	9056	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Chromium (Cr^{+6})	Method Blank	3500 Cr-D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	7196A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	3500 Cr-D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	7196A	Frequency: 1 with each batch of samples processed not to exceed 20 samples prepped Criteria: % recovery for water must be within ± 15% and for solids must be within ±20%; RPD[3] within lab limits Corrective Action: Rerun all samples associated with unacceptable LCS/LCSD
	Matrix Spike	3500 Cr-D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	7196A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Advisory limits are 75% - 125% recovery Corrective Action: Flag data associated with unacceptable Matrix Spike
	Matrix Spike Duplicate	3500 Cr-D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data outside of limits	7196A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Advisory limits are 75% - 125% recovery; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	3500 Cr-D	Not Applicable	7196A	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Conductivity	Method Blank	120.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9050A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	120.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9050A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike	120.1	Not Applicable	9050A	Not Applicable
	Matrix Spike Duplicate	120.1	Not Applicable	9050A	Not Applicable
	Duplicate	120.1	Frequency: 1 with each batch of 20 samples processed Criteria: RPD[3] must be within laboratory QC limits Corrective Action: Flag associated data if outside of limits	9050A	Frequency: 1 with each batch of 20 samples processed Criteria: RPD[3] must be within laboratory QC limits Corrective Action: Flag associated data if outside of limits

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Cyanide (Amenable)	Method Blank	335.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9012A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	335.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9012A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Rerun all samples associated with unacceptable LCS/ LCSD
	Matrix Spike	335.1	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	9012A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Advisory limits are 75% - 125% recovery Corrective Action: Flag data associated with unacceptable Matrix Spike
	Matrix Spike Duplicate	335.1	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data outside of limit	9012A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Advisory limits are 75% - 125% recovery; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable Matrix Spike
	Duplicate	335.1	Not Applicable	9012A	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Cyanide (Total)	Method Blank	335.3	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9012A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	335.3	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9012A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Rerun all samples associated with unacceptable LCS
	Matrix Spike	335.3	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	9012A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Advisory limit is 75% - 125% recovery Corrective Action: Flag data associated with unacceptable Matrix Spike
	Matrix Spike Duplicate	335.3	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data outside of limits	9012A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Limits are 75% - 125% recovery; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	335.3	Not Applicable	9012A	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Flashpoint / Ignitability	Method Blank	—	Not Applicable	1020A	Not Applicable
	Laboratory Control Sample	—	Not Applicable	1020A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] must be ≤20% Corrective Action: Rerun all samples associated with unacceptable LCS/LCSD
	Matrix Spike	—	Not Applicable	1020A	Not Applicable
	Matrix Spike Duplicate	—	Not Applicable	1020A	Not Applicable
	Duplicate	—	Not Applicable	1020A	Frequency: 1 per batch of ≤20 samples Criteria: RPD[3] must be ≤20% Corrective Action: Flag data associated with unacceptable Duplicate

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Fluoride	Method Blank	300.0[5] 340.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	300.0[5] 340.2	Frequency: 1 with each batch of samples processed not to exceed 10 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: If not within laboratory control limits, rerun all associated samples	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within control limits, rerun all associated samples
	Matrix Spike	300.0[5] 340.2	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits 300.0 Criteria: 90-110% recovery Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with MS outside of limit
	Matrix Spike Duplicate	300.0[5] 340.2	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	300.0[5] 340.2	Not Applicable	9056	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Hardness	Method Blank	130.2 2340B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	—	Not Applicable
	Laboratory Control Sample / Laboratory Control Sample Duplicate	130.2 2340B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	Not Applicable
	Matrix Spike	130.2 2340B	Method 130.2: Not Applicable Method 2340B: Frequency, Criteria, and Corrective Action: See ICP Metals Method 200.7 Requirements	—	Not Applicable
	Matrix Spike Duplicate	130.2 2340B	Method 130.2: Not Applicable Method 2340B: Frequency, Criteria, and Corrective Action: See ICP Metals Method 200.7 Requirements	—	Not Applicable
	Duplicate	130.2 2340B	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: RPD[3] must be within laboratory control limits Corrective Action: Flag data outside of limit	—	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Iron (Ferrous)	Method Blank	3500-Fe D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	—	Not Applicable
	Laboratory Control Sample / Laboratory Control Sample Duplicate	3500-Fe D	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	Not Applicable
	Matrix Spike	3500-Fe D	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	—	Not Applicable
	Matrix Spike Duplicate	3500-Fe D	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data outside of limit	—	Not Applicable
	Duplicate	3500-Fe D	Not Applicable	—	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Nitrate	Method Blank	300.0[5] 353.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	300.0[5] 353.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: If not within laboratory control limits, rerun all associated samples	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within control limits, rerun all associated samples
	Matrix Spike	300.0[5] 353.2	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits 300.0 Criteria: 90-110% recovery Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with MS outside of limit
	Matrix Spike Duplicate	300.0[5] 353.2	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	300.0[5] 353.2	Not Applicable	9056	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Nitrite	Method Blank	300.0[5] 353.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	300.0[5] 353.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: If not within laboratory control limits, rerun all associated samples	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within control limits, rerun all associated samples
	Matrix Spike	300.0[5] 353.2	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits 300.0 Criteria: 90-110% recovery Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with MS outside of limit
	Matrix Spike Duplicate	300.0[5] 353.2	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	300.0[5] 353.2	Not Applicable	9056	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Nitrate-Nitrite	Method Blank	353.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	—	Not Applicable
	Laboratory Control Sample / Laboratory Control Sample Duplicate	353.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	Not Applicable
	Matrix Spike	353.2	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	—	Not Applicable
	Matrix Spike Duplicate	353.2	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 80-120% recovery; RPD[3] 20% Corrective Action: Flag data outside of limit	—	Not Applicable
	Duplicate	353.2	Not Applicable	—	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
pH	Method Blank	150.1 4500-H^+ B	Not Applicable	9040B 9045C	Not Applicable
	Laboratory Control Sample / Laboratory Control Sample Duplicate	150.1 4500-H^+ B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Sample provided by external source, must be within ± 0.05 pH units Corrective Action: If not within laboratory control limits, rerun all associated samples	9040B 9045C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Sample provided by external source, must be within ± 0.05 pH units Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike	150.1 4500-H^+ B	Not Applicable	9040B 9045C	Not Applicable
	Matrix Spike Duplicate	150.1 4500-H^+ B	Not Applicable	9040B 9045C	Not Applicable
	Duplicate	150.1 4500-H^+ B	Method 150.1 Frequency: 1 with each batch of samples processed not to exceed 20 samples Method 4500-H^+ B Frequency: 1 with each batch of 10 samples Method 150.1 Criteria: ≤ 20 % RPD[3] limit Method 4500-H^+ B Criteria: ≤ 25 % RPD[3] limit Corrective Action: Flag data outside of limit.	9040B 9045C	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Advisory limits are ≤ 20% RPD[3] Corrective Action: Flag data associated with unacceptable Duplicate

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Phenolics	Method Blank	420.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9066	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	420.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9066	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike	420.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with unacceptable Matrix Spike	9066	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with unacceptable Matrix Spike
	Matrix Spike Duplicate	420.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable MSD	9066	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	420.2	Not Applicable	9066	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Ortho-Phosphate-P	Method Blank	300.0[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample	300.0[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: If not within laboratory control limits, rerun all associated samples	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within control limits, rerun all associated samples
	Matrix Spike	300.0[5]	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits 300.0 Criteria: 90-110% recovery Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with MS outside of limit
	Matrix Spike Duplicate	300.0[5]	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	300.0[5]	Not Applicable	9056	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Phosphorus (Total and Ortho-phosphate)	Method Blank	365.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	—	Not Applicable
	Laboratory Control Sample / Laboratory Control Sample Duplicate	365.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	Not Applicable
	Matrix Spike	365.1	Frequency: 1 per 10 samples Criteria: Must be within laboratory QC limits Corrective Action: Flag data outside of limit	—	Not Applicable
	Matrix Spike Duplicate	365.1	Frequency: 1 per 10 samples Criteria: Must be within laboratory QC limits Corrective Action: Flag data outside of limit	—	Not Applicable
	Duplicate	365.1	Not Applicable	—	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Solids	Method Blank	160.1 160.2 160.3	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: If analyte level in method blank is ≥ RL for the analyte of interest in the sample, all associated samples with reportable levels of analyte are reprepared and reanalyzed.	—	Not Applicable
	Laboratory Control Sample / Laboratory Control Sample Duplicate	160.1 160.2 160.3	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, reprepare and rerun all associated samples	—	Not Applicable
	Matrix Spike	160.1 160.2 160.3	Not Applicable	—	Not Applicable
	Matrix Spike Duplicate	160.1 160.2 160.3	Not Applicable	—	Not Applicable
	Duplicate	160.1 160.2 160.3 160.5	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Sample results should agree within 20% if both the sample and sample duplicate results are > 5 X RL Corrective Action: Flag data outside of limit- Address in the project narrative	—	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Specific Conductance	Method Blank	120.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9050A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	120.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9050A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike	120.1	Not Applicable	9050A	Not Applicable
	Matrix Spike Duplicate	120.1	Not Applicable	9050A	Not Applicable
	Duplicate	120.1	Frequency: 1 with each batch of 20 samples processed Criteria: RPD[3] must be within laboratory QC limits Corrective Action: Flag associated data if outside of limits	9050A	Frequency: 1 with each batch of 20 samples processed Criteria: RPD[3] must be within laboratory QC limits Corrective Action: Flag associated data if outside of limits

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Sulfate	Method Blank	300.0[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control sample Duplicate	300.0[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: If not within laboratory control limits, rerun all associated samples	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within control limits, rerun all associated samples
	Matrix Spike	300.0[5]	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits 300.0 Criteria: 90-110% recovery Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with MS outside of limit
	Matrix Spike Duplicate	300.0[5]	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits 300.0 Criteria: 90-110% recovery; RPD[3] 20% Corrective Action: Flag data outside of limit	9056	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	300.0[5]	Not Applicable	9056	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Sulfide	Method Blank	376.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9030B 9034	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	376.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9030B 9034	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike	376.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	9030B 9034	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag associated data
	Matrix Spike Duplicate	376.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag associated data	9030B 9034	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag associated data
	Duplicate	376.1	Not Applicable	9030B 9034	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Sulfite	Method Blank	377.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	—	Not Applicable
	Laboratory Control Sample	377.1	Not Applicable	—	Not Applicable
	Matrix Spike	377.1	Not Applicable	—	Not Applicable
	Matrix Spike Duplicate	377.1	Not Applicable	—	Not Applicable
	Duplicate	377.1	Frequency: 1 with each batch of samples processed not to exceed 10 samples Criteria: ≤ 20 % RPD[3] Corrective Action: Flag data outside of limit.	—	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Total Organic Carbon (TOC)	Method Blank	415.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	9060	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	415.1	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples	9060	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: If not within laboratory control limits, rerun all associated samples
	Matrix Spike	415.1	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	9060	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag associated data
	Matrix Spike Duplicate	415.1	Frequency: 1 per 10 samples, minimum of one per batch of samples processed Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag data outside of limit	9060	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % recovery must be within laboratory control limits; RPD[3] within lab limits Corrective Action: Flag associated data
	Duplicate	415.1	Not Applicable	9060	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Moisture	Method Blank	—	Not Applicable	—	Not Applicable
	Laboratory Control Sample	—	Not Applicable	—	Not Applicable
	Matrix Spike	—	Not Applicable	—	Not Applicable
	Matrix Spike Duplicate	—	Not Applicable	—	Not Applicable
	Duplicate	—	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: ≤20% RPD[3] Corrective Action: Flag data outside of limit.	—	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: ≤20% RPD[3] limit Corrective Action: Reanalyze if sample remaining. If not, flag data outside of limit.

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Organic Lead by GFAA, Mercury by CVAA	Method Blank	200 series	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than practical quantitation limit Corrective Action: Rerun all samples associated with unacceptable blank	7000A series; HML 939-M[7]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than practical quantitation limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	200 series	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery of analyte must be within ± 20 % / RPD[3] < 20% Corrective Action: Rerun all samples associated with unacceptable LCS/LCSD	7000A series; HML 939-M[7]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery of analyte must be within ± 20 % / RPD[3] < 20% Corrective Action: Rerun all samples associated with unacceptable LCS/LCSD
	Matrix Spike	200 series	Frequency: with each batch of samples processed not to exceed 20 samples Criteria: Recovery must be within 75-125 % Corrective Action: Flag data associated with unacceptable MS. (See SOP for detailed corrective action procedure and for other QC procedures.)	7000A series; HML 939-M[7]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Recovery must be within 75-125 % Corrective Action: Flag data associated with unacceptable MS. (See SOP for detailed corrective action procedure and for other QC procedures.)
	Matrix Spike Duplicate	200 series	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Recovery must be within 75-125 % , RPD[3] must be within 20 % Corrective Action: Flag data associated with unacceptable MSD	7000A series; HML 939-M[7]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Recovery must be within 75-125 % , RPD[3] must be within 20 % Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	200 series	Not Applicable	7000A series; HML 939-M[7]	Not Applicable

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Organic Lead by GFAA, Mercury by CVAA (continued)	Serial Dilution	200 series	Frequency: 1 with each batch of samples processed not to exceed 20 samples, as requested Criteria: % Difference <10% Corrective Action: Flag data associated with unacceptable Serial Dilution	7000A series; HML 939-M[7]	Frequency: 1 with each batch of samples processed not to exceed 20 samples, as requested Criteria: % Difference <10% Corrective Action: Flag data associated with unacceptable Serial Dilution
	Analytical / Post Digestion Spikes	200 series	Frequency: 1 with each batch of samples processed not to exceed 20 samples, as requested Criteria: 85-115% recovery Corrective Action: MSA for batch	7000A series; HML 939-M[7]	Frequency: 1 with each batch of samples processed not to exceed 20 samples, as requested Criteria: 85-115% recovery Corrective Action: MSA for batch
ICP Metals	Method Blank	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than practical quantitation limit Corrective Action: Rerun all samples associated with unacceptable blank	6010B 6020	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than practical quantitation limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample / Laboratory Control Sample Duplicate	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery of analyte must be ± 85-115% / RPD[3] < 15% Corrective Action: Rerun all samples associated with unacceptable LCS/LCSD	6010B 6020	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery of analyte must be ± 20 % / RPD[3] < 20% Corrective Action: Rerun all samples associated with unacceptable LCS/LCSD
	Matrix Spike	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Limits for percent recovery are 75-125% Corrective Action: Flag data associated with unacceptable Matrix Spike	6010B 6020	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Limits for percent recovery are 75-125% Corrective Action: Flag data associated with unacceptable Matrix Spike

TABLE 8.4-5
Inorganic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
ICP Metals (continued)	Matrix Spike Duplicate	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Limits for percent recovery are 75-125%, RPD[3] must be within 20 % Corrective Action: Flag data associated with unacceptable Matrix Spike	6010B 6020	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Limits for percent recovery are 75-125%, RPD[3] must be within 20 % Corrective Action: Flag data associated with unacceptable Matrix Spike
	Duplicate	200.7 200.8	Not Applicable	6010B 6020	Not Applicable
	Serial Dilution	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % Difference <10% Corrective Action: Flag data associated with unacceptable Serial Dilution	6010B 6020	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: % Difference <10% Corrective Action: Flag data associated with unacceptable Serial Dilution
	Analytical / Post Digestion Spike	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: 75-125% recovery Corrective Action: Flag data associated with unacceptable PDS	6010B 6020	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: 75-125% recovery Corrective Action: Flag data associated with unacceptable PDS

Footnotes

(1) National Pollutant Discharge Elimination System
(2) Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).
(3) RPD-Relative Percent Difference
(4) Orthophosphate only
(5) Method not listed in 40 CFR Part 136.
(6) Current promulgated method is a Guidance Method Only, SW-846, Final Update III, Rev.3, 12/96.
(7) CA Department of Toxic Substances Control, HML 939-M, Determination of Organic Lead Compounds

TABLE 8.4-6
Organic Laboratory Quality Control Samples

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Aromatic Volatiles by GC	Method Blank	602	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	8021B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	602	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Rerun all samples associated with unacceptable LCS	8021B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte must be within laboratory acceptance limits Corrective Action: Rerun all samples associated with unacceptable LCS
	Matrix Spike	602	Frequency: 1 per 10 samples from each site or 1 per month, whichever is more frequent Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable Matrix Spike	8021B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike
	Matrix Spike Duplicate	602	Not Applicable	8021B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike Duplicate
	Duplicate	602	Not Applicable	8021B	Not Applicable

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Aromatic Volatiles by GC (continued)	Surrogates	602	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: All surrogates must be within laboratory established control limits before sample analysis may proceed. Sample Criteria: Re-extract samples or flag sample data not meeting surrogate criteria	8021B	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: All surrogates must be within laboratory established control limits before sample analysis may proceed. Sample Criteria: Reprepare and reanlayze samples or flag sample data not meeting surrogate criteria
	Internal Standards	602	Optional: Internal standards are added to the method blank and all samples (QC included). If used, same compounds as used for surrogates may be appropriate.	8021B	Optional: Internal standards are added to the method blank and all samples (QC included). If used, same compounds as used for surrogates may be appropriate.

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Dissolved Gases in Water	Method Blank	--	Not Applicable	RSK-175[4]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank SOP AUS-GC-0002
	Laboratory Control Sample	--	Not Applicable	RSK-175[4]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte must be within laboratory acceptance limits Corrective Action: Rerun all samples associated with unacceptable LCS SOP AUS-GC-0002
	Matrix Spike	--	Not Applicable	RSK-175[4]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike SOP AUS-GC-0002
	Matrix Spike Duplicate	--	Not Applicable	RSK-175[4]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike Duplicate SOP AUS-GC-0002

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Dissolved Gases in Water (continued)	Duplicate	--	Not Applicable	--	Not Applicable
	Surrogates	--	Not Applicable	--	Not Applicable
	Internal Standards	--	Not Applicable	--	Not Applicable

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Static Headspace	Method Blank	--	Not Applicable	AUS-GC-0002[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank SOP AUS-GC-0002
	Laboratory Control Sample / Laboratory Control Sample Duplicate	--	Not Applicable	AUS-GC-0002[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS/LCSD SOP AUS-GC-0002
	Matrix Spike	--	Not Applicable	AUS-GC-0002[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike SOP AUS-GC-0002
	Matrix Spike Duplicate	--	Not Applicable	AUS-GC-0002[5]	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike Duplicate SOP AUS-GC-0002

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Static Headspace (continued)	Duplicate	--	Not Applicable	--	Not Applicable
	Surrogates	--	Not Applicable	--	Not Applicable
	Internal Standards	--	Not Applicable	--	Not Applicable

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Gasoline Range Organics	Method Blank	--	Not Applicable	8015B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	--	Not Applicable	8015B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte must be within laboratory acceptance limits Corrective Action: Rerun all samples associated with unacceptable LCS
	Matrix Spike	--	Not Applicable	8015B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike
	Matrix Spike Duplicate	--	Not Applicable	8015B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike Duplicate
	Duplicate	--	Not Applicable	8015B	Not Applicable

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Gasoline Range Organics (continued)	Duplicate	--	Not Applicable	--	Not Applicable
	Surrogates	--	Not Applicable	--	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: All surrogates must be within laboratory established control limits before sample analysis may proceed. Sample Criteria: Reprepare and reanlayze samples or flag sample data not meeting surrogate criteria
	Internal Standards	--	Not Applicable	--	Not Applicable

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Glycols and Alcohols by Direct Aqueous Injection GC-FID	Method Blank	--	Not Applicable	8015B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable method blank as per SOP; if samples are analyzed without re-extraction, flag results for contaminant analytes.
	Laboratory Control Sample / Laboratory Control Sample Duplicate	--	Not Applicable	8015B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS/LCSD as per SOP; if samples are analyzed without re-extraction, flag results for failing analytes
	Matrix Spike	--	Not Applicable	8015B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable MS

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Direct Aqueous Injection (continued)	Matrix Spike Duplicate	--	Not Applicable	8015B	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	--	Not Applicable	8015B	Not Applicable
	Surrogates	--	Not Applicable	8015B	Surrogates spiked into method blank and all samples (QC included) Method Blank and LCS Criteria: Results must fall within laboratory-established control limits Sample Criteria: Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria
	Internal Standards	--	--	8015B	Optional

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Pesticides/ PCBs	Method Blank	608	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable method blank as per SOP; if samples are analyzed without re-extraction, flag results for contaminant analytes. SOP AUS-GC-0007	8081A / 8082	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable method blank as per SOP; if samples are analyzed without re-extraction, flag results for contaminant analytes. SOP AUS-GC-0007
	Laboratory Control Sample / Laboratory Control Sample Duplicate	608	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Evaluate individual target analyte results If MS in batch, follow MS corrective action If no MS in batch, re-extract and reanalyze all samples associated with unacceptable LCS/LCSD as per SOP; if samples are analyzed without re-extraction, flag results for failing analytes SOP AUS-GC-0007	8081A / 8082	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: percent recovery for each analyte must be within laboratory acceptance limits Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS/LCSD as per SOP; if samples are analyzed without re-extraction, flag results for failing analytes SOP AUS-GC-0007

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Pesticides/ PCBs (continued)	Matrix Spike	608	Frequency: 1 per 10 samples from each site or 1 per month, whichever is more frequent Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Evaluate individual target analyte results If MS unacceptable, evaluate LCS; if LCS acceptable, data are reported and MS data flagged If LCS also unacceptable, re-extract and reanalyze all associated samples as per SOP; if samples are analyzed without re-extraction, flag results for failing analytes SOP AUS-GC-0007	8081A / 8082	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike SOP AUS-GC-0007
	Matrix Spike Duplicate	608	Not Applicable	8081A / 80882	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable MSD SOP AUS-GC-0007
	Duplicate	608	Not Applicable	8081A / 8082	Not Applicable

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Pesticides/ PCBs (continued)	Surrogates	608	Not specified in method	8081A / 8082	Surrogates spiked into method blank and all samples (QC included) Method Blank Criteria and LCS: Results must fall within laboratory established control limits Sample Criteria: Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria SOP AUS-GC-0007
	Internal Standards	608	Optional	8081A 8082	Optional

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Total Petroleum Hydrocarbons by TCEQ Method TX1005 and TX1006	Method Blank	--	Not Applicable	1005 1006	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable method blank as per SOP; if samples are analyzed without re-extraction, flag results for contaminant analytes.
	Laboratory Control Sample / Laboratory Control Sample Duplicate	--	Not Applicable	1005 1006	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS/LCSD as per SOP; if samples are analyzed without re-extraction, flag results for failing analytes
	Matrix Spike	--	Not Applicable	1005 1006	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable MS

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Total Petroleum Hydrocarbons by TCEQ Method TX1005 (continued)	Matrix Spike Duplicate	--	Not Applicable	1005 1006	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	--	Not Applicable	1005 1006	Not Applicable
	Surrogates	--	Not Applicable	1005 1006	Surrogates spiked into method blank and all samples (QC included) Method Blank and LCS Criteria: Results must fall within laboratory established control limits Sample Criteria: Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria.
	Internal Standards	--	--	1005 1006	Not Applicable

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Petroleum Hydro-carbons / Oil and Grease	Method Blank	1664A	Frequency: 1 with each preparation batch Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	---	---
	Laboratory Control Sample	1664A	Frequency: 1 with each analytical batch Criteria: Waters - See limits in Table 2 of SOP AUS-WC-0004 Corrective Action: Rerun all samples associated with unacceptable LCS	---	---
	Matrix Spike	1664A	Frequency: 1 with every 10 samples per site Criteria: See percent recovery limits in Table 2 of SOP AUS-WC-0004 Corrective Action: See Section 9 of SOP AUS-WC-0004	---	---
	Matrix Spike Duplicate	1664A	Not Applicable	---	---
	Duplicate	1664A	Not Applicable	---	---

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Diesel Range Organics	Method Blank	--	Not Applicable	8015B	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable method blank as per SOP; if samples are analyzed without re-extraction, flag results for contaminant analytes.
	Laboratory Control Sample / Laboratory Control Sample Duplicate	--	Not Applicable	8015B	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS/LCSD as per SOP; if samples are analyzed without re-extraction, flag results for failing analytes
	Matrix Spike	--	Not Applicable	8015B	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable MS

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Diesel Range Organics (continued)	Matrix Spike Duplicate	--	Not Applicable	8015B	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable MSD
	Duplicate	--	Not Applicable	8015B	Not Applicable
	Surrogates	--	Not Applicable	8015B	Surrogates spiked into method blank and all samples (QC included) Method Blank and LCS Criteria: Results must fall within laboratory-established control limits Sample Criteria: Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria
	Internal Standards	--	--	8015B	Optional

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Semivolatiles by GC/MS	Method Blank	625	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable method blank as per SOP; if samples are analyzed without re-extraction, flag results for contaminant analytes SOP AUS-MS-0005	8270C	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Re-extract and reanalyze all samples associated with unacceptable method blank as per SOP; if samples are analyzed without re-extraction, flag results for contaminant analytes SOP AUS-MS-0005
	Laboratory Control Sample / Laboratory Control Sample Duplicate	625	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery must be within acceptance limits given in method for each analyte Corrective Action: Evaluate individual target analyte results If MS in batch, follow MS corrective action If no MS in batch, re-extract and reanalyze all samples associated with unacceptable LCS/LCSD as per SOP; if samples are analyzed without re-extraction, flag results for failing analytes SOP AUS-MS-0005	8270C	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each control analyte must be within laboratory acceptance limits Corrective Action: Re-extract and reanalyze all samples associated with unacceptable LCS/LCSD as per SOP; if samples are analyzed without re-extraction, flag results for failing analytes SOP AUS-MS-0005

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Semivolatiles by GC/MS (continued)	Matrix Spike	625	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each analyte should be within advisory limits given in method Corrective Action: Evaluate individual target analyte results If MS unacceptable, evaluate LCS; if LCS acceptable, data are reported and MS data flagged If LCS also unacceptable, re-extract and reanalyze all associated samples as per SOP; if samples are analyzed without re-extraction, flag results for failing analytes SOP AUS-MS-0005	8270C	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike SOP AUS-MS-0005
	Matrix Spike Duplicate	625	Not Applicable	8270C	Frequency: 1 with each extraction batch of samples not to exceed 20 samples Criteria: Percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike Duplicate SOP AUS-MS-0005
	Duplicate	625	Not Applicable	8270C	Not Applicable

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Semivolatiles by GC/MS (continued)	Surrogates	625	Surrogates spiked into method blank and all samples (QC included) Method Blank and LCS Criteria: All surrogates must be in control before sample analysis may proceed Sample Criteria: Re-extract samples or flag sample data not meeting surrogate criteria SOP AUS-MS-0005	8270C	Surrogates spiked into method blank and all samples (QC included) Method Blank and LCS Criteria: All surrogates must be in control before sample analysis may proceed Sample Criteria: Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria SOP AUS-MS-0005
	Internal Standards	625	Frequency: Internal standards spiked into method blank and all samples (QC included) Criteria: All internal standard recoveries must be within laboratory control limits Corrective Action: Flag sample data not meeting internal standard recovery requirements SOP-AUS-MS-0005	8270C	Internal Standards are added to all samples (QC samples included); internal standard area of daily standard must be within 50% to 200% of the response in the mid level of the initial calibration standard The retention time (RT) for any internal standard (IS) in the continuing calibration must not exceed ± 0.5 minutes from mid level initial calibration standard IS RT SOP-AUS-MS-0005

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Volatiles by GC/MS	Method Blank	624	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	8260B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank, see SOP AUS-MS-0004
	Laboratory Control Sample / Laboratory Control Sample Duplicate	624	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable Matrix Spike	8260B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery for each analyte must be within laboratory acceptance limits Corrective Action: Rerun all samples associated with unacceptable LCS/LCSD, see SOP AUS-MS-0004
	Matrix Spike	624	Frequency: 1 per ≤ 20 samples from each site or 1 per month, whichever is more frequent Criteria: percent recovery for each analyte should be within advisory limits given in method Corrective Action: Flag data associated with unacceptable Matrix Spike	8260B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: flag data associated with unacceptable Matrix Spike, see SOP AUS-MS-0004
	Matrix Spike Duplicate	624	Not Applicable	8260B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike Duplicate, see SOP AUS-MS-0004

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Analysis	QC Sample	Method	NPDES[1]	Method	RCRA (SW846) [2]
Volatiles by GC/MS (continued)	Duplicate	624	Not Applicable	8260B	Not Applicable
	Surrogates	624	Surrogates spiked into Method Blank and all samples (QC included) Method Blank Criteria: All surrogates must be in control before sample analysis may proceed. Sample Criteria: Re-extract samples or flag sample data not meeting surrogate criteria	8260B	Surrogates spiked into Method Blank and all samples (QC included) Method Blank Criteria and LCS: All surrogates must be in control before sample analysis may proceed. Sample Criteria: Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria, see SOP AUS-MS-0004
	Internal Standards	624	Frequency: Internal standards spiked into method blank and all samples (QC included) Criteria: All internal standard recoveries must be within laboratory control limits Corrective Action: Flag sample data not meeting internal standard recovery requirements	8260B	Internal Standards are added to all samples (QC samples included). Internal standard area of daily standard must be within 50% to 200% of the response in the mid level of the initial calibration standard. The retention time (RT) for any internal standard (IS) in the continuing calibration must not exceed ± 0.5 minutes from mid level initial calibration standard IS RT.

TABLE 8.4-6
Organic Laboratory Quality Control Samples
(Continued)

Footnotes

(1) National Pollutant Discharge Elimination System

(2) Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).

(3) Method not listed in 40 CFR Part 136.

(4) Method not listed in SW-846; method developed by Robert S. Kerr Environmental Research Lab, Ada OK, RSKSOP-175.

(5) Method not listed in SW-846.

TABLE 8.4-7
Volatile Organic Canisters Laboratory Quality Control Samples

Analysis	QC Sample	Method	CAA[1]
Total Non-Methane Hydrocarbons (TNMHC) by GC	Method Blank	TO12	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration of TNMHC must be less than limit specified in AUS-VA-0009 Corrective Action: Repeat blank analysis; if contamination still present, investigate and take measures to correct, minimize or eliminate problem If contamination is less than 1/10 of the measured concentration of THMHC of any sample, data may be flagged and reported in consultation with client; file NCM
	Laboratory Control Sample / Laboratory Control Sample Duplicate	TO12	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte must be within laboratory acceptance limits; RPD[2] within lab limits Corrective Action-Accuracy: Evaluate calibration verification; if acceptable recovery, proceed with analysis If calibration verification recovery unacceptable, stop and correct problem If samples are reported without reanalysis, data may be flagged for failing analytes and reported in consultation with client; file NCM Corrective Action-Precision: Analyze a third LCS; if RPDs between the third LCS and either the LCS or LCSD are within acceptance limits, proceed with analysis If RPDs are still out, stop and correct problem If samples are reported without reanalysis, data may be flagged for failing analytes and reported in consultation with client; file NCM
	Matrix Spike	TO12	Not Applicable
	Matrix Spike Duplicate	TO12	Not Applicable
	Duplicate	TO12	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: TNMHC % RPD[2] $\leq$30% Corrective Action: Repeat analysis; report as per SOP; file NCM
	Surrogates	TO12	Not Applicable
	Internal Standards	TO12	Not Applicable

TABLE 8.4-7
Volatile Organic Canisters Laboratory Quality Control Samples (continued)

Analysis	QC Sample	Method	CAA[1]
Fixed Gases TCD by GC	Method Blank	ASTM D1946-90	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration for all analytes must be less than limit specified in AUS-VA-0008 Corrective Action: Repeat blank analysis; if contamination still present, investigate and take measures to correct, minimize or eliminate problem If contamination is less than 1/10 of the measured concentration of any sample, data may be flagged and reported in consultation with client; file NCM
	Laboratory Control Sample / Laboratory Control Sample Duplicate	ASTM D1946-90	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte must be within laboratory acceptance limits; RPD[2] within lab limits Corrective Action-Accuracy: Evaluate calibration verification; if acceptable recovery, proceed with analysis If calibration verification recovery unacceptable, stop and correct problem If samples are reported without reanalysis, data may be flagged for failing analytes and reported in consultation with client; file NCM Corrective Action-Precision: Analyze a third LCS; if RPDs between the third LCS and either the LCS or LCSD are within acceptance limits, proceed with analysis If RPDs are still out, stop and correct problem If samples are reported without reanalysis, data may be flagged for failing analytes and reported in consultation with client; file NCM
	Matrix Spike	ASTM D1946-90	Not Applicable
	Matrix Spike Duplicate	ASTM D1946-90	Not Applicable
	Duplicate	ASTM D1946-90	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: RPD[2] $\leq$30% for all analytes with concentration > RL Corrective Action: Repeat analysis; report as per SOP; file NCM
	Surrogates	ASTM D1946-90	Not Applicable
	Internal Standards	ASTM D1946-90	Not Applicable

TABLE 8.4-7
Volatile Organic Canisters Laboratory Quality Control Samples (continued)

Analysis	QC Sample	Method	CAA[1]
C1-C3 Hydrocarbons by GC-FID	Method Blank	TO14A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration for all analytes must be less than limit specified in AUS-VA-0007 Corrective Action: Repeat blank analysis; if contamination still present, investigate and take measures to correct, minimize or eliminate problem If contamination is less than 1/10 of the measured concentration of any sample, data may be flagged and reported in consultation with client; file NCM
	Laboratory Control Sample / Laboratory Control Sample Duplicate	TO14A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte must be within laboratory acceptance limits; RPD[2] within lab limits Corrective Action-Accuracy: If one or more analytes are outside the established control limits for either the LCS or LCSD, check calculation, check instrument performance, and reanalyze the LCS and/or the LCSD. If not resolved, contact the PM for a decision whether to proceed. Corrective Action-Precision: Check calculations and check the instrument performance. If RPDs are still out but both accuracy recoveries are within acceptance criteria, prepare a NCM and qualify the data.
	Matrix Spike	TO14A	Not Applicable
	Matrix Spike Duplicate	TO14A	Not Applicable
	Duplicate	TO14A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: RPD[2] $\leq$30% for all analytes with concentrations > RL Corrective Action: Repeat analysis; report as per SOP; file NCM
	Surrogates	TO14A	Not Applicable
	Internal Standards	TO14A	Not Applicable

TABLE 8.4-7
Volatile Organic Canisters Laboratory Quality Control Samples (continued)

Analysis	QC Sample	Method	CAA[1]
Ambient Air by GC/MS	Method Blank	TO15	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration for all analytes must be less than limit specified in AUS-VA-0007 Corrective Action: Repeat blank analysis; if contamination still present, investigate and take measures to correct, minimize or eliminate problem If contamination is less than 1/10 of the measured concentration of any sample, data may be flagged and reported in consultation with client; file NCM
	Laboratory Control Sample / Laboratory Control Sample Duplicate	TO15	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery for each analyte must be within laboratory acceptance limits; RPD[2] within lab limits Corrective Action-Accuracy: If one or more analytes are outside the established control limits for either the LCS or LCSD, check calculation, check instrument performance, and reanalyze the LCS and/or the LCSD. If not resolved, contact the PM for a decision whether to proceed. Corrective Action-Precision: Check calculations and check the instrument performance. If RPDs are still out but both accuracy recoveries are within acceptance criteria, prepare a NCM and qualify the data.
	Matrix Spike	TO15	Not Applicable
	Matrix Spike Duplicate	TO15	Not Applicable
	Duplicate	TO15	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Four largest non-polar target analytes present $\geq$ RL must have RPD[2] $\leq$25% Corrective Action: Repeat analysis; flag results and report as per SOP; file NCM
	Surrogates	TO15	Frequency: 5 surrogate compounds added to all samples (QC included) Criteria: Percent recovery for each surrogate must be within laboratory acceptance limits Corrective Action: Repeat analysis; flag results and report as per SOP; file NCM

TABLE 8.4-7
Volatile Organic Canisters Laboratory Quality Control Samples (continued)

Analysis	QC Sample	Method	CAA[1]
Ambient Air by GC/MS	Internal Standards	TO15	Frequency: 2 internal standards compounds added to all samples (QC included) Criteria: IS area counts must be within 50% to 200% of the area counts in the calibration verification; calibration verification IS area counts must be within 50% to 200% of the area counts in the mid-level initial calibration standard Corrective Action: Repeat analysis; report as per SOP; file NCM

Footnotes

(1) Clean Air Act
(2) RPD-Relative Percent Difference

TABLE 8.4-8
Inorganic Filter Laboratory Quality Control Samples

Analysis	Method	QC Sample	Frequency	Criteria	Corrective Action
PM-10	40CFR50 App. J and App. B (Particulate)	Balance Zero Check	Prior to every filter weighing.	± 5mg of zero	Reweigh filters since last acceptable zero check
		Filter Tare Weight Check	Re-weigh every 10th filter ending with a Filter QC Check.	Within 2.8 mg	Re-weigh tare for all associated filters
		Exposed Filter Weight Check	Re-weigh every 10th filter ending with a Filter QC Check.	Within 5 mg	Re-weigh all associated filters

TABLE 8.5-1
Inorganic Sample Containers, Preservatives, and Holding Times

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3], [7]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method	Requirements
Acidity	Water	100 mL	305.1	250 mL plastic or glass, Cool, 4°C, 14 days	---	Not Applicable
	Solid[5]	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Alkalinity	Water	100 mL	310.1 2320B	250 mL plastic or glass, Cool, 4°C, 14 days	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Ammonia	Water	400 mL	350.1	500 mL plastic or glass, Cool, 4°C H_2SO_4 to pH < 2, 28 days	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Biochemical Oxygen Demand (BOD)	Water	200 mL	405.1	1000 mL plastic or glass, Cool, 4°C 48 hours	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Bromide	Water	100 mL	300.0[7] 320.1 ASTM D1246-88	250 mL plastic or glass, No preservative required, 28 days	9056	Cool, 4°C, analyze ASAP after collection
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Chemical Oxygen Demand (COD)	Water	100 mL	410.1 410.2 410.4	250 mL glass or plastic, Cool, 4°C, H_2SO_4 to pH < 2, 28 days	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable

TABLE 8.5-1
Inorganic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3], [7]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method	Requirements
Chloride	Water	50 mL	300.0[7] 325.1 325.2 325.3 4500 Cl E	250 mL plastic or glass, No preservative required, 28 days	9056 9251 9253	Method 9056: Cool, 4°C, analyze ASAP after collection. Method 9251/9253: 250ml plastic or glass, no preservative required, 28 days
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Chlorine, Residual	Water	100 mL	330.1 330.3	250 mL glass or plastic, Cool, 4°C, analyze immediately	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Chromium (Cr^{+6})	Water	100 mL	218.4 218.6 3500 Cr-D	Method 218.4, 218.6: 200 mL plastic or glass, Cool, 4°C, 24 hours Method 3500 Cr-D: 200 mL quartz, TFE, or polypropylene HNO_3 to pH <2 Cool, 4°C Analyze ASAP after collection, within 24 hrs	7196A 7199	200 mL plastic or glass, Cool, 4°C, 24 hours
	Solid	Not Applicable	---	Not Applicable	3060A/ 7196A	250 mL plastic or glass, 30 days to digestion, 96 hours after digestion
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Color	Water	100 mL	110.2	250 mL plastic or glass, Cool, 4°C, 48 hours	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable

TABLE 8.5-1
Inorganic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3], [7]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method	Requirements
Conductivity	Water	100 mL	120.1	200 mL glass or plastic, Cool, 4°C, 28 days	9050A	200 mL glass or plastic, Cool, 4°C, 24 hours
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Cyanide (Amenable)	Water	IL	335.1	1 liter plastic or glass, NaOH to pH >12 0.6g ascorbic acid[6] Cool, 4°C, 14 days unless sulfide is present. Then maximum holding time is 24 hours	9010B 9012A	1 liter plastic or glass, NaOH to pH >12 0.6g ascorbic acid[6] Cool, 4°C, 14 days
	Solid	50g	---	Not Applicable	9010B 9012A	Not Specified
	Waste	50g	---	Not Applicable	9010B 9012A	Not Specified
Cyanide (Total)	Water	IL	335.1 335.2 335.3 4500 CN^- D	1 liter plastic or glass, NaOH to pH >12 0.6g ascorbic acid[6] Cool, 4°C, 14 days unless sulfide is present. Then maximum holding time is 24 hours	9010B 9012A	1 liter plastic or glass, NaOH to pH >12 0.6g ascorbic acid[6] Cool, 4°C, 14 days
	Solid	50g	--	Not Applicable	9010B 9012A	8 or 16 oz glass Teflon-lined lids, Cool, 4°C, 14 days
	Waste	50g	--	Not Applicable	9010B 9012A	8 or 16 oz glass Teflon-lined lids, Cool, 4°C
Flashpoint (Ignitability)	Liquid	Not Applicable	---	Not Applicable	1010 1020A	No requirements, 250 mL amber glass, Cool, 4°C is recommended
	Solid	Not Applicable	--	Not Applicable	---	Not Applicable
	Waste	Not Applicable	--	Not Applicable	---	Not Applicable

TABLE 8.5-1
Inorganic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3], [7]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method	Requirements
Fluoride	Water	300 mL	300.0[7] 340.2	500 mL plastic, No preservation required, 28 days	9056	Cool, 4°C, analyze ASAP after collection
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Hardness (Total)	Water	50 mL	130.2 2340B	250 mL glass or plastic, HNO_3 to pH < 2, 6 months	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Iodide	Water	100 mL	345.1 Dionex	100 mL plastic or glass, Cool, 4°C, 24 hours		Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Iron (Ferrous)	Water	100 mL	3500-Fe D	1 liter glass or polyethylene container, 6 months **This test should be performed in the field.**	-	Not Applicable
	Solid	Not Applicable	-	Not Applicable	-	Not Applicable
	Waste	Not Applicable	-	Not Applicable	-	Not Applicable
Methylene Blue Active Substances (MBAS) (Surfactant)	Water	100 mL	425.1	250 mL plastic or glass, Cool, 4°C, 48 hours	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable

TABLE 8.5-1
Inorganic Sample Containers, Preservatives, and Holding Times
(Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3], [7]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method	Requirements
Nitrate	Water	100 mL	300.0[7] 353.2	Method 300.0: 250 mL plastic or glass, Cool, 4°C, 48 hours. Method 352.1: 250 mL plastic or glass, Cool, 4°C, 48 hours.	9056	Method 9056: Cool, 4°C, analyze ASAP after collection Method 9210: Cool, 4°C Preserve by adding 1 mL of 1M boric acid solution per 100 mL of sample
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Specified
Nitrite	Water	50 mL	300.0[7] 354.1	250 mL plastic or glass Cool, 4°C, 48 hours	9056	Cool, 4°C, analyze ASAP after collection
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Nitrate-Nitrite	Water	100 mL	353.1 353.2 353.3	250 mL plastic or glass, H_2SO_4 to pH < 2, 28 days	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Ortho-phosphate	Water	50 mL	300.0[7] 365.1 365.2 365.3 365.4	100 mL plastic or glass, Filter on site Cool, 4°C, 48 hours	9056	Cool, 4°C, analyze ASAP collection
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
pH	Water	50 mL	150.1 4500-H^+ B	100 mL plastic or glass. Analyze immediately. **This test should be performed in the field.**	9040B	100 mL plastic or glass. Analyze immediately. **This test should be performed in the field.[8]**
	Solid	Not Applicable	---	Not Applicable	9045C	4 oz glass or plastic, Cool, 4°C, Analyze as soon as possible.[8]

TABLE 8.5-1
Inorganic Sample Containers, Preservatives, and Holding Times
(Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3], [7]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method	Requirements
pH (continued)	Waste	Not Applicable	---	Not Applicable	9045C	4 oz glass or plastic, Cool, 4°C, Analyze as soon as possible.[8]
Phenolics	Water	100 mL	420.1 420.2	500 mL glass, Cool, 4°C, H_2SO_4 to pH < 2, 28 days	9065 9066	1 liter glass recommended, Cool, 4°C, H_2SO_4 to pH < 4, 28 days
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	9065	Not Specified
Phosphorus (Total)	Water	50 mL	365.1 365.2 365.3 365.4	100 mL plastic or glass, H_2SO_4 to pH < 2, 28 days	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Odor	Water	IL	140.1	200 mL glass only, Cool, 4°C, 24 hours		Not Applicable
	Solid	Not Applicable	--	Not Applicable	---	Not Applicable
	Waste	Not Applicable	--	Not Applicable	---	Not Applicable
Settleable Solids	Water	1000 mL	160.5	1000 mL plastic or glass, Cool, 4°C, 48 hours	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Silica, Dissolved	Water	50 mL	370.1	Plastic only, 100 mL, Cool, 4°C, 28 days	---	Not Applicable
	Solid Waste	Not Applicable Not Applicable	--- ---	Not Applicable Not Applicable	--- ---	Not Applicable Not Applicable
Specific Conductance	Water	50 mL	120.1	250 mL plastic or glass, Cool, 4°C, 24 hours	9050A	250 mL plastic or glass, Cool, 4°C, 28 days
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable

TABLE 8.5-1
Inorganic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3], [7]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method	Requirements
Sulfate (SO_4)	Water	100 mL	300.0[7] 375.1 375.4	100 mL plastic or glass, Cool, 4°C, 28 days	9056 9038	Method 9056: Cool, 4°C, analyze ASAP collection Method 9038: 200 mL plastic or glass, Cool, 4°C, 28 days
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	100 mL	---	Not Applicable	9038	200 mL plastic or glass, Cool, 4°C, 28 days
Sulfide	Water	100 mL	376.1	500 mL plastic or glass, Cool, 4°C, Add 2 mL zinc acetate plus NaOH to pH > 9, 7 days	9030B 9034	500 mL plastic, no headspace, Cool, 4°C, Add 4 drops of 2N zinc acetate per 100 mL of sample, adjust the pH to > 9 with 6 N NaOH solution, 7 days
	Solid	50 g	---	Not Applicable	9030B 9034	Cool, 4°C, fill surface of solid with 2N Zinc acetate until moistened, store headspace-free
	Waste	50 g	---	Not Applicable	9030B 9034	Cool, 4°C, fill surface of solid with 2N Zinc acetate until moistened, store headspace-free

TABLE 8.5-1
Inorganic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3], [7]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method	Requirements
Sulfite (SO_3)	Water	100 mL	377.1	100 mL plastic or glass, No preservative required, analyze immediately **This test should be performed in the field.**	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Temperature	Water	200 mL	170.1	1 liter plastic or glass, **analyze immediately in the field**	---	Not Applicable
	Solid	Not Applicable	--	Not Applicable	--	Not Applicable
	Waste	Not Applicable	--	Not Applicable	--	Not Applicable
Total Dissolved Solids (Filterable)	Water	100 mL	160.1	250 mL plastic or glass, Cool, 4°C, 7 days	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Total Kjeldahl Nitrogen (TKN)	Water	500 mL	351.2 351.3	500 mL plastic or glass, Cool, 4°C, H_2SO_4 to pH < 2, 28 days	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Total Organic Carbon (TOC)	Water	100 mL	415.1	100 mL plastic or glass, Cool, 4°C, H_2SO_4 to pH < 2, 28 days	9060	100 mL glass or 40 mL VOA vials, Cool, 4°C, H_2SO_4 or HCl to pH < 2, 28 days
	Solid	10 g	Walkley-Black[7]	Not Applicable	9060	Not Specified
	Waste	Not Applicable	---	Not Applicable	9060	Not Specified

TABLE 8.5-1
Inorganic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3], [7]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method	Requirements
Total Organic Halides (TOX)	Water	100 mL	5320B [7] 450.1 [7]	Method 5320B: 500 mL amber glass, Teflon®-lined lid, Cool, 4°C, HNO_3 to pH <2, no headspace, 14 days Method 450.1: 500 mL amber glass, Teflon®-lined lid, Cool, 4°C, HNO_3 to pH <2, no headspace, 28 days	9020B	500 mL amber glass, Teflon®-lined lid, Cool, 4°C, H_2SO_4 to pH < 2, no headspace, 28 days
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Total Solids	Water	100 mL	160.3	250 mL plastic or glass, Cool, 4°C, 7 days	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Total Suspended Solids (Nonfilterable)	Water	100 mL	160.2	250 mL plastic or glass, Cool, 4°C, 7 days	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Turbidity	Water	50 mL	180.1	250 mL plastic or glass, Cool, 4°C, 48 hours	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Volatile Solids	Water	100 mL	160.4	250 mL plastic or glass, Cool, 4°C, 7 days	---	Not Applicable
	Solid	Not Applicable	---	Not Applicable	---	Not Applicable
	Waste	Not Applicable	---	Not Applicable	---	Not Applicable
Moisture	Water	Not Applicable	---	Not Applicable	---	Not Applicable
	Solid	10 g	---	Refer to specific method used	---	Refer to specific method used
	Waste	10 g	---	Refer to specific method used	---	Refer to specific method used

TABLE 8.5-1
Inorganic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3], [7]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method	Requirements
Metals (excludes Hg and Organic Lead)	Water	100 mL	200 series	1 liter glass or polyethylene container, HNO_3 to pH $\leq$ 2, 6 months	6010B, 6020, 7000A series	1 liter glass or polyethylene container, HNO_3 to pH $\leq$ 2, 6 months
	Solid	200 g	200 series	8 or 16 oz glass or polyethylene container storage at 4 °C	6010B, 6020, 7000A series	8 or 16 oz glass or polyethylene container, storage at 4°C, 6 months
	Waste	200 g	200 series	Not Applicable	6010B, 6020, 7000A series	8 or 16 oz glass or polyethylene container, storage at 4°C, 6 months
Mercury (CVAA)	Water	100 mL	245.1	1 liter glass or polyethylene container, HNO_3 to pH $\leq$ 2, 28 days	7470A	1 liter glass or polyethylene container, HNO_3 to pH $\leq$ 2, 28 days
	Solid	200 g	245.5	8 or 16 oz glass or polyethylene container, Cool, 4°C, 28 days	7471A	8 or 16 oz glass or polyethylene container, Cool, 4°C, 28 days (CORP-MT-0007)
	Waste	200 g	--	Not Applicable	7471A	8 or 16 oz glass or polyethylene container, Cool, 4°C, 28 days (CORP-MT-0007)
Organic Lead (GFAA)	Water	500 mL	--		HML 939-M[9]	500-mL amber glass bottles with Teflon-lined caps without headspace, storage at 4°C, 14 days

TABLE 8.5-1
Inorganic Sample Containers, Preservatives, and Holding Times
(Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3], [7]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method	Requirements
Organic Lead (GFAA) (continued)	Solid	4-ounce	--	Not Applicable	HML 939-M[9]	4-oz. amber glass jars with airtight, Teflon-lined lids, storage at 4°C, 14 days
	Waste	Not Applicable	--	Not Applicable	--	Not Applicable

Footnotes

(1) Minimum sample size indicates sample amount needed for a single analysis. Matrix spikes or duplicates will require an additional sample amount of at least this amount for each additional QC sample aliquot required.
(2) National Pollutant Discharge Elimination System - MCAWW, March 1983.
(3) Holding times are calculated from date of collection.
(4) Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA, (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).
(5) Solid matrix type includes soil, sediment, sludge and other solid materials not classified as waste.
(6) Samples to be analyzed for cyanide should be field-tested for residual chlorine. If residual chlorine is detected, ascorbic acid should be added.
(7) Method not listed in 40 CFR Part 136.
(8) If not done in the field (ASAP) per the method and requested by client, analyze in lab within 48 hours.
(9) California HML Method 939-M “Determination of Organic Lead Compounds by Graphite Furnace Atomic Absorption Spectrometry”, Revision No. 5, 6/10/02.

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
Direct Aqueous Injection	Water	40 mL	---	Not Applicable	8015B	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace, Cool, 4°C, 14 days..
	Solid	5 g	---	Not Applicable	8015B	4 or 8 oz. glass with Teflon-lined lid, Cool 4°C, 14 days.
	Waste	5 g	---	Not Applicable	8015B	4 or 8 oz. glass with Teflon-lined lid, Cool 4°C, 14 days.
DRO/GRO	Water	40 mL	---	Not Applicable	8015B	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace, Cool, 4°C, 14 days..
	Solid		---	Not Applicable	8015B	4 or 8 oz. glass with Teflon-lined lid, Cool 4°C, 14 days.
	Waste		---	Not Applicable	8015B	4 or 8 oz. glass with Teflon-lined lid, Cool 4°C, 14 days.
Aromatic Volatiles	Water	40 mL	602	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace, Cool, 4°C, Add sodium thiosulfate if residual chlorine, 7 days with pH > 2, 14 days with pH $\leq$ 2	8021B	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace, Cool, 4°C, Add sodium thiosulfate if residual chlorine, 1:1 HCl to pH $\leq$ 2, 14 days with pH $\leq$ 2
	Solid[5]	5 g or 25 g	---	Not Applicable	8021B	4 or 8 oz glass with Teflon®-lined lid, Cool 4 °C, 14 days. Field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis. Soil sample can also be

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
						taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for Encore Sampler is 48 hours (before the sample is added to methanol or sodium bisulfate). Cool, 4°C (See Note 12 Page 136 for holding time.)
	Waste	5 g or 25 g	--	Not Applicable	8021B	4 or 8 oz glass with Teflon®-lined lid, Cool 4 °C, 14 days. Field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis.

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	Method	NPDES[2], [3]		RCRA (SW846)[3], [4]
				Requirements	Method[6]	Requirements
Aromatic Volatiles (continued)	Waste	5 g or 25 g	--	Not Applicable	8021B	Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for Encore Sampler is 48 hours (before the sample is added to methanol or sodium bisulfate). Cool, 4°C. (See Footnote 12 for holding time.)
Acrolein & Acrylonitrile by GC	Water	40 mL	603	Glass with Teflon®-lined septum, Cool, 4 °C (± 2°C), 0.008% $Na_2S_2O_3$[11], Adjust pH 4-5[8] 14 days	8031 (Acrylo-nitrile only)	Glass with Teflon®-lined septum, Cool, 4 °C (± 2°C), 0.008% $Na_2S_2O_3$[11], Adjust pH 4-5[8] 14 days
	Solid	-	-	Not Applicable	-	Not Applicable
	Waste	-	-	Not Applicable	-	Not Applicable
Dioxins/ Dibenzo-furans (LRMS)	Water	1L	613	1 liter amber glass with Teflon®-lined lid, Cool, 4°C, Extraction, 7 days Analysis, 40 days	8280A	1 liter glass amber with Teflon®-lined lid, Cool 4°C, if residual chlorine is present in aqueous samples, add 80 mg of sodium thiosulfate per liter of sample, if sample pH >9, adjust to pH 7-9 with H_2SO_4, Extract within 30 days Analyze within 45 days of extraction
	Solid	10 g	--	Not Applicable	8280A	8 or 16 oz glass amber wide mouth with Teflon®-lined lid, Cool 4°C, Extract within 30 days Analyze within 45 days of extraction

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
Dioxins/ Dibenzo-furans (LRMS) (continued)	Waste	10 g	--	Not Applicable	8280A	8 or 16 oz glass amber wide mouth with Teflon®-lined lid, Cool 4°C, Extract within 30 days and Analyze within 45 days of extraction
	Water	1L	613	1 liter amber glass with Teflon®-lined lid, Cool, 4°C, Extraction, 7 days Analysis, 40 days	--	Not Applicable
	Solid	10 g	--	Not Applicable	--	Not Applicable
	Waste	10 g	--	Not Applicable	--	Not Applicable
Dioxins/Dibenzo -furans (HRGC/HRMS)	Water	I L	1613B	1.1 liter amber glass w/fluoropolymer-lined screw cap. Add sodium thiosulfate if residual chlorine. If pH > 9, H_2SO_4 to pH 7-9. Cool, 0-4°C in the dark. Extraction, 1 year. Analysis, 1 year.	8290	1 liter glass amber with Teflon®-lined lid, Cool, 4°C, Extraction, 30 days Analysis, 45 days from date of extraction
	Solid	10g	1613B	500 mL amber wide, mouth, glass w/fluoropolymer-lined screw cap. Cool, <4°C in the dark until receipt in Lab, then <-10°C in the dark. Extraction, 1 year. Analysis, 1 year.	8290	8 or 16 oz glass amber wide mouth with Teflon®-lined lid, Cool, 4°C, Extraction, 30 days Analysis, 45 days from date of extraction

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
Dioxins/Dibenzo -furans (HRGC/HRMS) (continued)	Waste	10g	1613B	500 mL amber wide, mouth, glass w/fluoropolymer-lined screw cap. Cool, <4°C in the dark until receipt in Lab, then <-10°C in the dark. Extraction, 1 year. Analysis, 1 year.	8290	8 or 16 oz glass amber wide mouth with Teflon®-lined lid, Cool, 4°C, Extraction, 30 days Analysis, 45 days from date of extraction
PCBS By HRGC/HRMS	Water	1 L	1668	1.1 liter amber glass w/fluoropolymer-lined screw cap. Add sodium thiosulfate if residual chlorine. H_2SO_4 to pH 2-3. Cool, 0-4°C in the dark. Extraction, 1 year. Analysis, 1 year.	--	Not Applicable
	Solid	10g	1668	500 mL amber wide, mouth, glass w/fluoropolymer-lined screw cap. Cool, <4°C in the dark until receipt in Lab, then <-10°C in the dark. Extraction, 1 year. Analysis, 1 year.	--	Not Applicable
	Waste	10g	1668	500 mL amber wide, mouth, glass w/fluoropolymer-lined screw cap. Cool, <4°C in the dark until receipt in Lab, then <-10°C in the dark. Extraction, 1 year. Analysis, 1 year.	--	Not Applicable

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times
(Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
Halogenated Volatiles By GC	Water	40 mL	--	Not Applicable	8021B	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace, Cool, 4°C, Add sodium thiosulfate if residual chlorine, 1:1 HCl to pH $\leq$ 2, 14 days
	Solid[5]	5 g or 25 g	--		8021B	4 or 8 oz glass with Teflon®-lined lid, Cool 4 °C, 14 days. Field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for Encore Sampler is 48 hours (before the sample is added to methanol or sodium bisulfate). Cool, 4°C. (See Footnote 12 for holding time.)

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
Halogenated Volatiles (continued)	Waste	5 g or 25 g	--	Not Applicable	8021B	4 or 8 oz glass with Teflon®-lined lid, Cool 4 °C, 14 days. Field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for Encore Sampler is 48 hours (before the sample is added to methanol or sodium bisulfate). Cool, 4°C. (See Footnote 12 for holding time.)
Herbicides	Water	1L	615 [10]	1 liter amber glass with Teflon®-lined lid, Sodium thiosulfate or ascorbic acid if residual chlorine present, Cool, 4°C, Extraction, 7 days Analysis, 40 days after extraction	8151A	1 liter amber glass with Teflon®-lined lid. If residual chlorine present, add 3 mL sodium thiosulfate per gallon. Cool, 4°C, Extraction, 7 days Analysis, 40 days of the start of the extraction
	Solid	50 g	--	Not Applicable	8151A	4 or 8 oz glass wide-mouth with Teflon®-lined lid, Cool 4 °C, Extraction, 14 days Analysis, 40 days of the start of the extraction

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
Herbicides (continued)	Waste	50 g	--	Not Applicable	8151A	4 or 8 oz glass widemouth with Teflon®-lined lid. Cool 4 °C Extraction, 14 days Analysis, 40 days of the start of the extraction
Nitroaromatics	Water	1L	--	Not Applicable	8330	1 liter amber glass with Teflon®-lined lid. If residual chlorine present, add 3 mL sodium thiosulfate per gallon. Cool, 4°C, Extraction, 7 days Analysis, 40 days of the start of the extraction
	Solid	50 g	---	Not Applicable	8330	4 or 8 oz glass widemouth with Teflon®-lined lid Cool, 4°C, Extraction, 14 days Analysis, 40 days of the start of the extraction
	Waste	50 g	---	Not Applicable	8330	4 or 8 oz glass widemouth with Teflon®-lined lid Cool, 4 °C, Extraction, 4 days Analysis, 40 days of the start of the extraction
Organo-phosphorus Pesticides	Water	1L	---	Not Applicable	8141A	1 liter amber glass with Teflon®-lined lid. If residual chlorine present, add 3 mL sodium thiosulfate per gallon. Cool, 4°C, Extraction, 7 days Analysis, 40 days of the start of the extraction

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times
(Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
Organo-phosphorus Pesticides (continued)	Solid	50 g	---	Not Applicable	8141A	4 or 8 oz glass widemouth with Teflon®-lined lid. Cool, 4°C, Extraction, 14 days Analysis, 40 days of the start of the extraction
	Waste	50 g	---	Not Applicable	8141A	4 or 8 oz glass widemouth with Teflon®-lined lid. Cool, 4°C, Extraction, 14 days Analysis, 40 days of the start of the extraction
PAHs by GC and HPLC	Water	1L	610	1 liter amber glass with Teflon®-lined lid, Adjust pH to 5-9 if extraction not to be done within 72 hours of sampling. Add sodium thiosulfate if residual chlorine present. Cool, 4°C, Extraction, 7 days Analysis, 40 days after extraction	8100 8310	1 liter amber glass with Teflon®-lined lid. If residual chlorine present, add 3 mL sodium thiosulfate per gallon, Cool, 4°C, Extraction, 7 days Analysis, 40 days of the start of the extraction
	Solid	50 g	---	Not Applicable	8100 8310	4 or 8 oz glass wide mouth with Teflon®-lined lid, Cool, 4°C, Extraction, 14 days Analysis, 40 days of the start of the extraction

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times
(Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
PAHs by GC and HPLC (continued)	Waste	50 g	---	Not Applicable	8100 8310	4 or 8 oz glass wide mouth with Teflon®-lined lid, Cool, 4°C Extraction, 14 days Analysis, 40 days of the start of the extraction
Pesticides/ PCBs	Water	1L	608	1 liter amber glass with Teflon®-lined lid, Adjust pH to 5-9 if extraction not to be done within 72 hours of sampling. Add sodium thiosulfate if residual chlorine present and aldrin is being determined. Cool, 4°C, Extraction, 7 days Analysis, 40 days after extraction	8081A 8082	1 liter amber glass with Teflon®-lined lid, If residual chlorine present, add 3 mL 10% sodium thiosulfate per gallon, Cool, 4°C, Extraction, 7 days Analysis, 40 days of the start of the extraction
	Solid	50 g	---	Not Applicable	8081A 8082	4 or 8 oz glass wide mouth with Teflon®-lined lid, Cool, 4°C, Extraction, 14 days Analysis, 40 days of the start of the extraction
	Waste	50 g	---	Not Applicable	8081A 8082	4 or 8 oz glass wide mouth with Teflon®-lined lid, Cool, 4°C Extraction, 14 days Analysis, 40 days of the start of the extraction

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times (Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
Petroleum Hydrocarbons/ Oil and Grease	Water	1L	413.1 413.2 418.1	1 liter glass, Cool, 4°C, HCl to pH <2, 28 days	9070	1 liter glass with Cool, 4°C, HCl to pH <2, 28 days
	Solid	---	---	Not Applicable	9071A	8 oz. glass with Teflon®-lined lid, Holding Time not specified
	Waste	---	---	Not Applicable	9071A	8 oz. glass with Teflon®-lined lid, Holding Time not specified
	Water	1 L	1664[7]	1 liter glass, Cool, 0-4°C HCl or H_2SO_4 to pH <2 28 days	---	---
	Solid	30 g	1664[7]	8 or 16 oz. wide mouth glass jar, Cool, 0-4°C, 28 days	---	---
	Waste	---	---	Not Applicable	---	---
Purgeable Halocarbons By GC	Water	40 mL	601	40 mL glass VOA vial (in triplicate) with Teflon®-lined septa with no headspace, Cool, 4°C, Add sodium thiosulfate if residual chlorine present, 14 days	8021B	40 mL glass VOA vial (in triplicate) with Teflon®-lined septa with no headspace, Cool, 4°C, 1:1 HCl to pH $\leq$ 2, sodium thiosulfate if residual chlorine present, 14 days

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times
(Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
Purgeable Halocarbons By GC (continued)	Solid	5 g or 25 g	---	Not Applicable	8021B	Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for Encore Sampler is 48 hours (before the sample is added to methanol or sodium bisulfate). Cool, 4°C. (See Footnote 12 for holding time.)
	Waste	5 g or 25 g	---	Not Applicable	8021B	4 or 8 oz glass with Teflon®-lined lid, Cool 4 °C, 14 days. Field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for Encore Sampler is 48 hours (before the sample is added to methanol or sodium bisulfate). Cool, 4°C. (See Footnote 12 for holding time.)

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times
(Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
Semivolatiles	Water	1L	625	1 liter amber glass with Teflon®-lined lid, Cool, 4°C, Extraction, 7 days Analysis, 40 days	8270C	1 liter amber glass with Teflon®-lined lid, If residual chlorine present, add 3 mL sodium thiosulfate per gallon, Cool, 4°C, Extraction, 7 days Analysis, within 40 days of extraction
	Solid	50 g	---	Not Applicable	8270C	8 or 16 oz glass wide mouth with Teflon-lined lid, Cool, 4°C, Extraction, 14 days Analysis, within 40 days of extraction
	Waste	50 g	---	Not Applicable	8270C	8 or 16 oz glass wide mouth with Teflon®-lined lid, Cool, 4°C, Extraction, 14 days Analysis, within 40 days of extraction
Volatile Organics	Water	40 mL	624	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace, Cool, 4°C, Add sodium thiosulfate if residual chlorine, 7 days with pH > 2, 14 days with pH ≤ 2[8]	8260B	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace, Cool, 4°C, Add sodium thiosulfate if residual chlorine, 1:1 HCl to pH ≤ 2, 14 days with pH ≤ 2[9]

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times
(Continued)

Analytical Parameters	Matrix	Minimum Sample Size[1]	NPDES[2], [3]		RCRA (SW846)[3], [4]	
			Method	Requirements	Method[6]	Requirements
Volatile Organics (continued)	Solid[5]	5 g or 25 g	--	Not Applicable	8260B	4 or 8 oz glass with Teflon®-lined lid, Cool 4 °C, 14 days. Field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for Encore Sampler is 48 hours (before the sample is added to methanol or sodium bisulfate). Cool, 4°C. (See Footnote 12 for holding time.)
	Waste	5 g or 25 g	--	Not Applicable	8260B	4 or 8 oz glass with Teflon®-lined lid, Cool 4 °C, 14 days. Field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for Encore Sampler is 48 hours (before the sample is added to methanol or sodium bisulfate). Cool, 4°C. (See Footnote 12 for holding time.)

TABLE 8.5-2
Organic Sample Containers, Preservatives, and Holding Times
(Continued)

Footnotes

(1) Minimum sample size indicates sample amount needed for a single analysis. Matrix spikes or duplicates will require an additional sample amount of at least this amount for each additional QC sample aliquot required.
(2) National Pollutant Discharge Elimination System - 40 CFR Part 136, Appendix A.
(3) Holding times are calculated from the date of collection.
(4) Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).
(5) Solid matrix type includes soil, sediment, sludge or other solids not classified as waste.
(6) Only one determination method is listed when separate methods are required for preparation and analysis.
(7) Method 1664 was promulgated by the EPA with an effective date of June 14, 1999.
(8) For acrolein and acrylonitrile the pH should be adjusted to 4-5. This pH adjustment is not required if acrolein is not measured. Samples requiring analysis of acrolein that received no pH adjustment must be analyzed within three days of sampling.
(9) For acrolein and acrylonitrile the pH should be adjusted to 4-5.
(10) Method not listed in 40 CFR Part 136.
(11) Should only be used in the presence of residual chlorine.
(12) Depending on regulatory programs, EnCore™ samplers may be preserved for up to 14 days from sampling by freezing at -5 to -12°C until analysis. Alternatively the EnCore™ sample may be transferred to a 40-ml VOA vial and preserved by freezing at -5 to -12°C until analysis. Some regulatory agencies may require 4 or 8 oz glass with Teflon®-lined lid, Cool 4°C, 14 days. This technique is not recommended, but will be supported where required. (Preservation and holding times are subject to client specifications.)

TABLE 8.5-3
Volatile Organic Canisters Sample Containers, Preservatives, and Holding Times

Analytical Parameters	Matrix	Minimum Sample Size	CAA[(1), (2)]	
			Method	Requirements
Volatile Organic Canisters	Air	2.8L canister	ASTM D1946-90 TO12 TO14A TO15	2.8L, 6L, or 15L Summa® Passivated Canisters that have passed a blanking check of <3 ppbvc for ambient samples and <20 ppbvc for source samples Ambient samples should be analyzed within 30 days of collection (per TO15 only)

Footnotes

(1) Clean Air Act
(2) Holding times are calculated from the date of collection.

TABLE 8.5-4
Sample Containers, Preservatives, and Holding Times for TCLP[1] and SPLP[2]

Analytical Parameters	Matrix	Minimum Sample Size[3]	TCLP Method 1311, SPLP Method 1312, & CA WET Requirements	
			From Field Collection to TCLP/SPLP Extraction	From TCLP/SPLP Extraction to Analysis
Mercury	Liquid Solid Waste	1L	1L glass, Cool, 4°C, 28 days	Glass or polyethylene 28 days
Metals (except mercury)	Liquid Solid Waste	1L	1L glass, Cool, 4°C, 180 days	Glass or polyethylene 180 days
Semivolatiles	Liquid Solid Waste	1L	1L glass, Cool 4°C, 14 days	1L glass Extraction of leachate within 7 days of TCLP extraction, Analyze extract within 40 days
Volatiles	Liquid Solid Waste	6 oz	4 oz glass, Cool 4°C, 14 days	40 mL glass, 14 days

Footnotes

(1) TCLP = Toxicity Characteristic Leaching Procedure

(2) SPLP = Synthetic Precipitation Leaching Procedure

(3) Smaller sample size is adequate for solid samples or individual fractions. A combined volume of 32 oz. is recommended for semivolatiles and metals. A separate 4 oz. container should always be used for the volatile fraction. Volatile fractions should be stored with minimal headspace.

TABLE 8.5-5
STL Austin Instrument List

INSTRUMENT	MANUFACTURER	MODEL	DETECTOR	SERIAL #	AUTO-SAMPLER	DATE OF PURCHASE
GC (A2)	HEWLETT PACKARD	5890	FID / FID	2908A22002	Dual HP 7673A	Jan-90 (new)
GC (F1)	HEWLETT PACKARD	5890	PID / FID	2843A20839	TEKMAR Solatek 72	Jan-91 (new)
GC (G1)	HEWLETT PACKARD	5890 SERIES II	DUAL ECD	2950A26311	HP 6890	Jan-91 (new)
GC (K1)	HEWLETT PACKARD	5890	PID / FID	2429A02342	NONE	Jan-90 (new)
GC (L1/11)	HEWLETT PACKARD	5890	Dual FID	2541A06282	HP 7673	Jan-91 (new)
GC (N1/10)	HEWLETT PACKARD	5890 SERIES II	FID / NPD	2950A27743	HP 7673	Jan-90 (new)
GC (Q2)	HEWLETT PACKARD	6890	FID/PID	US00006548	Tekmar LCS 2000 + Archon	
GC (7)	HEWLETT PACKARD	5890 SERIES II	DUAL ECD	3033A31110	HP 7673	
GC (2)	HEWLETT PACKARD	5890 SERIES II+	DUAL ECD	3336A58899	HP 6890	
GC (12/13)	HEWLETT PACKARD	6890	DUAL FID	3336A51313	HP 7673	
GC (1)	HEWLETT PACKARD	5890	DUAL ECD	2443A03279	HP 7673	
GC (3)	HEWLETT PACKARD	5890	DUAL FID	2631A08718	HP 7673A	
GC (5)	HEWLETT PACKARD	5890	DUAL ECD	2518A05428	HP 7673	
GC (14)	HEWLETT PACKARD	5890 SERIES II+	DUAL FPD	3336A61782	HP 6890	
GC (15)	HEWLETT PACKARD	5890	FID	3203A40785	HP 7673A	
GC (8)	HEWLETT PACKARD	5890 SERIES II	DUAL ECD	2921A24023	HP 6890	
GC (IDA 1)	HEWLETT PACKARD	5890	FID	2950A27667	NONE	
GC (D2)	HEWLETT PACKARD	5890	FID	3019A28767		
GC (SYS F)	HEWLETT PACKARD	5890	MULTI-DETECTOR	2750A18182		
GC (SYS LG)	HEWLETT PACKARD	5890		3140A39307		
GC (TCD-A1)	HEWLETT PACKARD	5710A	TCD	1904A08303		
GCMS (A1)	HEWLETT PACKARD	5890		2938A25885		Jan-90 (new)
	HEWLETT PACKARD	5970	MSD	2950A11585		
GCMS (B3)	HEWLETT PACKARD	6890		US00028330	HP7683	Jun-99 (new)
	HEWLETT PACKARD	5973	MSD	US92522676		
GCMS (E2)	HEWLETT PACKARD	6890		US00028732	TEKMAR Aquatek 70/Velocity XPT	Jun-99 (new)
	HEWLETT PACKARD	5973A	MSD	US92522677		
GCMS (I1)	HEWLETT PACKARD	6890		US000240405	TEKMAR Solatek 72/Velocity XPT	Mar-98 (new)
	HEWLETT PACKARD	5973	MSD	US72821206		
GCMS (J1)	HEWLETT PACKARD	6890		US00028334	TEKMAR Solatek 72/Velocity XPT	Jun-99 (new)

TABLE 8.5-5
STL Austin Instrument List

INSTRUMENT	MANUFACTURER	MODEL	DETECTOR	SERIAL #	AUTO-SAMPLER	DATE OF PURCHASE
	HEWLETT PACKARD	5973	MSD	US91922548		
GCMS (K1)	HEWLETT PACKARD	6890		US00028331	HP7683	Jun-99 (new)
	HEWLETT PACKARD	5973	MSD	US92522673		
GCMS (MSDA)	HEWLETT PACKARD	5890 SERIES II		3310A49475	ARCHON	
	HEWLETT PACKARD	5972	MSD	3329A00555		
GCMS (MSDB)	HEWLETT PACKARD	5890 SERIES II		3310A47980	ARCHON	
	HEWLETT PACKARD	5972	MSD	3329A00542		
GCMS (MSDC)	HEWLETT PACKARD	6890		US00006567	ARCHON	
	HEWLETT PACKARD	5973	MSD	US63810338		
GCMS (N1/	HEWLETT PACKARD	6890		US00030199	HA G1513A	
MSD4)	HEWLETT PACKARD	5973	MSD	US92522708		
GCMS (VMSA)	HEWLETT PACKARD	5890		3235A45768		
	HEWLETT PACKARD	5972	MSD	3251A00126		
GCMS (VMSC)	HEWLETT PACKARD	6890		US00030192	HP G1513A	
	HEWLETT PACKARD	5973	MSD	US92522688		
GCMS (VMSO)	HEWLETT PACKARD	6890		CN10337012		Oct-03 (new)
	HEWLETT PACKARD	5973	MSD	US33220026		
GFAA (B3/Z3)	PERKIN ELMER	5100ZL	GFAA / CVAA / Flame	142659, 8024	PE AS70	
CVAA (E2)	LEEMAN	PS200II	CVAA	HG 8020	BUILT IN	Jan-94 (new)
ICP (A2)	THERMAL JARRELL ASH	61E - TRACE	TRACE	367590	TJA 200	Jan-95 (new)
ICP (C1)	THERMAL JARRELL ASH	61E - TRACE	TRACE	270490	TJA 200	Mar-94 (new)
ICPMS (A1)	PERKIN ELMER	ELAN 9000	MSD	P1000302	YES	Apr-03 (new)
TOC (B2)	TEKMAR/DOHRMAN	PHOENIX 8000		US04009005	YES	Feb-04 (new)
IC (B1)	DIONEX	DX-100	ELCD	91290	NO	Jan-93 (new)
IC (C1)	DIONEX	DX-100		911502		
Conductivity Meter (A2)	YSI	Model 32		3076	None	
Conductivity Meter (B1)	ORION	126		32248008	None	
LACHAT	LACHAT	2300		2000 0115	YES	Jan-91 (new)
SEAL (C2)	SEAL	AQ2		090343		2003 (new)
Spectro-photometer (B1)	HACH	DR 3000		890701990		
Ion Analyzer (D1)	ORION	EA 940		3500		

TABLE 8.5-5
STL Austin Instrument List

INSTRUMENT	MANUFACTURER	MODEL	DETECTOR	SERIAL #	AUTO-SAMPLER	DATE OF PURCHASE
pH (E1)	FISHER	925		123		
Titrator (A1)	METTLER	DL70ES		3114076030		
Ignitability / Flashpoint (B1)	ERDCO	RT00001		1108		

TABLE 8.5-6

Periodic Equipment Calibrations

Type of Equipment	Calibration Requirements
Balances	• Must be serviced and calibrated annually by an approved vendor. • Calibration must be checked daily or before use by analyst with weight(s) classified as Class 1 (formerly termed Class S) by NIST or Class 1 traceable. Acceptance criteria vary according to weight used and accuracy of balance. Acceptance criteria must be documented in the log. • All Class 1 weights must be certified by an outside vendor every three years. • All non-Class 1 weights must be checked against NIST Class 1 weights annually.
Thermometers	• Working glass thermometers must be verified against a certified NIST thermometer at least annually as described in operation-specific SOPs. • Working non-glass thermometers must be verified against a certified NIST thermometer annually as described in operation-specific SOPs. • The NIST thermometer must be recertified every three years.
Refrigerators/Freezers	• Thermometers must be immersed in a liquid such as mineral oil or glycol • Temperature of units used for sample or standard storage must be checked daily as described in operation-specific SOPs. Refrigerator acceptance limits: 1°C - 4°C Freezer acceptance limits: < - 10°C
Ovens	• Temperature of units must be checked daily or before use. • Acceptance limits vary according to use as described in operation-specific SOPs and must be documented in the temperature log.
Micropipettors	• Calibrations are checked gravimetrically as required by the operation-specific SOP. • Must be calibrated at the frequency (normally quarterly) required by the manufacturer at a minimum.
Syringes, Volumetric Glassware and Graduated Glassware	• All syringes and volumetric glassware are purchased as Class A items. • Class A items are certified by the manufacturer to be within ± 1% of the measured volume, therefore, calibration of these items by STL Austin is not required. • All analysts are trained in the proper use and maintenance of measuring devices to ensure the measurement of standards, reagents and sample volumes are within method tolerances.
Pressure Gauges	• Must be calibrated annually with Heise hand-held calibrator. • Hand-held calibrator must be re-certified every year (NIST traceable).

TABLE 8.5-7
Summary of Inorganic Method Calibrations

Analysis	Calibration	NPDES[1]		RCRA (SW846)[2]	
		Method	Requirement	Method	Requirement
Alkalinity	Initial	310.1 2320B	3-point calibration of pH meter (±0.05 pH units of true value)	--	Not Applicable
	Continuing	310.1 2320B	Not Applicable	--	Not Applicable
	Ending	310.1 2320B	Not Applicable	--	Not Applicable
Ammonia	Initial	350.1	6 levels including blank, "r"[3] ≥0.995	--	Not Applicable
	Continuing	350.1	1 level or LCS every 10 samples ± 10% of true value	--	Not Applicable
	Ending	350.1	1 level or LCS every 10 samples ± 10% of true value	--	Not Applicable
Bromide	Initial	300.0[4]	3 levels plus a blank “r”[3] ≥0.995	9056	3 levels plus a blank “r”[3] ≥0.995
	Continuing	300.0[4]	1 level every 10 samples ± 10% of true value	9056	1 level every 10 samples ± 10% of true value
	Ending	300.0[4]	1 level every 10 samples ± 10% of true value	9056	1 level every 10 samples ± 10% of true value
Chemical Oxygen Demand (COD)	Initial	410.4	5 levels plus a blank "r"[3] ≥ 0.995	--	Not Applicable
	Continuing	410.4	1 level every 10 samples ± 10% of true value	--	Not Applicable
	Ending	410.4	1 level ± 10% of true value	--	Not Applicable

TABLE 8.5-7
Summary of Inorganic Method Calibrations
(Continued)

Analysis	Calibration	NPDES[1]		RCRA (SW846)[2]	
		Method	Requirement	Method	Requirement
Chloride	Initial	300.0[4] 4500-Cl E	3 levels plus blank "r"[3] ≥0.995	9056	3 levels plus a blank "r"[3] ≥ 0.995
	Continuing	300.0[4] 4500-Cl E	1 level every 10 samples ±10% of true value	9056	1 per batch of 20 samples, ± 10% of true value
	Ending	300.0[4] 4500-Cl E	1 level, ±10% of true value	9056	1 level, ±10% of true value
Chromium Cr^{+6}	Initial	3500 Cr-D	3 levels plus blank	7196A	5 levels plus blank "r"[3] ≥0.995
	Continuing	3500 Cr-D	1 level every 10 samples ± 10% of true value	7196A	1 level every 10 samples ± 10%
	Ending	3500 Cr-D	1 level ± 10% of true value	7196A	1 level ± 10%
Conductivity	Initial	120.1	Standard KCl solution	9050A	1 level to determine cell constant
	Continuing	120.1	Not Applicable	9050A	Not Applicable
	Ending	120.1	Not Applicable	9050A	Not Applicable
Cyanide (Amenable)	Initial	335.1	7 levels plus blank "r"[3] ≥ 0.995	9012A	7 levels plus blank "r"[3] ≥ 0.995
	Continuing	335.1	1 level every 10 samples ± 10% of true	9012A	1 mid-level every 10 samples ± 15% of true value
	Ending	335.1	1 level ± 10 % of true value	9012A	± 15% of true value

TABLE 8.5-7
Summary of Inorganic Method Calibrations
(Continued)

Analysis	Calibration	NPDES[1]		RCRA (SW846)[2]	
		Method	**Requirement**	**Method**	**Requirement**
Cyanide (Total)	Initial	335.3 4500-CN E	7 levels plus blank "r"[3] ≥ 0.995	9012A	7 levels plus blank "r"[3] ≥ 0.995
	Continuing	335.3 4500-CN E	1 mid-level every 10 samples ±10 % of true value	9012A	1 mid-level every 10 samples ±15% of true value
	Ending	335.3 4500-CN E	1 mid-level ±10 % of true value	9012A	±15% of true value
Flashpoint	Initial	--	Not Applicable	1020A	p-Xylene reference standard must have flashpoint of 27.2°C ± 1.1°C
	Continuing	--	Not Applicable	1020A	Not Applicable
	Ending	--	Not Applicable	1020A	Not Applicable
Fluoride	Initial	300.0[4] 340.2	Method 300.0: 3 levels plus a blank, "r"[3] ≥ 0.995 Method 340.2: 6 levels "r"[3] ≥ 0.995	9056	3 levels plus a blank "r"[3] ≥ 0.995
	Continuing	300.0[4] 340.2	1 mid-level every 10 samples ± 10% of true value	9056	1 per batch of 20 samples ± 10% of true value
	Ending	300.0[4] 340.2	1 mid-level ± 10% of true value	9056	1 level, ±10% of true value
Hardness	Initial	130.2 2340B	Method 130.2: Standardize titrant Method 2340B: See ICP Metals 200.7	--	Not Applicable
	Continuing	130.2 2340B	Method 130.2: Not Applicable Method 2340B: See ICP Metals 200.7	--	Not Applicable
	Ending	130.2 2340B	Method 130.2: Not Applicable Method 2340B: See ICP Metals 200.7	--	Not Applicable

TABLE 8.5-7
Summary of Inorganic Method Calibrations
(Continued)

Analysis	Calibration	NPDES[1]		RCRA (SW846)[2]	
		Method	Requirement	Method	Requirement
Iron (Ferrous)	Initial	3500-Fe D	3 levels plus a blank "r"[3] ≥ 0.995	-	Not Applicable
	Continuing	3500-Fe D	1 mid-level every 10 samples ± 10% of true value	-	Not Applicable
	Ending	3500-Fe D	1 mid-level ± 10% of true value	-	Not Applicable
Nitrate	Initial	300.0[4]	3 levels plus a blank "r"[3] ≥0.995	9056	3 levels plus a blank "r"[3] ≥0.995
	Continuing	300.0[4]	1 mid-level every 10 samples, ±10% of true value	9056	1 per batch of 20 samples, ±10% of true value
	Ending	300.0[4]	1 mid-level ±10% of true value	9056	1 mid-level ±10% of true value
Nitrite	Initial	300.0[4]	3 levels plus a blank "r"[3] ≥0.995	9056	3 levels plus a blank "r"[3] ≥0.995
	Continuing	300.0[4]	1 mid-level every 10 samples, ±10% of true value	9056	1 per batch of 20 samples, ±10% of true value
	Ending	300.0[4]	1 mid-level ±10% of true value	9056	1 mid-level ±10% of true value
Nitrate-Nitrite	Initial	353.2	5 levels plus blank "r"[3] ≥0.995	--	Not Applicable
	Continuing	353.2	1 level every 10 samples ±10% of true value	--	Not Applicable
	Ending	353.2	1 mid-level ±10% of true value	--	Not Applicable

TABLE 8.5-7
Summary of Inorganic Method Calibrations
(Continued)

Analysis	Calibration	NPDES[1]		RCRA (SW846)[2]	
		Method	Requirement	Method	Requirement
pH	Initial	150.1 4500-H^+ B	2 point calibration that brackets the expected pH of the sample (± 0.05 pH units of true value)	9040B 9045C	2 point calibration (± 0.05 pH units of true value)
	Continuing	150.1 4500-H^+ B	Not Applicable	9040B 9045C	Not Applicable
	Other	150.1 4500-H^+ B	Third point check	9040B 9045C	Third point check
	Ending	150.1 4500-H^+ B	1 buffer check ±0.05 pH units	9040B 9045C	Not Applicable
Phenolics	Initial	420.2	5 levels plus a blank "r"[3] ≥ 0.995	9065 9066	5 levels plus a blank “r”[3] 0.995
	Continuing	420.2	1 mid-level every 10 samples ± 10% true value	9065 9066	1 mid-level ± 15% true value
	Ending	420.2	1 mid-level ± 10% true value	9065 9066	1 mid-level ± 15% true value
Phosphorus (Total and Ortho-phosphate)	Initial	365.1	6 levels plus a blank	--	Not Applicable
	Continuing	365.1	1 mid-level every 10 samples, ±10% of true value	--	Not Applicable
	Ending	365.1	Not Applicable	--	Not Applicable
Phosphorus (Ortho-phosphate)	Initial	300.0[4]) 365.1	3 levels plus a blank “r”[3] ≥0.995	9056	3 levels plus a blank “r”[3] ≥0.995
	Continuing	300.0[4] 365.1	1 mid-level every 10 samples, ±10% of true value	9056	1 level every 10 samples ± 10% of true value
	Ending	300.0[4] 365.1	1 level ±10% of true value	9056	1 level ± 10% of true value

TABLE 8.5-7
Summary of Inorganic Method Calibrations
(Continued)

Analysis	Calibration	NPDES[1]		RCRA (SW846)[2]	
		Method	Requirement	Method	Requirement
Settleable Solids	Initial	160.5	Not Applicable	--	Not Applicable
	Continuing	160.5	Not Applicable	--	Not Applicable
	Ending	160.5	Not Applicable	--	Not Applicable
Specific Conductance	Initial	120.1	Standardize meter with 0.01 M KCl	9050A	Standardize meter with 0.01 M KCl
	Continuing	120.1	1 level every 10 samples ± 10% of true value	9050A	1 level every 10 samples ± 10% of true value
	Ending	120.1	1 level ± 10% of true value	9050A	1 level ± 10% of true value
Sulfate	Initial	300.0[4]	3 levels plus blank, "r"[3] ≥ 0.995	9056	3 levels plus a blank, "r"[3] ≥ 0.995
	Continuing	300.0[4]	1 mid-level after every 10 samples, ±10% of true value	9056	1 per batch of 20 samples, ±10% of true value
	Ending	300.0[4]	1 level ± 10% of true value	9038 9056	1 level, + 10% of true value

TABLE 8.5-7
Summary of Inorganic Method Calibrations
(Continued)

Analysis	Calibration	NPDES[1]		RCRA (SW846)[2]	
		Method	Requirement	Method	Requirement
Sulfide	Initial	376.1	This is a titration method. Therefore, calibrations are not applicable.	9030B 9034	This is a colorimetric titration. Therefore, calibration is not applicable.
	Continuing	376.1	Not Applicable	9030B 9034	Not Applicable
	Ending	376.1	Not Applicable	9030B 9034	Not Applicable
Sulfite	Initial	377.1	This is a colorimetric titration. Therefore, calibration is not applicable.	--	Not Applicable
	Continuing	377.1		--	Not Applicable
	Ending	377.1		--	Not Applicable
Total Dissolved Solids	Initial	160.1	This is a gravimetric determination. Calibrate balance prior to analysis	--	Not Applicable
	Continuing	160.1		--	Not Applicable
	Ending	160.1		--	Not Applicable
Total Solids	Initial	160.3	This is a gravimetric determination. Calibrate balance before use.	--	Not Applicable
	Continuing	160.3		--	Not Applicable
	Ending	160.3		--	Not Applicable
Total Suspended Solids (Nonfilterable)	Initial	160.2	This is a gravimetric determination. Calibrate balance before use.	--	Not Applicable
	Continuing	160.2		--	Not Applicable
	Ending	160.2		--	Not Applicable
Total Volatile Solids	Initial	160.4	This is a gravimetric determination. Calibrate balance before use.	--	Not Applicable
	Continuing	160.4		--	Not Applicable
	Ending	160.4		--	Not Applicable

TABLE 8.5-7
Summary of Inorganic Method Calibrations
(Continued)

Analysis	Calibration	NPDES[1]		RCRA (SW846)[2]	
		Method	Requirement	Method	Requirement
Total Kjeldahl Nitrogen (TKN)	Initial	351.2	5 levels plus blank "r"[3] ≥ 0.995	--	Not Applicable
	Continuing	351.2	1 mid- level every 10 samples ± 10% of true value	--	Not Applicable
	Ending	351.2	± 10% of true value	--	Not Applicable
Total Organic Carbon (TOC)	Initial	415.1	5 levels plus blank "r"[3] ≥ 0.995	9060	5 levels plus blank "r"[3] ≥ 0.995
	Continuing	415.1	1 mid-level every 10 samples ± 15% of true value	9060	1 mid-level every 10 samples ± 15% of true value
	Ending	415.1	1 level ± 15% of true value	9060	1 level ± 15% of true value
Total Organic Carbon (TOC)	Initial	Walkley/ Black	Duplicate titration of $FeSO_4$ ± 10% of true value	--	Not Applicable
	Continuing	Walkley/ Black	1 mid-level ± 10% of true value	--	Not Applicable
	Ending	Walkley/ Black	1 mid-level ± 10% of true value	--	Not Applicable
Water Content (Moisture)	Initial	--	Calibrate Balance	--	Calibrate Balance
	Continuing	--	Not Applicable	--	Not Applicable
	Ending	--	Not Applicable	--	Not Applicable

TABLE 8.5-7
Summary of Inorganic Method Calibrations
(Continued)

		NPDES[1]		RCRA (SW846)[2]	
Analysis	**Calibration**	**Method**	**Requirement**	**Method**	**Requirement**
GFAA Metals (excludes Hg)	Initial	--	Not Applicable	HML 939-M	3 levels plus blank ICV ± 10% of true value "r"[3] ≥ 0.995 SOP AUS-MT-0011
	Continuing	--	Not Applicable	HML 939-M	Every 10 samples ± 20% of true value SOP AUS-MT-0011
	Ending	--	Not Applicable	HML 939-M	± 20% of true value SOP AUS-MT-0011
	Other	--	Not Applicable	--	Not Applicable

TABLE 8.5-7
Summary of Inorganic Method Calibrations
(Continued)

Analysis	Calibration	NPDES[1]		RCRA (SW846)[2]	
		Method	**Requirement**	**Method**	**Requirement**
ICP & ICP/MS Metals (excludes Hg)	Initial	200.7 200.8	2 levels and blank "r"[3] ≥ 0.995 ICV: verify quantitation at ± 5% of true value, ICV RSD < 3% from replicate SOP AUS-MT-0001, AUS-MT-0012	6010B 6020	1 level and blank Minimum: "r"[3] ≥ 0.995 ICV: verify quantitation at ± 10% of true value, ICV RSD < 5% from replicate SOP AUS-MT-0001, AUS-MT-0012
	Continuing	200.7 200.8	Every 10 samples Method 200.7: ± 5% of true value Method 200.8: ±10% of true value CCV RSD < 5% from replicate SOP AUS-MT-0001, AUS-MT-0012	6010B 6020	Mid-level calibration standard Every 10 samples ± 10% of true value CCV RSD < 5% from replicate SOP AUS-MT-0001, AUS-MT-0012
	Ending	200.7 200.8	Method 200.7: ± 5% of true value Method 200.8: ±10% of true value CCV RSD < 5% from replicate SOP AUS-MT-0001, AUS-MT0012	6010B 6020	Mid-level calibration standard ± 10% of true value CCV RSD < 5% from replicate SOP AUS-MT-0001, AUS-MT-0012
	Other	200.7 200.8	ICSA, ICSAB: Analyze at beginning of run. For ICSA, AB criteria see Section 9, SOP AUS-MT-0001, AUS-MT-0012. Annually: ICP interelement correction factors Semiannually: Linear Dynamic Range Verification Quarterly: Instrument detection limits	6010B 6020	ICSA, ICSAB: Analyze at beginning of run. For ICSA, AB criteria see Section 9, SOP AUS-MT-0001, AUS-MT-0012. Annually: ICP interelement correction factors Semiannually: Linear Dynamic Range Verification Quarterly: Instrument detection limits

TABLE 8.5-7
Summary of Inorganic Method Calibrations
(Continued)

Analysis	Calibration	NPDES[1]		RCRA (SW846)[2]	
		Method	**Requirement**	**Method**	**Requirement**
Mercury by CVAA	Initial	245.1 245.5	5 levels plus blank ICV ± 10% of true value "r"[3] ≥ 0.995 SOP AUS-MT-0005/0007	7470A 7471A	5 levels plus blank ICV ± 10% of true value "r"[3] ≥ 0.995 SOP AUS-MT-0005/0007
	Continuing	245.1 245.5	Daily or every 10 samples, whichever is more frequent ± 10% of true value SOP AUS-MT-0005/0007	7470A 7471A	Every 10 samples ± 20% of true value SOP AUS-MT-0005/0007
	Ending	245.1 245.5	± 10% of true value SOP AUS-MT-0005/0007	7470A 7471A	± 10% of original prepared standard SOP AUS-MT-0005/0007
	Quantitation Limit Check Standard	245.1 245.5	Quarterly, or as needed.	7470A 7471A	Quarterly, or as needed.
	Other	245.1 245.5	Annually: - Instrument detection limits	7470A 7471A	Annually - Instrument detection limits

Footnotes

(1) National Pollutant Discharge Elimination System

(2) Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December, 1996).

(3) "r" = correlation coefficient

(4) Method not listed in 40 CFR Part 136.

TABLE 8.5-8
Summary of Organic Method Calibrations

Analytical Parameter	Calibration	NPDES[1]		RCRA (SW846) [2]	
		Method	Requirement	Method	Requirement
Aromatic Volatiles by GC	Initial	602	Minimum of 3 levels If % RSD <10%, use average RF; otherwise, calibration curve employed with $r^2 \geq 0.995$ SOP No. AUS-GC-0006	8021B	Minimum of 5 levels If % RSD <20%, use average RF; otherwise, calibration curve employed with $r^2 \geq 0.995$ SOP No. AUS-GC-0006
	Continuing	602	Analyze QC check sample and evaluate per method requirements SOP No. AUS-GC-0006	8021B	Mid-level calibration standard analyzed at beginning of each shift and every 12 hours after. % D ≤15%, gases 20% D. Evaluate per SOP No. AUS-GC-0006 requirements.
	Ending	602	Not Applicable	8021B	Not Applicable
	Other	602	Not Applicable	8021B	Not Applicable
Dissolved Gases in Water	Initial	--	Not Applicable	RSK-175[8]	Minimum of 3 levels "r"[3] ≥ 0.995, otherwise, rerun curve SOP AUS-GC-0002
	Continuing	--	Not Applicable	RSK-175[8]	Mid-level calibration standard analyzed every 20 samples. % D ≤15% Evaluate per SOP AUS-GC-0002 requirements
	Ending	--	Not Applicable	RSK-175[8]	Mid-level calibration standard % D ≤15% Evaluate per SOP AUS-GC-0002 requirements.
	Other	--	Not Applicable	RSK-175[8]	Not Applicable

TABLE 8.5-8
Summary of Organic Method Calibrations
(Continued)

Analytical Parameter	Calibration	NPDES[1]		RCRA (SW846) [2]	
		Method	Requirement	Method	Requirement
Gasoline Range Organics	Initial	--	Not Applicable	8015B	Minimum of 5 levels If % RSD <20%, use average RF; otherwise, calibration curve employed with $r^2 \geq 0.995$ SOP AUS-GC-0006
	Continuing	--	Not Applicable	8015B	Mid-level calibration standard analyzed every 12 hour shift % D ≤15% SOP AUS-GC-0006
	Ending	--	Not Applicable	8015B	Mid-level calibration standard % D ≤15% SOP AUS-GC-0006
	Other	--	Not Applicable	8015B	Not Applicable
Glycols and Alcohols by Direct Aqueous Injection GC-FID	Initial	--	Not Applicable	8015B	Minimum of 5 levels If % RSD <20%, use average RF; otherwise, calibration curve employed, "r"[3] ≥0.990 SOP AUS-GC-0005
	Continuing	--	Not Applicable	8015B	Mid-level calibration standard analyzed every 12 hours, or more frequently as needed. % D <15% of predicted response for any analyte quantitated and reported; or average %D <15%. SOP AUS-GC-0005
	Ending	--	Not Applicable	8015B	Mid-level calibration standard. % D <15% of predicted response for any analyte quantitated and reported; or average %D <15%. SOP AUS-GC-0005
	Other	--	Not Applicable	8015B	Not Applicable

TABLE 8.5-8
Summary of Organic Method Calibrations
(Continued)

Analytical Parameter	Calibration	NPDES[1]		RCRA (SW846) [2]	
		Method	Requirement	Method	Requirement
Pesticides/ PCBs by GC	Initial	608	Minimum of 3 levels If % RSD <10%, use average RF; otherwise, calibration curve employed	8081A / 8082	Minimum of 5 levels. If % RSD <20%, use average RF; otherwise, calibration curve employed. SOP AUS-GC-0007.
	Continuing	608	1 or more calibration standards analyzed daily % D ± 15% of predicted response	8081A / 8082	Mid-level calibration standard analyzed every 10 samples. % D <15% of predicted response for any analyte quantitated and reported; or average %D <15%. SOP AUS-GC-0007
	Ending	608	Not Applicable	8081A / 8082	Mid-level calibration standard. % D <15% of predicted response for any analyte quantitated and reported; or average %D <15%. SOP No. AUS-GC-0007
	Other	608	Not Applicable	8081A / 8082	Not Applicable

TABLE 8.5-8
Summary of Organic Method Calibrations
(Continued)

Analytical Parameter	Calibration	NPDES[1]		RCRA (SW846) [2]	
		Method	Requirement	Method	Requirement
Total Petroleum Hydrocarbons by TCEQ Method TX1005	Initial	--	Not Applicable	TNRCC 1005[10]	Minimum of 5 levels If %RSD ≤25%, use average RF; otherwise use curve with "r"[3] ≥0.995 SOP AUS-GC-0003
	Continuing	--	Not Applicable	TNRCC 1005[10]	Mid-level calibration standard analyzed every 20 samples %D < 25% SOP AUS-GC-0003
	Ending	--	Not Applicable	TNRCC 1005[10]	Mid-level calibration standard %D <25% SOP AUS-GC-0003
	Other	--	Not Applicable	TNRCC 1005[10]	Not Applicable
Total Petroleum Hydrocarbons by TCEQ Method TX1006	Initial		Not Applicable	TNRCC 1006[10]	Minimum of 5 levels If %RSD ≤25%, use average RF; otherwise use curve with "r"[3] ≥0.995 SOP AUS-GC-0017
	Continuing		Not Applicable	TNRCC 1006[10]	Mid-level calibration standard analyzed every 20 samples %D < 25% SOP AUS-GC-0017
	Ending		Not Applicable	TNRCC 1006[10]	Mid-level calibration standard %D <25% SOP AUS-GC-0017
	Other		Not Applicable	TNRCC 1006[10]	Not Applicable

TABLE 8.5-8
Summary of Organic Method Calibrations
(Continued)

Analytical Parameter	Calibration	NPDES[1]		RCRA (SW846) [2]	
		Method	Requirement	Method	Requirement
Petroleum Hydrocarbons/ Oil and Grease	Initial	1664	Calibrate analytical balance at 2 mg and 1000 mg Calibration must be ±10% at 2 mg and ±0.5% at 1000 mg or recalibrate balance SOP AUS-WC-0004	--	--
	Continuing	1664	Not Applicable	--	--
	Ending	1664	Not Applicable	--	--
	Other	1664	Not Applicable	--	--
Diesel Range Organics (Diesel, Kerosene, Jet Fuel)	Initial	--	Not Applicable	8015B	Minimum of 5 levels If % RSD <20%, use average RF; otherwise, calibration curve employed. SOP AL/SOP055
	Continuing	--	Not Applicable	8015B	Mid-level calibration standard analyzed every 10 samples % D <15% of predicted response for any analyte quantitated and reported, or average %D <15% SOP AL/SOP055
	Ending	--	Not Applicable	8015B	Mid-level calibration standard % D < 15% of predicted response for any analyte quantitated and reported, or average %D <15%. SOP AL/SOP055
	Other	--	Not Applicable	8015B	Not Applicable

TABLE 8.5-8
Summary of Organic Method Calibrations
(Continued)

Analytical Parameter	Calibration	NPDES[1]		RCRA (SW846) [2]	
		Method	Requirement	Method	Requirement
Semivolatiles by GC/MS	Initial	625	Minimum of 3 levels, lowest near but above MDL If % RSD ≤35%, use average RF; otherwise calibration curve employed SOP AUS-MS-0005	8270C	Minimum of 5 levels, % RSD for RF for CCCs[4] <30% SPCCs[5]: RF >0.050 SOP AUS-MS-0005
	Continuing	625	1 level every 24 hours Acceptance criteria are found in the method and SOP AUS-MS-0005	8270C	Mid-level standard every 12 hours (after tuning) %D for CCCs[4] ≤20 % between RF from standard and average RF from initial SPCCs[5]: RF >0.050 SOP AUS-MS-0005
	Ending	625	Not Applicable	8270C	Not Applicable
	Other	625	DFTPP[7] tuning every 24 hours before standard or sample runs. SOP AUS-MS-0005	8270C	DFTPP[7] tuning at the beginning of every 12 hour shift. SOP AUS-MS-0005

TABLE 8.5-8
Summary of Organic Method Calibrations
(Continued)

Analytical Parameter	Calibration	NPDES[1]		RCRA (SW846) [2]	
		Method	Requirement	Method	Requirement
Volatiles by GC/MS	Initial	624	Minimum of 3 levels, lowest near but above MDL If % RSD ≤35%, use average RRF; otherwise calibration curve employed SOP AUS-MS-0004	8260B	Minimum of 5 levels, %RSD for RF for CCCs[4] <30.0% SPCCs[5]: RF ≥0.300 for Chlorobenzene and 1,1,2,2-tetrachloroethane, Chloromethane and 1,1-dichloroethane, and RF >0.100 for Bromoform, Chloromethane and 1,1-Dichloroethane SOP AUS-MS-0004
	Continuing	624	1 level every 24 hours Acceptance criteria are found in the method and SOP AUS-MS-0004	8260B	Mid-level standard every 12 hours (after tuning) %Drift for CCCs[4] < 20.0% between RF from standard and avg RF from initial SPCCs[5]: RF ≥ 0.300 for Chlorobenzene and 1,1,2,2-tetrachloroethane, Chloromethane and 1,1-dichloroethane, and RF >0.100 for Bromoform. Chloromethane and 1,1-Dichloroethane SOP AUS-MS-0004
	Ending	624	Not Applicable	8260B	Not Applicable
	Other	624	BFB[6] tuning every 24 hours before standard or sample runs. SOP AUS-MS-0004	8260B	BFB[6] tuning at the beginning of every 12 hour shift. SOP AUS-MS-0004

TABLE 8.5-8
Summary of Organic Method Calibrations
(Continued)

Footnotes

(1) National Pollutant Discharge Elimination System

(2) Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).

(3) "r" = correlation coefficient

(4) CCC - Continuing Calibration Compounds

(5) SPCC - System Performance Check Compound

(6) BFB - Bromofluorobenzene

(7) DFTPP – Decafluorotriphenylphosphine

(8) Method not listed in SW-846; method developed by Robert S. Kerr Environmental Research Lab, Ada OK, RSKSOP-175.

(9) Method not listed in 40 CFR Part 136.

(10) Method not listed in SW-846.

TABLE 8.5-9
Summary of Volatile Organic Canister Method Calibrations

Analytical Parameter	Calibration	CAA [1]	
		Method	Requirement
Total Non-methane Hydrocarbon (TNMHC) by GC	Initial	TO12	Calibrate with minimum of 3 levels annually, or when daily calibration check fails to meet acceptance criteria RSD[2] for RF for all analytes ≤30.0% Linear regression for analytes outside RSD[2] criteria, "r"[3] ≥ 0.995 and intercept (b) must be between 0 and limits specified in AUS-VA-0009
	Continuing	TO12	Mid-level standard analyzed once per batch of samples processed not to exceed 20 samples Recovery 70% - 130% AUS-VA-0009
	Ending	TO12	Not Applicable
	Other	TO12	Not Applicable
Fixed Gases TCD by GC	Initial	ASTM D1946-90	Calibrate with minimum of 3 levels annually, or when daily calibration check fails to meet acceptance criteria RSD[2] for average RF for all compounds ≤30.0% Linear regression for analytes outside RSD[2] criteria, "r"[3] ≥ 0.995 and intercept (b) must be between 0 and limits specified in AUS-VA-0008
	Continuing	ASTM D1946-90	Mid-level standard analyzed once per batch of samples processed not to exceed 20 samples Percent recovery for each analyte must be within laboratory acceptance limits AUS-VA-0008
	Ending	ASTM D1946-90	Not Applicable
	Other	ASTM D1946-90	Not Applicable
C1 – C3 Hydrocarbons by GC/FID	Initial	TO14A	Calibrate with minimum of 3 levels annually, or when daily calibration check fails to meet acceptance criteria RSD[2] for average RF for all compounds ≤30.0% Linear regression for analytes outside RSD[2] criteria, "r"[3] ≥ 0.995 and Y intercept must be between 0 and limits specified in AUS-VA-0007
	Continuing	TO14A	Mid-level standard analyzed once per batch of samples processed not to exceed 20 samples Percent recovery for each analyte must be within laboratory acceptance limits AUS-VA-0007
	Ending	TO14A	Not Applicable
	Other	TO14A	Not Applicable

TABLE 8.5-9
Summary of Volatile Organic Canister Method Calibrations
(Continued)

Analytical Parameter	Calibration	CAA [1]	
		Method	Requirement
Ambient Air by GC/MS	Initial	TO15	Calibrate with minimum of 5* levels annually, or when daily calibration check fails to meet acceptance criteria, or when significant instrument maintenance is performed RSD[2] for average RF for target compounds ≤30.0% AUS-VA-0007 **Polar compounds may only have a 3-level calibration.*
	Continuing	TO15	Mid-level standard analyzed once per batch of samples processed not to exceed 20 samples Percent recovery for each analyte must be within laboratory acceptance limits AUS-VA-0007
	Ending	TO15	Not Applicable
	Other	TO15	BFB[4] tuning at the beginning of each batch of samples processed not to exceed 20 samples

Footnotes

(1) Clean Air Act
(2) RSD – relative standard deviation
(3) "r" = correlation coefficient
(4) BFB - Bromofluorobenzene

TABLE 8.6-1
Precision and Accuracy Measurements

Measurement	Definition
Accuracy	The degree of agreement of a measurement with an accepted reference or true value. The only true or known values in the laboratory are spiked samples. Expressed as laboratory control sample (LCS) percent recovery (% R): $$LCS\ \%\ Recovery = \frac{X}{t}\ x\ 100$$ where: X = observed concentration t = concentration of spike added Expressed as matrix spike/matrix spike duplicate (MS/MSD) sample percent recovery (% R): $$MS\ /\ MSD\%\ Recovery = \frac{X_s - X}{t} x100$$ where: X_s = observed concentration in spiked sample X = observed concentration in unspiked sample t = concentration of spike added
Precision	The measure of analytical reproducibility of two values. Expressed as the relative percent difference (RPD) of two values. $$RPD = \left[\frac{\lvert X_1 - X_2 \rvert}{\left(\frac{X_1 + X_2}{2} \right)} \right] x\ 100$$ where: X_1 = first observed concentration X_2 = second observed concentration

TABLE 8.6-1
Precision and Accuracy Measurements
(Continued)

Measurement	Definition
Arithmetic mean	The average of a set of values. $$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$ where: $\bar{x}$ = the mean x_i = the ith data value n = number of data values
Standard Deviation	A measure of the random (probable) error associated with a single measurement within a data set. $$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$ where: s = sample standard deviation $\bar{x}$ = the mean x_i = the ith data value n = number of data values
Quality Control Chart	A graphical representation of analytical accuracy. Displays the arithmetic mean of a data set, the upper and lower warning limits and the upper and lower control limits.
ACCURACY	
Upper Control Limit (UCL)	$UCL = \bar{x} + 3s$
Upper Warning Limit (UWL)	$UWL = \bar{x} + 2s$
Lower Warning Limit (LWL)	$LWL = \bar{x} - 2s$
Lower Control Limit (LCL)	$LCL = \bar{x} - 3s$
PRECISION	
RPD	Zero to (mean RPD + 3s)

TABLE 8.11-1
Instrument Maintenance Schedule
Flame Atomic Absorption Spectroscopy[(1)]

Daily	Monthly	As Needed
Verify proper safety precautions are working.	Clean all filters and fans.	Check drain receptacle.
Verify gas box operates properly and safely.	Change capillary tubing	Check background corrector for alignment.
Verify sensitivity using elements in UV/VIS spectrum.	Clean optical windows	Clean burner head.
		Clean nebulizer.
		Clean spray chamber.
		Check sample introduction O-rings.

TABLE 8.11-2
Instrument Maintenance Schedule
Cold Vapor Atomic Absorption (Leeman PS 200) [(1)]

Daily	As Needed	Annually
Change drying tube	Change pump tubing	Change Hg lamp.
Check pump tubing/drain tubing	Check/change Hg lamp	
Check gas pressure	Clean optical cell	
Check aperture reading	Lubricate pump	
Check tubing		

TABLE 8.11-3
Instrument Maintenance Schedule
ICP-MS (PE ELAN9000) (1)

Daily	As Needed	Monthly	Every 3 Months
Check the level of the waste solution in the container.	Clean or replace air filters.	Check filters; replace as needed.	Change pump oil.
Visually check the torch condition and measure for proper alignment.	Check nebulizer spray pattern with deionized water for uniform droplets. Clean the nebulizer and spray chamber,		
	Check detector and adjust to the proper voltage.		
Visually check peristaltic pump for acceptable roller pressure, condition of the sample tubing and the drain tubing, and correct pump rotation.	Regenerate getter to clean.		
Visually check the condition and level of the oil in the roughing pump.	Visually check the condition of each cone for cleanliness and proper orifice size.		
Check Argon tanks for sufficient pressure output, 70-120 psi.			
Check coolant plumbing for leaks. Check electrical connections. Check coolant level to prevent corrosion. Pressure at 35-60 psi. Recommended setpoint at 50 ± 2 psi.			
Record vacuum system reading each day in logbook. Doing this gives you an indication of the cone condition. If the orifices are clogged, the pressure is lower. If the orifices are worn, the pressure is higher. Two pressures to record: running and base. Base pressure is vacuum achieved after the instrument has been on for hours and before plasma is lit. Running pressure is vacuum achieved after the plasma is lit and the instrument has been running for one hour.			

TABLE 8.11-4
Instrument Maintenance Schedule
ICP[1]

Daily	Monthly or As Needed	Semi-annually	Annually
Check gases Check that argon tank pressure is 50-60 psi and that a spare tank is available. Check aspiration tubing Clean plasma torch assembly to remove accumulated deposits.	Clean nebulizer and drain chamber; keep free flowing to maintain optimum performance.	Change vacuum pump oil.	Notify manufacturer service engineer for scheduled preventive maintenance service.
Check vacuum pump gage. (<10 millitorr)	Clean filters on back of power unit to remove dust.	Replace coolant water filter. (may require more or less frequently depending on the quality of water)	
Check that cooling water supply system is full and drain bottle is not full. Also that drain tubing is clear, tight fitting and has few bends.	Replace when needed: peristaltic pump tubing sample capillary tubing autosampler sipper probe		
Check that nebulizer is not clogged.	Check yttrium position.		
Check that capillary tubing is clean and in good condition.	Check O-rings		
Check that peristaltic pump windings are secure.	Clean/lubricate pump rollers.		
Check that high voltage switch is on.			
Check that exhaust screens are clean.			
Check that torch, glassware, aerosol injector tube, bonnet are clean.			

TABLE 8.11-5
Instrument Maintenance Schedule
Graphite Furnace Atomic Absorption[1]

Daily	Weekly	Monthly	Semi-annually	Annually
Check gas lines and gas supply.	Clean optical windows.	Check coolant level in cooling unit. Add coolant if error message appears.	Change graphite contacts	Notify manufacturer service engineer to clean optics.
Clean contact cylinders.				
Check tubes and platform; replace if corroded, faking, or if low absorbance results. Check autosampler tubing and alignment. Flush autosampler tubing				Check optics
PE4100ZL: clean fume extraction tip, replace fume extraction filter and H_2O trap.				
As needed, trim sampling capillary.				
Check drain lines and waste containers; empty as needed.				
Check acid rinse containers; fill as needed.				

TABLE 8.11-6
Instrument Maintenance Schedule
Gas Chromatograph[1]

Daily	As Needed	Quarterly/Semi-annually/Annually
Check for sufficient supply of carrier and detector gases. Check for correct column flow and/or inlet pressures.	Replace front portion of column packing or break off front portion of capillary columns. Replace column if this fails to restore column performance or when column performance (e.g. peak tailing, poor resolution, high backgrounds, etc.) indicates it is required.	Quarterly ELCD: change-roughing resin, clean cell assembly. Quarterly FID: clean detector
Check temperatures of injectors and detectors. Verify temperature programs.	Change glass wool plug in injection port and/or replace injection port liner when front portion of column packing is changed or front portion of capillary column is removed.	Semi-annually ECD: perform wipe test.
Check inlets, septa. Clean injector port	Replace septum	Annually ELCD: change finishing resin, clean solvent filter. Annually FID: Replace flame tip ECD: detector cleaning and re-foiling, every five years or whenever loss of sensitivity, or erratic response or failing resolution is observed.
Check baseline level.	Perform gas purity check (if high baseline indicates that impure carrier gas may be in use).	
Check reactor temperature of electrolytic conductivity detector. Inspect chromatogram to verify symmetrical peak shape and adequate resolution between closely eluting peaks.	Replace or repair flow controller if constant gas flow cannot be maintained.	
	Replace fuse.	
	Reactivate external carrier gas dryers.	
	Detectors: clean when baseline indicates contamination or when response is low. Clip column leader FID: clean/replace jet, replace ignitor. NPD: clean/replace collector assembly. PID: clean lamp window quarterly or replace as needed, replace seals. ELCD: check solvent flow weekly, change reaction tube, replace solvent, change reaction gas, clean/replace Teflon® transfer line. ECD: follow manufacturers suggested maintenance schedule FPD: clean/replace jet, replace photo-multiplier tube	
	Reactivate flow controller filter dryers when presence of moisture is suspected.	

TABLE 8.11-6
Instrument Maintenance Schedule
Gas Chromatograph[1]
(Continued)

Daily	As Needed	Quarterly/Semi-annually/Annually
GC (continued)	HP 7673 Autosampler: replace syringe, fill wash bottle, dispose of waste bottle contents.	
	Purge & trap devices: periodic leak checks quarterly, replace/condition traps (when poor response or disappearance of reactive or poorly trapped compounds), clean sample lines, valves (if they become contaminated), clean glassware. Clean sparger weekly. Check purge flow monthly. Bake trap as needed to correct for high background. Change trap annually, or as needed whenever loss of sensitivity, or erratic response or failing resolution is observed.	
	Purge & trap autosamplers: leak check system, clean sample lines, valves. PTA-30 autosampler also requires cleaning the syringes, frits, valves, and probe needles, adjustment of micro switches, replacement of Teflon® valve, and lubrication of components.	

TABLE 8.11-7
Instrument Maintenance Schedule
Mass Spectrometer[1]

Daily	Weekly	As Needed[2]	Quarterly	Annually
Check for sufficient gas supply. Check for correct column flow and/or inlet pressure.	Check mass calibration (PFTBA or FC-43)	Check level of oil in mechanical pumps and diffusion pump if vacuum is insufficient. Add oil if needed between service contract maintenance.	Check ion source and analyzer (clean, replace parts as needed)	Replace the exhaust filters on the mechanical rough pump every 1-2 years.
Check temperatures of injector, detector. Verify temperature programs.		Replace electron multiplier when the tuning voltage approaches the maximum and/or when sensitivity falls below required levels.	Check vacuum, relays, gas pressures and flows	
Check inlets, septa.		Clean Source, including all ceramics and lenses - the source cleaning is indicated by a variety of symptoms including inability of the analyst to tune the instrument to specifications, poor response, and high background contamination.	Change oil in the mechanical rough pump. Re-lubricate the turbomolecular pump-bearing wick.	
Check baseline level.		Repair/replace jet separator.		
Check values of lens voltages, electron multiplier, and relative abundance and mass assignments of the calibration compounds.		Replace filaments when both filaments burn out or performance indicates need for replacement.		
		Clean rods.		

TABLE 8.11-8
Instrument Maintenance Schedule
Ion Chromatograph[1]

As Needed	Daily	Weekly	Monthly	Semi-annually
Clean micromembrane suppressor when decreases in sensitivity are observed.	Check plumbing/leaks.	Check pump heads for leaks.	Check all air and liquid lines for discoloration and crimping, if indicated.	Clean conductivity cell.
Check fuses when power problems occur.	Check gases.	Check filter (inlet)	Check/change bed supports guard and analytical columns, if indicated.	Check conductivity cell for calibration.
Reactivate or change column when peak shape and resolution deteriorate or when retention time shortening indicates that exchange sites have become deactivated.	Check pump pressure.			
De-gas pump head when flow is erratic.	Check conductivity meter.			

TABLE 8.11-9
Instrument Maintenance Schedule
LACHAT Auto Analyzer[1]

As Needed	Daily	Monthly	Semi-annually	Annually
Prepare fresh reagents.	Check detector. Clean detector cell and make sure there are no trapped bubbles in detector cell. Check Valves Check Reference source	Replace tubing.	Lubricate pump roller.	Clean pump rollers with steel wool and lubricate.
	Check peristaltic tubing. Check sampler Check auto diluter	Clean pump, diluter, and XYZ Sampler.		
	Clean sample probe shaft.			

TABLE 8.11-10
Instrument Maintenance Schedule
Sonicator[(1)]

Daily	As Needed
Daily when used: Inspect probe tips for inconsistencies (etching/pitting).	Replace probe tip.
	Disassemble and clean sonicator probe tips.
	Tune sonicator assembly.

TABLE 8.11-11
Instrument Maintenance Schedule
Analytical/Top Loading Balances[(1)]

Daily	Annually
Check using Class S-verified weights once daily or before use Clean pan and weighing compartment	Manufacturer cleaning and calibration.

TABLE 8.11-12
Instrument Maintenance Schedule
Refrigerators/Walk-in Coolers[(1)]

Daily	As Needed
Temperatures checked and logged.	Refrigerant system and electronics serviced.

TABLE 8.11-13
Instrument Maintenance Schedule
Ovens[(1)]

Daily	As Needed
Temperatures checked and logged.	Electronics serviced.

TABLE 8.11-14
Instrument Maintenance Schedule
Specific Digital Ion Analyzer(1)

Daily	As Needed
Daily when used: Calibrate with check standards. Inspect electrode daily, clean as needed. Inspect electrode proper levels of filling solutions daily, fill as needed. Clean probe, each use.	Electronics serviced.

TABLE 8.11-15
Instrument Maintenance Schedule
Conductance Meter(1)

Daily	As Needed
Daily when used: Check probe and cables. Standardize with KCl. Inspect conductivity cell	Electronics serviced.

TABLE 8.11-16
Instrument Maintenance Schedule
Chemical Oxygen Demand (COD) Reactor(1)

Daily	As Needed
Daily when used: Temperature checked and logged. Visual inspection for cleanliness.	Electronics serviced.

TABLE 8.11-17
Instrument Maintenance Schedule
Spectrophotometer[1]

As Needed	Daily	Monthly	Annually
Dust the lamp and front of the front lens.	Check the zero %A adjustment.	Clean windows	Check instrument manual.
	Clean sample compartment		Perform wavelength calibration.
	Clean cuvettes		Replace lamp annually or when erratic response is observed.
			Clean and align optics.

TABLE 8.11-18
Instrument Maintenance Schedule
pH Meter[1]

As Needed	Daily
Clean electrode.	Inspect electrode. Verify electrodes are properly connected and filled.
Refill reference electrode.	Inspect electrode proper levels of filling solutions. Make sure electrode is stored in buffer.

TABLE 8.11-19
Instrument Maintenance Schedule
Total Organic Carbon Analyzer (Dohrman Phoenix)

Daily	As Needed	Weekly	Monthly	Semi-Annually
Check: Oxygen supply Persulfate supply Acid supply Carrier gas flow rate (~ 150 cc/min) IR millivolts for stability (after 30 min. warm-up) Reagent reservoirs	Check injection port septum after 50-200 runs. Tube end-fitting connections after 100 hours or use. Indicating drying tube. NDIR zero, after 100 hours of use. Sample pump, after 2000 hours for use. Digestion vessel/condensation chamber, after 2000 hours of use. Permeation tube, after 2000 hours of use. NDIR cell, after 2000 hours of use.	Check liquid-flow-rate-pump-tubing conditions on autosampler Check injection port septum	Clean digestion vessel Clean condenser column Do the leak test	Change pump tubing

TABLE 8.11-20
Instrument Maintenance Schedule
Digestion Block

Annually
Check temperature with NIST thermometer

TABLE 8.11-21
Instrument Maintenance Schedule
Flash Point Tester

Daily	Annually
Check tubing	Check thermometer against NIST thermometer
Clean sample cup each use	
Check gas	
Clean flash assembly	
Check stirrer	

TABLE 8.11-22
Instrument Maintenance Schedule
Entech Pre-concentrator

As Needed	
Change control boards	Replace fittings
Change power supply	Check multi-port valve alignment
Change sample traps	Change back plane
Change sample lines	

Footnotes to Preventive Maintenance Tables

(1) Refer to manufacturer's instructions for each instrument to identify and perform maintenance operations.
(2) Also see Table 8.11-11 for applicable "As Needed" GC maintenance.

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9.0 Quality Assessment and Response

This section describes the procedures for monitoring and assessing conformance to quality specifications and for correcting and documenting conditions that are adverse to quality.

9.1 Nonconformance and Corrective Action

Procedures and responsibilities related to control of nonconforming items and activities are discussed below, along with corrective action response requirements related to these procedures.

9.1.1 Nonconformance

A nonconformance is an unplanned deviation from an established protocol or plan. In some cases, a nonconformance may be an exceptionally permitted departure from documented policies and procedures or from standard specifications. A deviation that is systematic, or recurring, is termed a deficiency. A single isolated event or event beyond the control of STL Austin is then termed an anomaly.

Nonconformances can be identified on the basis of internal or external systems or performance audits, sample processing, routine calibration and monitoring of analytical and support equipment, or QC sample analyses. The Technical Director, Operations Manager, Project Manager, QA Manager, Laboratory Manager and Analyst may be involved in identifying the most appropriate corrective action. Incidents of reissuing reports as a consequence of nonconformances are compiled in monthly QA reports to management. Significant incidents may be brought to the immediate attention of the Corporate QA Director for resolution.

9.1.2 Corrective Action

Corrective actions are measures taken to rectify conditions adverse to quality and, where possible, to prevent their reoccurrence. Corrective actions should be timely, determine the root cause, and evaluate any propagation of the error or problem. Whenever a systematic error is discovered that affects the accuracy or defensibility of results reported to STL Austin's clients, Corporate QA involvement followed by client notification will be part of the corrective action. Corrective actions should be implemented with an understanding of the technology and work activities associated with the quality element, with appropriate training of STL Austin staff and vendors, and should be monitored for progress and success.

Depending on the nature of the problem, the corrective action employed may be formal or informal. In either case, occurrence of the problem, the corrective action employed, and verification that the problem has been eliminated must be documented properly. On-the-spot actions are used to correct minor problems, such as recalibration, retuning, or a minor repair (e.g., replacement of a minor part) of a malfunctioning instrument or the correction of poor analytical technique being used by an analyst. These occurrences are documented in the appropriate injection, run or analysis logbooks.

Similarly, routine instrument maintenance, malfunctions and power failures are also documented in the appropriate instrument maintenance logbooks. These events do not require a formal Nonconformance Memo (NCM) process. Corrective actions specific to analytical methods are discussed in the SOPs.

9.1.3 Responsibilities

A detailed description of the responsibilities associated with nonconformance and corrective action, as well as the procedures to be followed, is provided in SOP Number AUS-QA-0013, "Nonconformance and Corrective Action."

9.1.4 Nonconformance Memo (NCM)

All nonconformances, deficiencies and anomalies, are documented via an electronic process (*e.g.*, Clouseau or QCER) or on a paper form that meets NCM requirements as approved by QA. An allowed exception is log-in conformance problems, which are documented on the COC Addendum (see LQM Section 8.5.) Deficiencies and anomalies may be documented on separate systems or forms. A log or computerized data base will be maintained for all nonconformances determined to be deficiencies. Deficiencies will be examined for trends periodically, and this evaluation will be documented and reported to management. A copy (paper or electronic) of the nonconformance memo will be kept in the project files along with the data it refers to. A copy (paper or electronic) shall also be kept in the quality files or TraQAr (electronic database for tracking nonconformances.)

9.2 Internal Audits

Internal audits are performed to assess the degree of adherence to established policies, procedures and standards. STL personnel who are independent of the area being evaluated conduct these assessments. Audits can identify areas for improvement with regard to compliance with policies, procedures and standards. Audits also provide a means for correction prior to system failure.

Audits and assessments are generally conducted through the use of checklists and relevant reference documents. The findings of all audits and assessments are documented as is the laboratory response and any corrective actions. Follow-up checks are performed and the status of implementation of corrective actions is documented for all categories of audits and assessments. This cycle continues until all issues are closed.

9.2.1 Audit Types and Frequency

The following types of audits are performed at STL Austin.

Audit Type	Performed By	Frequency
Systems Audits	QA Department or designee	Annual per lab section
Analytical Reports	QA Department	As needed to ensure an effective secondary review process

Audit Type	Performed By	Frequency
Data Authenticity Audits	QA Department	100% of all analysts per year
Electronic Data Audits	QA Department	100% of all organic instruments per year
Spot Assessments	QA Department or designee	As needed to monitor specific issues
Proficiency Testing	Coordinated by QA Department	Two samples per year per program as required by NELAC

Where specific clients or regulators programs, such as AFCEE, require more frequent data audits, then the higher frequency data auditing will be performed.

9.2.2 Systems Audits

Facility systems audits are comprehensive technical and systems evaluations covering each operational and support area at least once per year. Generally, a rotating schedule is established throughout the year to ensure adequate coverage of all areas. This schedule can change as situations in the lab warrant. The objectives and schedule of the audit are communicated to the lab groups being assessed in advance of the audit. At the completion of the audit, a debriefing may be held to outline the findings, including identification of positive performance, to discuss areas of deficiencies, and to answer questions. The QA Manager issues the audit report within 30 calendar days of the audit. The audit report is addressed to the area supervisor and/or manager, and copied to the General Manager and Laboratory Director. Written audit responses are required within 30 calendar days of the date of the audit report. The audit response from the lab areas must follow the format of the original audit report, and is sent from the respondents to all individuals copied on the audit report. Where a corrective action requires longer than 30 days to complete, the target date for the corrective action is stated and evidence of corrective action is submitted to the QA department in the agreed upon time frame.

This process is further described in STL SOP S-Q-002, “System Audits,” and STL Austin SOP AUS-QA-0023, “Audits, Internal Surveillances and Assessments.”

9.2.3 Data Audits

Data audits are focussed to assess the level of method compliance, regulatory compliance, accuracy and completeness of test results, and documentation and adherence to established QC criteria, laboratory SOPs, technical policy and project specific QC criteria. The data audit is used to identify any lab errors that may have occurred. Significant issues found in the course of the audit are brought to the attention of appropriate personnel for clarification, and oversight of corrections to final reports as necessary. Data audits include spot–checking of manual integrations to determine if they are appropriate and documented according to SOP AUS-QA-0027, “Acceptable Manual Integration Practices.” If significant errors are identified in client reports during data audits, then the reports are revised and the revision sent to the client (also see LQM Section 8.9.4.)

9.2.3.1 Data Authenticity Audits

The QA department shall coordinate and document annual data authenticity audits of all analysts. These audits shall be performed by qualified staff members.

9.2.3.2 Electronic Data Audits

The QA department shall conduct and document annual electronic data audits of all organic instrumentation, at a minimum.

9.2.4 Spot Assessments

Spot assessments, equivalent to special audits in the STL QMP, are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, validator concerns, corrective actions, control chart or NCM trends, proficiency testing results, data audits or external audit issues. Spot assessments are focused on a specific issue. The frequency, report format, distribution and timeframes are tailored to address the nature of the issue.

The scope of the assessment is determined by the QA Manager and may be directed based on information obtained from client inquiries, trends in recorded nonconformances, performance audits or other sources. A spot assessment may be used to assess a procedure performance relative to the documented SOP. This assessment identifies deviations from requirements that may not be detected in a detailed review of the data package alone. Such an assessment is conducted by observation of the associates performing the task compared with the documented SOP. In some cases, the assessment may be conducted through interviews with the associate when observation of a task is not possible. Review of relevant documentation for the completed procedure is included in such an assessment. A checklist may be used in conducting the assessment. The results of the assessment are documented, as are the corrective actions. All deficiencies noted as a result of a spot assessment must be corrected by the responsible staff in a timely manner.

This process is further described in the SOP AUS-QA-0023, “Audits, Internal Surveillances and Assessments.”

9.2.5 Proficiency Testing

Proficiency testing (PT) samples are conducted to verify the ability of the laboratory to correctly identify and quantitate compounds in PT samples. PT samples may be supplied internally or externally as single-blind or double-blind samples and can be used to assess if a deficiency has been corrected. The results of internal performance audits may be used to document the proficiency of the analyst performing the work or to assess the overall performance of an analytical method.

PT samples are handled and tested in the same manner as environmental samples; therefore it is not acceptable to run multiple replicates that would not otherwise be performed, it is not acceptable to

average multiple results, and PT results cannot be shared among labs in advance of the close of the study. PT test sample data is archived using the same requirements as for project and raw data record retention.

The results of each proficiency test shall be reported to laboratory management. All PT results that are identified as unacceptable must be investigated. The findings of the investigation and corrective action taken must be documented. In the event that no root cause can be identified for PT failure, a makeup PT may be requested and acceptable results can be used to document corrective action for the failed PT and for closure.

9.2.5.1 External PT Samples

STL Austin participates in a number of PT studies, as shown in Table 9.2-1. As part of this program, the laboratory analyzes PT samples from an approved vendor at lease twice annually for the analytes, matrix, methods and NELAC fields of testing for which the lab is maintaining accreditation.

9.2.5.2 Internal PT Samples

Each STL facility performing chemical analyses also participates in a double-blind performance evaluation annually. An external vendor is contracted to submit double-blind samples to the STL laboratories. Both the level of customer service and the accuracy of the test results are assessed objectively by the external contractor. The PT contractor provides a detailed report to the Corporate QA Manager and to each of the STL facilities.

The laboratory also analyzes internal PTs as needed.

9.3 External Audits

Audits of the STL Austin laboratory are performed by external agencies and clients. All scheduled audits are placed on the facility's calendar with the knowledge of the Laboratory Director and the Laboratory QA Manager to assure no scheduling conflicts occur and that appropriate staff will be available to meet the agencies' or clients' objectives.

All deficiencies reported to the laboratory must be responded to within the time line specified by the auditing agency. A plan of action to correct the deficiencies, as well as corrective actions taken, must be documented. It is the responsibility of the QA Manager to coordinate the response to the audit report. The development and implementation of the corrective actions is the responsibility of the Operations Management as related to their respective areas. All responses must be approved by the Laboratory Director prior to submittal to the auditor. A copy of the audit report and the laboratory's response must be provided to the Laboratory Director. It is the responsibility of the QA Manager to verify implementation of the corrective actions and inform the responsible manager of the closure of all deficiencies from the audit.

9.4 Client Inquiries and Complaints

Client inquiries and complaints are taken seriously and promptly addressed to ensure that client expectations are met. The STL Austin Customer Feedback form is used to document compliments, complaints and other input, as well as the action initiated and resolution on complaints and other requests. See SOP AUS-PM-0002, "Procedures to Address Customer Complaints and Erroneous Reports.

Client inquiries and complaints are generally received through the Project Manager or Customer Service Manager. Typically, the PM or CSM communicates with the client to determine the details of the inquiries, including technical data problems, deliverable issues, turn around problems, etc. Technical and deliverable issues are coordinated by the PM and usually involve input from operations, QA, and management staff. As appropriate, a formal written response to the client is coordinated by the PM, but may on occasion be delivered by the CSM or the Account Manager. Details of the types and levels of complaints and required documentation are described in Section 4.8 of the STL QMP.

9.5 Management Reviews

9.5.1 Quality Reports to Management

The QA Manager prepares and maintains copies of reports to management on a monthly basis indicating the effectiveness of the Quality System. The laboratory's monthly QA report to management includes, at a minimum, a discussion of the following activities that occurred during the month:

- Audits
  - Internal System Audits
  - External System Audits
  - Data audits
- Revised Reports / Client Feedback
  - Frequency of revised reports
  - Total number of client complaints
  - Total number of compliments
- Certifications / Approvals
  - Issues or changes
  - Lapses or potential revocations
- Proficiency Testing
  - Study participation and scores
  - Combined PT scores
  - Repeat failures and/or significant problems
- SOP Status
  - Percentage of SOPs revised or reviewed in the past 24 months
- Miscellaneous QA and Operational Issues
  - Narrative outlining improvements, regulatory compliance issues, general concerns and assistance required from management

- Metrics Spreadsheet
  - Summary of metrics in template provided by Corporate QA

The monthly QA report is forwarded to the Laboratory Director, General Manager and Corporate QA Director. The information from all STL laboratories' QA reports is compiled by the Corporate QA Director and presented as part of the Corporate QA Monthly Report to the STL Chief Operating Officer.

9.5.2 Management Review of the Quality System

As part of the laboratory's self-assessment program, the Laboratory Director will conduct evaluations of the status of the laboratory quality system annually each January to review their suitability and effectiveness, and to introduce necessary changes or improvements. The evaluation shall consider the following:

- The suitability of policies and procedures;
- Reports from managerial and supervisory personnel;
- The outcome of recent internal audits;
- Corrective and preventative actions;
- Assessments by external bodies;
- The results of interlaboratory comparisons and proficiency tests;
- Status of QA documents;
- Reviews of QA related requirements in RFPs, SOWs, SAPs and QAPPs;
- Changes in the volume and type of work and the effects on the QA systems;
- Client feedback;
- Complaints;
- Quality control activities; and
- Resources and staff training.

The management review of the quality system shall also take into account monthly quality assurance reporting, goal setting and periodic reviews of the LQM. This management review shall be documented and the records of review findings and actions maintained in the Quality and Operations files.

TABLE 9.2-1
Performance Testing Sample Programs

Program Description	Analyses Performed	Frequency of Participation
ERA WP	Minerals, pH, Hardness, Demand, Nutrients-Simple, Nutrients-Complex, Cyanide, Phenolics, Oil, Grease, Bromide, Nitrite, Settleable Solids, Sulfide, Trace Metals, Mercury, Tin, Titanium, Chromium VI, Volatiles, PCBs in Water, PCBs in Oil, Pesticides, Chlordane, Toxaphene, Herbicides, Base Neutrals, Acids and PAHs	Semi-annually
ERA Soil	Trace Metals, Cyanide, Chromium VI, Anions, Corrosivity pH, Ignitability/Flashpoint, Semivolatiles (BNAs, Pesticides), Chlordane, Toxaphene, Volatiles, Herbicides, PAHs, PCBs, Nitroaromatics, Ketones and Nitrosamines	Semi-annually
ERA UST	Gasoline, BTEX, MTBE and Diesel in both Soil and Water; TPH in Water	Semi-annually
ERA TX 1005	Low-level and high-level Fuels in both Soil and Water	Semi-annually
ERA DMRQA	Trace Metals, Mercury, pH, Hardness, Grease & Oil, Demand (COD, TOC), Nutrients-Simple, Nutrients-Complex, Cyanide and Phenolics	Annually
RTC RCRA Soil	Organo Lead	Semi-annually
URS-Austin	TO15	Quarterly
U.S. Army Corps of Engineers	Project-specific Parameters	As needed per approval period

10.0 Quality Improvement

Quality improvement at STL is a critical element of our quality and business. Every STL employee must understand that continuous improvement is a guiding principle pertinent to all aspects of our business and are encouraged to identify and promote opportunities for quality improvement.

The key elements of quality improvement include:

- Standardization of procedures;
- Continuous quality improvement;
- Understanding the clients' needs; and
- Quality measures and standards.

10.1 Standardization of Procedures

Due to the vast number of methods that have been introduced into the environmental analytical field, as well as revisions and proposed updates to currently promulgated methods, many methodologies contain conflicting requirements. It is through the generation and use of standard operating procedures, which contain STL Austin's best technical interpretation of published methods that STL succeeds in providing quality standardized analytical testing to our clients. STL Austin will generate and implement new SOPs and policies as the need arises, and will train associates in their importance and use.

Any departures from standardized procedures must be documented and, if a deficiency is noted, it is documented with a NCM. For further details refer to Section 9.1.1.

10.2 Continuous Quality Improvement

The continuous improvement of processes throughout STL Austin is the responsibility of all employees. All employees are empowered and encouraged to bring suggestions for process improvement changes to the attention of laboratory management. Management is responsible for assessing the recommendation for improvement and following through with an implementation plan when appropriate.

10.2.1 Preventative Action Plan

Preventative action is defined as a feedback system that allows the laboratory to detect and correct a problem before non-conformances or serious problems occur. The feedback tools employed must be broad enough in scope to detect a wide variety of potential failures in lab processes, methods or procedures. Instituting a preventative action plan is a requirement of the STL QMP that derives from ISO Guide 17025 (Section 4.11). It is also consistent with the DOE Quality Assurance Order (O 414.1A) requiring that the laboratory have a system of assessment activities to promote quality improvements. This is a practical form of quality improvement.

10.2.2 Quality System Indices

There are defined quality indices that are reported to laboratory managers on a regular basis to allow them to monitor trends in laboratory quality systems. The assessment activities themselves are described in previous sections of this chapter. The indices and reports used by management include the following:

Index	Minimum Reporting Frequency	Responsible Party for Reports
PT Scores	Monthly	QA Manager
Client Complaints – number and nature	Monthly	QA Manager
SOP Status – percent of SOPs reviewed with 24 months	Monthly	QA Manager
MDL Status – MDLs run within the month	Monthly	Analyst & Lab Manager
External Audit Findings – number and nature	Monthly	QA Manager
Internal Audit Findings – number and nature	Monthly	QA Manager
QA Systems Audit Findings – number and nature	Annually	QA Manager or Lead Auditor Appointed by Corporate Quality Director
Score from Management Review of Quality Systems – percent score defined in report	Annually	Laboratory Director

10.2.3 Data Quality Trending

Each operational group is responsible for appointing analysts to monitor control charts for select compounds for trends that might lead to out of control situations. The selected compounds are indicators proven to be most sensitive to stability of standards, preparation technique, and/or instrument maintenance conditions. If trends are detected, they are reported to the area supervisor so that direction can be provided for improvement.

10.3 Understanding the Client's Needs

Client satisfaction must be a goal of all STL employees. Periodic client surveys provide a useful tool to measure if we are meeting their needs. While quality is defined as meeting the requirements of our clients, both internal and external, we must also strive to exceed our clients' expectations. Every STL employee is either directly or indirectly involved in meeting our client's needs, therefore effective communication of these needs to all employees as described in this LQM is essential.

Any verbal or written inquires or complaints from clients to any associate must be addressed in a timely manner and any issue concerning data quality must be documented. (See LQM Section 9.4 and QMP Section 4.8.)

10.4 Quality Measures and Standards

Measures and standards used by STL Austin are fundamental to assessing and achieving our commitment to continuous improvement. With most business processes, performance is generally measured at the end. STL Austin managers must provide continuous feedback to all employees regarding performance measures and standards.

Key Result Indicators (KRIs) provide one of STL Austin's measures. Additional measures and standards shall be added to track programs, processes, or projects, as appropriate.

KRIs measure performance in areas considered critical to achieving quality in customer satisfaction and business performance. KRIs focus quality measures on the customer as well as the processes that our customers value. KRIs are intended to demonstrate continuous improvement and focus on the 'vital few' issues for the business. STL Austin KRIs include:

- Client complaints;
- On-time delivery;
- Holding time violations;
- Reissued reports;
- Turn-around-time; and
- Safety.

Measurements of performance include internal and external audits, performance evaluations, and double-blind evaluations, which are further described in Section 9.0. Improved results from these measurements indicate successful process improvements.

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Glossary

Glossary (continued)

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Glossary (continued)

acceptance limits
Data quality limits specified for analytical method performance.

accuracy
Accuracy is the degree of agreement between a measurement and the true or expected value, or between the average of a number of measurements and the true or expected value. Systematic errors affect accuracy. For chemical properties, accuracy is expressed either as a percent recovery (R) or as a percent bias (R - 100).

aliquot, aliquant
A measured portion of a sample taken for analysis.

analytical spike
A sample created by spiking target analytes into a prepared portion of a sample just prior to analysis. (Also see matrix spike.)

anomaly
See nonconformance.

areas needing improvement
Represent isolated instances of noncompliance or issues that are judged to have a less immediate impact on data quality. Laboratory management must correct the situation or otherwise ensure that the condition does not recur. This term replaces the previous term used “Observations.”

arithmetic mean
The arithmetic mean ($\bar{x}$) is the average of a set of values. It is equal to the sum of the observed values divided by the number of observations. Also called "average".

where: $\bar{x}$ = the mean
x_i = the ith data value
n = number of data values

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Glossary (continued)

assessment
The evaluation process used to measure the performance or effectiveness of a system and its elements. Assessment is used as an all-inclusive term to denote any of the following: performance, systems, data and compliance audits, management systems reviews, peer reviews, inspections, or spot assessments.

associate
Employee.

audit
A planned and documented investigative evaluation of an item or process to determine its adequacy and effectiveness as well as compliance with established procedures, instructions, drawings, quality management plans, and other applicable documents.

benchmarking
A step-by-step method of improving performance by identifying and studying best practices and comparing them to industry practices.

bias
A systematic (consistent) error in test results. Bias is expressed as the difference between the population mean and the true or reference value, or as estimated from sample statistics, the difference between the sample average and the reference value.

blind performance evaluation sample
A sample either submitted to the laboratory or prepared in the laboratory whereby the concentrations of parameters of concern are known by the preparer and not by the laboratory.

calibration
Establishment of a relationship between various calibration standards and the measurements of them obtained by a measurement system, or portions thereof. The levels of the calibration standard should bracket the range of levels at which actual measurements are to be made. Calibration is also the act of making a scheduled comparison of instrument performance against national standards for instruments which measure physical parameters such as mass, time, and temperature. This type of calibration is independent of use in specific analyses and projects.

Glossary (continued)

calibration curve
The graphical relationship between the known values for a series of calibration standards and instrument responses.

calibration factor (CF)
The ratio of the instrument response of an analyte to the amount injected. CFs are used in external standard calibrations.

$$CF = \frac{Total\ Area\ of\ Peak}{Mass\ Injected}$$

calibration standard
A standard used to quantitate the relationship between the output of a sensor and a property to be measured. Calibration standards should be traceable to standard reference materials (provided by NIST, or other recognized standards agencies) or a primary standard.

Certificate of Analysis
A STL report format containing analytical results without supporting/backup information.

certified reference material
A reference material accompanied by a certificate issued by an organization certifying the contents and concentration(s) of the material. (See also standard reference material.)

chain-of-custody (COC)
A system of documentation demonstrating the physical custody and traceability of samples.

check standard analyses
A standard (often a midpoint standard) analyzed at a frequency specified in the method or in a SOP to verify the continuing calibration of the standard curve.

client
Any individual or organization for whom items or services are furnished or work is performed in response to defined requirements and expectations.

Glossary (continued)

client sample
The material or collection media submitted to the laboratory for analysis. Field QC samples are considered client samples but laboratory QC samples are not counted as client samples when counting samples for QC batches.

coefficient of variation (relative standard deviation)
A measure of precision (relative dispersion). It is equal to the standard deviation (s) divided by the mean ($\bar{x}$) and multiplied by 100 to give a percentage value.

$$CV\ (RSD) = \left(\frac{s}{\bar{x}}\right) x\ 100$$

collocated samples
Independent samples collected in such a manner that they are equally representative of the variable(s) of interest at a given point in space and time. The results will indicate sampling as well as analytical variability.

comparability
Comparability is a measure of the confidence with which one data set can be compared to another. To ensure comparability, all laboratory analysts are required to use uniform procedures (i.e., SOPs) and a uniform set of units and calculations for analyzing and reporting environmental data.

completeness
Completeness is a measure of the percentage of measurements that are judged to be valid measurements. At a minimum, the objective for completeness of data is 90% for each constituent analyzed. It is usually expressed as a percentage:

$$\%\ Completeness = \frac{V}{n} x\ 100$$

where: V = number of measurements judged valid
n = total number of measurements

Glossary (continued)

composite
A sample composed of two or more increments.

control chart
A graphical representation of analytical accuracy. Displays the arithmetic mean of a data set, the upper and lower warning limits and the upper and lower control limits.

control table
A tabular presentation of test results with respect to time or sequence of measurement, together with limits within which the results are expected to lie when the analytical process is in a state of control.

controlled document
A document for which the distribution is known. Updates of the document are sent to the original recipients, unless the copy distributed is an uncontrolled copy.

corrective action
A measure taken to rectify conditions adverse to quality and, where necessary, to preclude their recurrence.

correlation coefficient
The correlation coefficient (r) is a determination of how closely data "fits" a straight line. It is a number between -1 and 1 that indicates the degree of linear relationship between two sets of numbers. A correlation coefficient of +1 (usually calculated to three decimal places or 1.000) means the data falls exactly on a straight line with positive slope. A correlation coefficient of -1 (or -1.000) means the data falls exactly on a straight line with negative slope.

customer
See client.

data quality objective (DQO)
Data quality objectives (DQOs) are qualitative and quantitative statements used to ensure the generation of the type, quantity, and quality of environmental data that will be appropriate for the intended application (EPA 2001). Typically, DQOs are identified during project scope and development of sampling and analysis plans. In this QA manual, however, we refer to only the analytical DQOs because laboratories generally do not have any authority over sample collection,

Glossary (continued)

shipment, or other field-related activities that may affect the data quality of the environmental sample before the sample is received in the laboratory. EPA has established six primary analytical

DQOs for environmental studies: precision, accuracy, representativeness, completeness, comparability, and detectability.

The components of analytical variability (uncertainty) can be estimated when QA and QC samples of the right types and quantities are incorporated into measurement procedures at the analytical laboratory. STL incorporates numerous QA and QC samples to obtain data for comparison with the analytical DQOs and to ensure that the measurement system is functioning properly. The QA and QC samples and their applications are described in Section 8.4 and are selected on the basis of method- or client-specific requirements. Field blanks, field duplicates, and performance evaluation (PE) samples are received from the client as unknown samples. Analytical laboratory QC samples for inorganic, organic, and radionuclide analyses may include calibration or instrument blanks, method blanks, background, duplicates, replicates, laboratory control samples (LCSs), calibration standards, matrix spikes (MSs), matrix spike duplicates (MSDs), surrogate spikes, and yield tracers.

data validation
See validation - data.

data verification
See verification - data.

deficiency
See nonconformance or finding.

degrees of freedom
The number of independent deviations used in calculating an estimate of the standard deviation.

double blind performance evaluation sample
A sample that contains select parameters at defined levels. The levels are unknown to the laboratory. The laboratory is also unaware that the sample is a performance evaluation sample.

duplicate sample analyses
Different aliquots of the same sample are analyzed to evaluate the precision of an analysis.

Glossary (continued)

error
The difference between an observed or measured value and its true value.

field blank
A blank that is prepared and handled in the field and analyzed in the same manner as its corresponding client samples.

field matrix spike
A sample created by spiking target analytes into a sample in the field at the point of sample acquisition.

finding
Noncompliant practices or policies which have significant adverse impact on data quality, technical defensibility, or regulatory acceptance of data. Findings require immediate attention by the laboratory management and must be resolved to comply with STL's quality documents and laboratory-established procedures often called deficiencies by auditors.

geometric mean
The nth root of the product of all values in a set of n values or the antilogarithm of the arithmetic mean of the logarithms of all the values of a set of n values. The geometric mean is generally used when the logarithms of a set of values are nearly normally (Gaussian) distributed, such as is the case of much population data.

initial calibration
Analysis of a series of analytical standards at different specified concentrations; used to define the linearity and dynamic range of the response of an instrument to the target compounds prior to the analysis of samples.

inspection
Examination or measurement of an item or activity to verify conformance to specific requirements.

instrument detection limit (IDL)
IDL is a calculated estimate of instrument detectability defined by the USEPA Contract Laboratory Program (CLP).

Glossary (continued)

internal standard (IS)
A compound added to every standard, QC sample, client sample, or sample extract at a known concentration prior to analysis for the purpose of quantitation. For example, internal standards are used as the basis for quantitation of the target compounds by GC/MS.

Laboratory Quality Manual (LQM)
The Laboratory Quality Manual (LQM) is a formal document that describes quality systems in terms of organizational structure, functional responsibilities of management and staff, and lines of authority. The LQM documents the QMS and describes both the organizational and project-specific principles, goals, controls, and tools of the QMS. The LQM provides the criteria and specifications for the generation of environmental analytical data. The LQM may include by reference other documentation relating to the laboratory's quality system.

linear regression
A statistical method for finding a straight line that best fits a set of two or more data points, thus providing a relationship between two or more variables.

matrix
The component or substrate which contains the analyte(s) of interest. Examples of matrices are water, soil or sediment, and air. Matrix is not synonymous with phase (liquid or solid).

matrix effect
An interference in the measurement of analyte(s) in a sample that is caused by materials in the sample. Matrix effects may cause elevated reporting limits or may prevent the acquisition of acceptable results.

matrix spike (MS)
An aliquot of a matrix fortified (spiked) with known quantities of specific compounds and subjected to an entire analytical procedure in order to indicate the appropriateness of the method for a particular matrix. The percent recovery for the respective compound(s) is then calculated.

matrix spike duplicate (MSD)
A second aliquot of the same matrix as the matrix spike (above) that is spiked in order to determine the precision of the method.

Glossary (continued)

may
Denotes permission but not a requirement.

mean
See arithmetic mean.

measurement
The process or operation of ascertaining the extent, degree, quantity, dimensions, or capability with respect to a standard.

median
The middle value of a set of data when the data set is ranked in increasing or decreasing order.

method
An assemblage of techniques.

method blank (MB)
An analytical control consisting of all reagents, which may include internal standards and surrogate standards, that is carried through the entire analytical procedure. The method blank is used to define the level of laboratory background contamination. Examples of method blanks are a volume of deionized or distilled laboratory water for water samples, a purified solid matrix for soil/sediment samples, or a generated zero air.

method detection limit (MDL)
The minimum concentration of an analyte that, in a given matrix and with a specific method, can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero. The MDL is operationally defined as:

$$MDL = st_{(n-1,\ \alpha = 0.99)}$$

where:

s = the standard deviation of a number of measurements of a blind or sample matrix containing the analyte at a concentration near the lowest standard recommended in the method and

$t_{(n-1,\ \alpha = 0.99)}$ = the student's value for a one-sided t-statistic appropriate for the number of samples used to determine (s), at the 99% confidence level and n-1 degrees of freedom.

Glossary (continued)

modified method
A standard or reference method which has been changed to meet project or matrix requirements.

must
Denotes a requirement is mandatory and has to be met.

notable practices
Laboratory practices that increase effectiveness and quality and represent improvements with respect to conventional laboratory operations.

nonconformance
An unplanned deviation from an established protocol or plan. The deviation may be the result of STL's actions, then termed a deficiency. If the deviation is the result of events beyond the control of STL, it is termed an anomaly.

operational calibration
Routinely performed as part of instrument usage, such as the development of a standard calibration curve. Operational calibration is generally performed for instrument systems.

outlier
A result excluded from the statistical calculations due to being deemed "suspicious" when applying the "Grubbs Test" (or equivalent).

parameter
A constant or coefficient that describes some characteristic of a population (e.g., standard deviation, mean, regression coefficients). Also, a chemical being measured, i.e., an analyte.

percent difference
When two independent measurements of the same characteristics are available, it is possible to use the percent difference instead of the coefficient of variation to measure precision.

$$\%D = \left| \frac{X_1 - X_2}{X_1} \right| x\ 100\%$$

where: $\%D$ = percent difference
X_1 = first value
X_2 = second value

Glossary (continued)

percent recovery
A measure of accuracy determined from the comparison of a reported spike value to its true spike concentration.

$$\%R = \frac{\textit{observed conc. - sample conc.}}{\textit{true spike conc.}} \times 100\%$$

performance audit
See performance evaluation.

performance evaluation (PE) or proficiency testing (PT)
A type of audit in which a known or characterized value is compared to the result obtained through the routine analysis of the sample in the laboratory to evaluate the proficiency of an analyst or laboratory.

periodic calibration
A calibration that is performed at prescribed intervals for equipment such as balances, thermometers, and balance weights. In general, they are performed on equipment that are distinct, singular purpose units, and are relatively stable in performance.

population
A generic term denoting any finite or infinite collection of individual things, objects, or events.

practical quantitation limit (PQL)
The lowest concentration a method can reliably achieve within limits of precision and accuracy and is derived from empirical, matrix-free method performance studies.

precision
Precision is an estimate of variability, that is, it is an estimate of agreement among individual measurements of the same physical or chemical property, under prescribed similar conditions. The precision of a measurement system is affected by random errors. Precision is expressed either as relative standard deviation (RSD) for replicate measurements greater than two or as relative percent difference (RPD) for duplicate measurements. Table 8.6-1 illustrates the formulae used to calculate units of precision (i.e., RSD and RPD).

Glossary (continued)

preventive maintenance
An organized program within the STL laboratories of actions (such as equipment cleaning, lubricating, reconditioning, adjustment and/or testing) taken to maintain proper instrument and equipment performance and to prevent instruments and equipment from failing during use.

primary standard
A material having a known, stable property that can be accurately measured or derived from established physical or chemical constants. It is readily reproducible and can be accepted (within stated limits) and used to establish the same value of another substance or item.

procedure
Detailed instructions to permit replication of a method. (See standard operating procedure.)

proficiency testing
A series of planned tests that will determine the ability of field technicians or laboratory analysts to perform routine analyses. The results from this testing may be used for comparison against established criteria or for relative comparisons among the data from a group of technicians or analysts.

project-specific reporting limit (PSRL)
See reporting limit.

protocol
Methodology specified in regulatory, authoritative, or contractual situations.

QC batch
The QC batch consists of a set of up to 20 field samples that behave similarly (i.e., same matrix) and are processed using the same procedures, reagents, and standards within the same time period.

QC check sample
A reference matrix containing known concentrations of parameters of interest. If prepared in the laboratory, it is made using stock standard solutions independent of those used for calibration. If the results of these parameters do not meet acceptance criteria, corrective actions are taken.

Glossary (continued)

qualification (personnel)
The characteristics of abilities gained through education, training, or experience, as measured against established requirements, such as standards or tests, that qualify an individual to perform a required function.

quality
The sum of features and properties/characteristics of a process, item, or service that bears on its ability to meet the stated needs of the user. STL has defined quality as meeting the needs of our clients, both internal and external.

quality assurance (QA)
An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the customer.

Quality Assurance Directive
QA directives are memos issued by the QA Director (or the QA Manager for the facility) to clarify policies, procedures, the QMP, and the LQM; or to give direction for an immediate action to ensure or maintain quality.

Quality Assurance Project or Program Plan (QAPP)
A formal document describing in comprehensive detail the necessary QA, QC, and other technical activities that must be implemented to ensure the results of the work performed will satisfy the stated performance criteria.

quality control (QC)
The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that it meets the stated requirements established by the client or by STL.

quality improvement
The process of improving the quality of operations. This process encourages worker recommendations for improvement of work processes and requires timely management evaluation and feedback or implementation.

Glossary (continued)

quality management
That aspect of the overall management system of the organization that determines and implements the quality policy. Quality management includes strategic planning, allocation of resources, and other systematic activities (e.g., planning, implementation, and assessment) pertaining to the quality management system.

quality management system (QMS)
A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, and implementation plan of an organization for ensuring quality in its work processes, products, and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC.

Quality Management Plan (QMP)
The Quality Management Plan is a formal document describing the management policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of STL to ensure the quality of its product and the utility of the product to its users.

random error
Variations of repeated measurements that are random in nature and individually not predictable.

range
The difference between the largest and smallest numbers in a set of numbers.

raw data
All documentation associated with the original recording of analytical results pertinent to a specific sample or set of samples. This may include laboratory worksheets, calculation forms, instrument-generated output, analyst notes, etc., from sample receipt through final reporting.

reagent water
Water in which an interferant is not observed at or above the minimum quantitation limit of the parameters of interest. The reagent water's purity and acceptability is verified by analysis with each set of samples.

Glossary (continued)

recovery
See percent recovery.

reference method
A method of known and demonstrated accuracy.

regression coefficients
The quantities describing the slope and intercept of a regression line.

relative error
An error expressed as a percentage of the true value or accepted reference value.

relative percent different (RPD)
Statistic for evaluating the precision of a replicate set. For replicate results:

$$RPD = \left[\frac{|X_1 - X_2|}{\left(\frac{X_1 + X_2}{2} \right)} \right] x\ 100$$

where: X_1 = first observed concentration
X_2 = second observed concentration

relative response factor (RRF)
A measure of the relative mass spectral response of a compound compared to its internal standard. RRFs are determined by analysis of standards and are used in the calculation of concentrations of analytes in samples. Because a RRF is the comparison of two responses, it is a unitless number. RRFs are determined by the following equation:

$$RRF = \frac{A_x}{A_{IS}} x \frac{C_{IS}}{C_x}$$

where: A = area of the characteristic ion measured
C = concentration

Glossary (continued)

IS = internal standard
x = analyte of interest

relative standard deviation (RSD)
See coefficient of variation.

reporting limit (RL)
One of two types of reporting limit conventions within STL. The Reporting Limit (RL) is a uniform reporting limit based on an evaluation of the PQLs and the expected method performance in routine water and soil matrices. Project-Specific Reporting Limits (PSRLs) are reporting limits that are defined by project requirements.

representative sample
A sample taken to represent a lot or population as accurately and precisely as possible.

representativeness
Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, a variation in a physical or chemical property at a sampling point, or an environmental condition. Data representativeness is primarily a function of sampling strategy; therefore, the sampling scheme must be designed to maximize representativeness. Representativeness also relates to ensuring that, through sample homogeneity, the sample analysis result (concentration) is representative of the constituent concentration in the sample matrix. At the laboratory, every effort must be made to analyze an aliquot that is representative of the original sample, and to ensure the homogeneity of the sample before subsampling.

reproducibility
The precision, usually expressed as a standard deviation, measuring the variability among results of measurements of the same sample at different laboratories.

response factor (RF)
A factor derived from the calibration of a compound that is used in the quantitation calculation of sample analytes. A response factor may be derived from an external standard calibration (then called a Calibration Factor) or from an internal standard calibration (then called a Relative Response Factor).

Glossary (continued)

secondary standard
A material having a property that is calibrated against a primary standard.

self assessment
Assessments of work conducted by individuals, groups, or organizations directly responsible for overseeing or performing the work.

shall
Denotes a requirement that is mandatory and has to be met.

should
Denotes a guideline or recommendation.

standard addition
The procedure of adding known increments of the analyte of interest to a sample to cause increases in detection response to subsequently establish, by extrapolation of the plotted responses, the level of the analyte of interest present in the original sample.

standard deviation
A measure of the dispersion about the mean of the elements in a population. The square root of the variance of a set of values:

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

where: s = standard deviation
Σ = sum of
X = observed values
n = number of observations

Glossary (continued)

standardization
The establishment of the value of a potential standard with respect to an established or known standard.

standard method
A method of known and demonstrated precision issued by an organization generally recognized as competent to do so.

standard operating procedure (SOP)
A written document that details an operation, analysis, or action, with prescribed techniques and steps, that is officially approved as the method for performing certain routine or repetitive tasks.

standard reference material (SRM)
A material produced in quantity, of which certain properties have been certified by the National Institute of Standards and Technology (NIST), formerly NBS, or other agencies to the extent possible to satisfy its intended use.

standard verification
Standard is checked by the laboratory or the vendor versus a known specification. See Section 8.5.4.3.

statistic
A constant or coefficient that describes some characteristic of a sample. Statistics are used to estimate parameters of populations.

stock solution
A concentrated solution of analyte(s) or reagent(s) prepared and verified by prescribed procedure(s), and used for preparing working standards or standard solutions.

subsample
A portion taken from a sample. A laboratory sample may be a subsample of a gross sample; similarly, a test portion may be a subsample of a laboratory sample.

supplier
See vendor.

Glossary (continued)

surrogate (surrogate standard)
Compounds, when required by a method, that are used added to every blank, sample, LCS, matrix spike, matrix spike duplicate, and standard. They are used to evaluate analytical efficiency by measuring recovery. Surrogates include brominated, fluorinated, or isotopically-labeled compounds that are not expected to be detected in environmental media.

systematic error
The condition of a consistent deviation of the results of a measurement process from the reference or known level.

systems audit or evaluation
A systematic on-site qualitative review of facilities, procedures, equipment, training, record keeping, data verification, and reporting aspects of a quality assurance system to arrive at a measure of the capability of the system.

technique
Physical or chemical principle for characterizing materials of chemical systems.

traceability of data
The entire documented chain of acquired data from the original acquisition effort through to the final tabulation, synthesis, reduction, and storage activities. The documentation will allow complete reconstruction of the data.

traceability of samples
During all environmental monitoring field efforts, acquired samples will be assigned specific and unique identification numbers. These sample numbers shall be accompanied by documentation (chain-of-custody form) which clearly identifies all parameters associated with sample acquisition. All additional sample-numbering systems applied to the sample must be clearly cross-referenced to the field sample number to provide for traceability of samples from acquisition to reporting of sample results.

traceability of standards
The ability of an analytical standard material used for calibration purposes to be traced to its source. The standards used by STL must be traceable via written documentation to sources which produce or sell verified or certified standards, i.e., National Institute for Standards and Technology, or vendors preparing standards from those sources which they have certified.

Glossary (continued)

validation - computer software
The process of establishing documented evidence which provides a high degree of assurance that a specific process will consistently produce a product meeting predetermined specifications and quality attributes. This process demonstrates and documents that the software performs correctly and meets all specified requirements.

validation - data
The process of a second party performing a systematic review of the raw and final data produced by a laboratory using predetermined criteria to ascertain the validity of the data with respect to the criteria (e.g., HAZWRAP data validation).

vendor
Any individual or organization furnishing items or services or performing work according to a procurement document. This is an all-inclusive term used in place of any of the following: supplier, seller, contractor, subcontractor, or consultant.

verification - computer software
The process of checking the accuracy of manually entered or automatically (electronically) calculated information.

verification - data
The process of reviewing data to ensure that data reduction has been correctly performed and that analytical results to be reported correspond to the data acquired and processed.

STL

Laboratory Quality Manual

STL Denver

Revision 2
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4955 Yarrow Street
Arvada, Colorado 80002
Phone: 303-736-0100
FAX: 303-431-7171
www.stl-inc.com

Robet C. Hanisch, Laboratory Director 303-736-0183
Michael Schmitt, Quality Assurance Manager 303-736-0117

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Leaders in Environmental Testing

Laboratory Quality Manual

STL Denver

Revision 2
May 2007

Approval Signatures

Robert Hanisch, Laboratory Director — Date: 5/21/07

Michael Schmitt, Quality Assurance Manager — Date: 5/21/07

Sherry Scaggiari, Operations Manager — Date: 5/22/07

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Quality Assurance Manual

TestAmerica Pensacola
3355 McLemore Dr.
Pensacola, Fl 32514
850-474-1001
850-478-2671

www.testamericainc.com

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Quality Assurance Manual
Approval Signatures

Laboratory Director – Susan Rembert	12/12/07 Date
QA Manager – Mandi Edwards	12/12/07 Date
Operations Manager – Lance Larson	12-12-07 Date
Customer/Sample Control/Field Director – John Meade	12-12-07 Date
Department Manager, Extractions – Stephanie Bubien	12-12-07 Date
Department Manager, Semivolatiles / EH&S – Steve Wilhite	12-12-07 Date
Department Manager, GCMS Volatiles – Richard McCoy	12-12-07 Date
Department Manager, GC Volatile – Shelley Kearley	12/12/07 Date
Department Manager, Metals – John Reed	12/12/07 Date
Department Manager, Wet Chemistry – Wendy Gimlin	12-12-07 Date

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Appendix C

USEPA Groundwater Sampling Guidance Paper (QAPP)

Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers

GROUND WATER FORUM ISSUE PAPER

Douglas Yeskis* and Bernard Zavala**

BACKGROUND

The Ground Water, Federal Facilities and Engineering Forums were established by professionals from the United States Environmental Protection Agency (USEPA) in the ten Regional Offices. The Forums are committed to the identification and resolution of scientific, technical, and engineering issues impacting the remediation of Superfund and RCRA sites. The Forums are supported by and advise OSWER's Technical Support Project, which has established Technical Support Centers in laboratories operated by the Office of Research and Development (ORD), Office of Radiation Programs, and the Environmental Response Team. The Centers work closely with the Forums providing state-of-the-science technical assistance to USEPA project managers.

This document provides sampling guidelines primarily for ground-water monitoring wells that have a screen or open interval with a length of ten feet or less and which can accept a sampling device. Procedures that minimize disturbance to the aquifer will yield the most representative ground-water samples. This document provides a summary of current and/or recommended ground-water sampling procedures. This document was developed by the Superfund/RCRA Ground Water Forum and incorporates comments from ORD, Regional Superfund hydrogeologists and others. These guidelines are applicable to the majority of sites, but are not intended to replace or supersede regional and/or project-specific sampling plans. These guidelines are intended to assist in developing sampling plans using the project-specific goals and objectives. However, unusual and/or site-specific circumstances may require approaches other than those specified in this document. In these instances, the appropriate Regional hydrologists/geologists should be contacted to establish alternative protocols.

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* U.S. Environmental Protection Agency, Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604

**U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Technology Innovative office
Office of Solid Waste and Emergency Response, US EPA, Washington, DC

Walter W. Kovalick, Jr., Ph.D.
Director

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INTRODUCTION

The goal of ground-water sampling is to collect samples that are “representative” of in-situ ground-water conditions and to minimize changes in ground-water chemistry during sample collection and handling. Experience has shown that ground-water sample collection and handling procedures can be a source of variability in water-quality concentrations due to differences in sampling personnel, sampling procedures, and equipment (U.S. Environmental Protection Agency, 1995).

Several different ground-water sampling procedures can be used, which vary primarily through the criteria used to determine when a sample is representative of ground-water conditions. No single method or procedure is universally applicable to all types of ground-water-sampling programs; therefore, consideration should be given to a variety of factors when determining which method is best suited to site-specific conditions. These site-specific conditions include sampling objectives, equipment availability, site location, and physical constraints. This paper will discuss each of these conditions and how they may contribute to the decision in choosing the appropriate sampling methodology and equipment to be used during ground-water sampling.

This paper focuses on ground-water sampling procedures for monitoring wells only where separate, free-phase, Non-Aqueous Phase Liquids (NAPLs) are not present in the monitoring well. Residential and/or municipal-production wells where special sampling procedures and considerations need to be implemented are not discussed in this document. The recommendations made in this paper are based on findings presented in the current literature, and will be subject to revision as the understanding of ground-water-sampling procedures increases.

SAMPLING OBJECTIVES

The objective of a good sampling program should be the collection of a "representative" sample of the current ground-water conditions over a known or specified volume of aquifer. Ideally to meet this objective, sampling equipment, sampling method, monitoring well construction, monitoring well operation and maintenance, and sample handling procedures should not alter the chemistry of the sample. A sample that is obtained from a poorly constructed well, or using improper sampling equipment, or using poor sampling techniques, or which has been preserved improperly, can bias the sampling results. Unrepresentative samples can lead to misinterpretations of ground-water-quality data. Generally, the costs of obtaining representative ground-water samples are insignificant when compared to potential remedial responses that may be implemented based on erroneous data or when considering the overall monitoring program costs over the life of the program (Nielson, 1991).

The data quality objectives (DQOs) of the sampling program should be thoroughly developed, presented and understood by all parties involved. To develop the DQOs, the purpose of the sampling effort and data use(s) should be clearly defined. The sampling guidelines presented here can be used for a variety of monitoring programs, these include site assessment, contaminant detection, site characterization, remediation, corrective action and compliance monitoring.

For example DQOs for a site characterization sampling effort might vary from those of a remediation monitoring sampling effort. This difference could be in how much of the screen interval should be sampled. A site characterization objective may be to collect a sample that represents a composite of the entire (or as close as is possible) screened interval of the monitoring well. On the other hand, the monitoring objective of a remediation monitoring program may be to obtain a sample that represents a specific portion of the screened interval.

Additionally, the site characterization may require analyses for a broad suite of contaminants, whereas, the remediation monitoring program may require fewer contaminants to be sampled. These differences may dictate the type of sampling equipment used, the type of information collected, and the sampling protocol.

In order to develop applicable DQOs, a site conceptual model should be developed. The site conceptual model should be a dynamic model which is constantly revised as new information is collected and processed. The conceptual model, as it applies to the DQOs, should focus on contaminant fate and transport processes, such as contaminant pathways, how the geologic materials control the contaminant pathways (depositional environments, geologic structure, lithology, etc.), types of contaminants present (i.e., hydrophobic versus hydrophilic), and the processes that influence concentrations of the contaminants present such as dilution, biodegradation, and dispersion. The detail of the conceptual model will depend greatly on the availability of information, such as the number of borings and monitoring wells and the amount of existing analytical data. Clearly, a site that is being investigated for the first time will have a much simpler conceptual model compared to a site that has had a Remedial Investigation, Feasibility Study, and Remedial Design, (or, within the RCRA Program, a RCRA Facility Assessment, a RCRA Facility Investigation, and a Corrective Measures Study), and is currently in remediation/corrective action monitoring. Specific parameters that a conceptual model should describe that may impact the design of a ground-water-sampling program include:

a) The thickness, lateral extent, vertical and horizontal flow direction, and hydraulic conductivity contrasts of the geologic materials controlling contaminant transport from the site (thick units versus thin beds versus fractures, etc.)

b) The types of contaminants to be sampled (volatile organic compounds, semi-volatile organic compounds, metals, etc.) and factors that could bias sampling results (turbidity for metals, co-solvation effects on PCBs, etc.)

c) Lateral and vertical distribution of contamination (contaminants distributed throughout an entire unit being monitored versus localized distribution controlled by small scale features, etc.)

Vertical aquifer characterization is strongly recommended prior to the completion of a ground-water monitoring well installation program. A detailed vertical aquifer characterization program should include field characterization of hydraulic conductivities, determination of vertical and horizontal flow directions, assessment of lithologic and geologic variations, and determination of vertical and horizontal contaminant distributions. The successful aquifer characterization program provides detailed information to guide the technical and cost-effective placement, vertically and areally, of monitoring wells.

INFORMATION NEEDED PRIOR TO SAMPLING

To ensure appropriate methodology and expedient collection of water-quality samples, information is needed before a sample is collected. Some information should be obtained prior to the start of field activities such as well condition, construction, water-level information, contaminant types and concentrations, and direction(s) of ground-water flow. Field measurements, such as depth to water and total well depth will be needed prior to purging. Before commencement of all field activities, the field health and safety plan should be consulted under the direction of the site health and safety officer.

BACKGROUND DATA

Well construction and maintenance information are needed to better plan the sampling program, optimize personnel, and obtain more representative samples. Prior to field activities, personnel should have specific information including well casing diameter, borehole diameter, casing material, lock number and keys, physical access to wells, and length of and depth to well screen. The diameter of each well casing is used to select the correct equipment and technique for purging and sampling the well. A site map with possible physical barriers and description of access is necessary to allow for the selection of proper equipment based on several factors, such as portability, ease of repair, power sources, containment of purge water, and well accessibility. The length and depth of each well screen and depth to water is important when placing a sampling device's intake at the proper depth for purging and sampling and for choosing a sampling device. Well development information is needed to ensure that purging and sampling rates will not exceed well development extraction rates. Previous sampling information should be provided and evaluated to determine the nature and concentrations of expected contaminants. This will be useful in determining the appropriate sampling method and quality assurance/quality control (QA/QC) samples (for example, field duplicates, equipment blanks, trip blanks). Attachment 1 is an example of a sampling checklist for field personnel. This information should be kept in the field for easy access during sampling activities.

When evaluating previous sampling information, consideration should be given to the amount of time that has expired between the last sampling effort and the planned sampling effort. If this time exceeds one year, the need for redevelopment of the monitoring wells should be evaluated. The necessity of redevelopment can be evaluated by measuring constructed depth compared to the measured depth. If the depth measurement indicates siltation of the monitoring well screen, or evidence exists that the well screen is clogged, the well should be redeveloped prior to sampling. The assessment of the condition of the monitoring wells should be completed several weeks prior to sampling activities in order to allow the proper recovery of the developed wells. This is especially important in wells where prior sampling has indicated high turbidity. The time for a well to re-stabilize after development is dependent on site-specific geology and should be specified in the site sampling plan. The development method, if necessary, should be consistent with the sampling objectives, best technical criteria and USEPA guidelines (Aller et al., 1991; Izraeli et al., 1992; Lapham et al., 1997).

REFERENCE POINT

Each well should be clearly marked with a well identifier on the outside and inside of the well casing. Additionally, each well should have a permanent, easily identified reference point from which all depth measurements are taken. The reference point (the top of the inner casing, outer casing, or security/protective casing) should remain constant through all measurements, should be clearly marked on the casing and its description recorded. Whenever possible, the inner casing is recommended as a reference point, because of the general instability of outer casings due to frost heaving, vehicular damage, and other phenomena which could cause movement of casings. The elevation of this reference point should be known and clearly marked at the well site (Nielson, 1991).

This reference point should also have a known latitude and longitude that are consistent with the Regional and National Minimum Data Elements requirements. The elevation of the reference point should be surveyed relative to Mean Sea Level (MSL) using the NAVD 88 datum.

TOTAL WELL DEPTH

The depth of the well is required to calculate the volume of standing water in the well and to document the amount of siltation that may have occurred. Moreover, measuring the depth to the bottom of a well provides checks for casing integrity and for siltation of the well screen. Corrosion can cause leaking or collapse of the well casing, which could lead to erroneous or misleading water-level measurements. Corrosion, silting, and biofouling can clog well screens and result in a sluggish response or no response to water-level changes, as well as changes in ground-water chemistry. Well redevelopment or replacement may be needed to ensure accurate collection of a representative water-quality sample.

Total well depths should be measured and properly recorded to the nearest one-tenth of a foot using a steel tape with a weight attached. The steel tape should be decontaminated before use in another well according to the site specific protocols. A concern is that when the steel tape and weight hit the bottom of the well, sediment present on the bottom of a well may be stirred up, thus increasing turbidity which will affect the sampling results. The frequency of total well depth measurements varies, with no consensus for all hydrogeologic conditions. The United States Geological Survey (USGS) recommends a minimum of once a year (Lapham et al., 1997). USEPA also recommended one measurement per year (Barcelona et al., 1985) but later recommended a total well depth be taken every time a water-quality is collected or a water-level reading taken (Aller et al., 1991). Therefore, when possible, the total depth measurements should be taken following the completion of sampling (Puls and Barcelona, 1996). When total-well-depth measurements are needed prior to sampling, as much time as possible should be allowed prior to sampling, such as a minimum of 24 hours. The weight of electric tapes are generally too light to determine accurate total well depth. If the total well depth is greater than 200 feet, stretching of the tape must be taken into consideration.

DEPTH TO WATER

All water levels should be measured from the reference point by the use of a weighted steel tape and chalk or an electric tape (a detailed discussion of the pros and cons of the different water level devices is provided in Thornhill, 1989). The steel tape is a more accurate method to take water levels, and is recommended where shallow flow gradients (less than 0.05 foot/feet or 0.015 meter/meters) or deep wells are encountered. However, in those cases where large flow gradients or large fluctuations in water levels are expected, a calibrated electric tape is acceptable. The water level is calculated using the well's reference point minus the measured depth to water. At depths approximately greater than 200 feet, the water-level-measuring device should be chosen carefully, as some devices may have measurable stretching.

The depth-to-water measurement must be made in all wells to be sampled prior to activities in any single well which may change the water level, such as bailing, pumping, and hydraulic testing. All readings are to be recorded to the nearest one-hundredth of a foot.

The time and date of the measurement, point of reference, measurement method, depth-to-water level measurement, and any calculations should be properly recorded. In addition, any known, outside influences (such as tidal cycles, nearby pumping effects, major barometric changes) that may affect water levels should be noted.

GROUND-WATER SAMPLING METHODS

The ground-water sampling methods to be employed should be dependent on site-specific conditions and requirements, such as data-quality objectives and well accessibility. Ground-water sampling methods vary based on the type of device used, the position of the sampler intake, the purge criteria used, and the composition of the ground water to be sampled (e.g., turbid, containing high volatile organics, etc.). All sampling methods and equipment should be clearly documented, including purge criteria, field readings, etc. Examples of appropriate documentation are provided in Attachment 2 of this document and Appendix E of the U.S. Environmental Protection Agency, 1995 document.

The water in the screen and filter pack is generally in a constant state of natural flux as ground water passes in and out of the well. However, water above the screened section remains relatively isolated and become stagnant. Stagnant water is subject to physio-chemical changes and may contain foreign material, which can be introduced from the surface or during well construction, resulting in non-representative sample data. To safeguard against collecting a sample biased by stagnant water, specific well-purging guidelines and techniques should be followed.

A non-representative sample also can result from excessive pumping of the monitoring well. Stratification of the contaminant concentrations in the aquifer may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point.

PURGING AND SAMPLING DEVICES

The device used to purge and sample a well depends on the inner casing diameter, depth to water, volume of water in the well, accessibility of the well, and types of contaminants to be sampled. The types of equipment available for ground-water sampling include hand-operated or motor-driven suction pumps, peristaltic pumps, positive displacement pumps, submersible pumps, various in-situ devices and bailers made of various materials, such as PVC, stainless steel and Teflon®. Some of these devices may cause volatilization and produce high pressure differentials, which could result in variability in the results of pH, dissolved oxygen concentrations, oxidation-reduction potential, specific electrical conductance, and concentrations of metals, volatile organics and dissolved gases. Therefore, the device chosen for well purging and sampling should be evaluated for the possible effects it may have on the chemical and physical analyses. In addition, the types of contaminants, detection levels, and levels of concern as described by the site DQOs should be consulted prior to the selection of a sampling device. The same device used for purging the monitoring well should be used for sampling to minimize agitation of the water column (which can increase turbidity, increase volatilization, and increase oxygen in the water).

In general, the device used for purging and sampling should not change geochemical and physical parameters and/or should not increase turbidity. For this reason, low-flow submersible or positive-displacement pumps that can control flow rates are recommended for purging wells. Dedicated sampling systems are greatly preferred since they avoid the need for decontamination of equipment and minimize turbulence in the well. If a sampling pump is used, the pump should be lowered into the well as slowly as possible and allowed to sit as long as possible, before pumping commences. This will minimize turbidity and volatilization within the well.

Sampling devices (bladders, pumps, bailers, and tubing) should be constructed of stainless steel, Teflon®, glass, and other inert materials to reduce the chance of these materials altering the ground water in areas where concentrations of the site contaminants are expected to be near detection limits. The sample tubing thickness should be maximized and the tubing length should be minimized so that the loss of contaminants through the tubing walls may be reduced and the rate of stabilization of ground-water parameters is maximized. The tendency of organics to sorb into and out of many materials makes the appropriate selection of sample tubing materials critical for these trace analyses (Pohlmann and Alduino, 1992; Parker and Ranney, 1998). Existing Superfund and RCRA guidance suggest appropriate compatible materials (U.S. Environmental Protection Agency, 1992). Special material considerations are important when sampling for non-routine analyses, such as age-dating and biological constituents.

Preferably, wells should be purged and sampled using a positive-displacement pump or a low-flow submersible pump with variable controlled flow rates and constructed of chemically inert materials. If a pump cannot be used because the recovery rate is so slow (less than 0.03 to 0.05 gallons per minute or 100 to 200 milliliters per minute) and the volume of the water to be removed is minimal (less than 5 feet (1.6 meters) of water), then a bailer with a double check valve and bottom-emptying device with a control-flow check valve may be used to obtain the samples. Otherwise, a bailer should not be used when sampling for volatile organics because of the potential bias introduced during sampling (Pohlmann, et al., 1990; Yeskis, et al., 1988; Tai, et al., 1991). A peristaltic

pump also may be used under these conditions, unless the bias by a negative pressure may impact the contaminant concentrations of concern (generally at depths greater than 15 to 20 feet (4.5 to 6 meters) of lift). Bailers should also be avoided when sampling for metals due to increased turbidity that occurs during the deployment of the bailer, which may bias inorganic and strongly hydrophobic parameters. Dedicated sampling pumps are recommended for metals sampling because the pumps avoid the generation of turbidity from frequent sampler deployment (Puls et al., 1992). A number of alternate sampling devices are becoming available, including passive diffusion samplers (Vroblesky and Hyde, 1997; Vroblesky, 2001a and b) and other in-situ sampling devices. These devices may be particularly useful to sampling low-permeability geologic materials, assuming the device is made of materials compatible with the analytical parameters, meet DQOs, and have been properly evaluated. However, the site investigator should ensure the diffusion membrane materials are selected for the contaminants of concern (COCs) present at the site. Comparison tests with an approved sampling method and diffusion samplers should be completed to confirm that the method is suitable for the site.

POSITION OF SAMPLE INTAKE

Essentially there are two positions for placement of the sample pump intake, within the screen and above the screen. Each of the positions offers advantages and disadvantages with respect to the portion of the well screen sampled, data reproducibility and potential purge volumes.

When the sampling pump intake is set above the well screen, the pump generally is set just below the water level in the well. The sampling pump then is pumped until a purge criterion is reached (commonly either stabilization of purge parameters or a set number of well volumes). If the distance between the water level and the top of the screen is long, there is concern that the water will be altered geochemically as it flows along the riser pipe, as water flows between the well screen and the sampling pump intake. This is especially a concern if the riser pipe is made of similar material as the COC (such as a stainless steel riser with nickel as a COC, or PVC with organics as a COC). Keely and Boateng (1987) suggested that to minimize this potential influence, the sample pump be lowered gradually while purging, so that at the time of the sampling the pump intake is just above the screen. This would minimize contact time between the ground water and the well construction materials while sampling, as well as ensure the evacuation of the stagnant water above the screen.

With the final location of the sampling pump intake just above the well screen, the sample results may be more reproducible than those collected by positioning the pump intake within the well screen. Results may be more reproducible because the sampler can ensure that the ground water is moving into the well with the same portions of the aquifer being sampled each time assuming the same pump rate. If the pump is placed into different portions of the screen each time, different portions of the aquifer may be sampled. Of course, this can be avoided by the use of dedicated, permanently installed equipment. Additionally, the placement of the pump at the same vertical position within the screen can be ensured by the use of calibrated sampling pump hose, sounding with a weighted tape, or using a pre-measured hose.

The placement of the pump above the screen does not guarantee the water-quality sample represents the entire well screen length. Any bias in the pump placement will be consistently towards the top of the well screen and/or to the zone of highest hydraulic conductivity. Another possible disadvantage, or advantage, depending on the DQOs, of the placement of the pump above the well screen is that the sample may represent a composite of water quality over the well screen. This may result in dilution of a portion of the screen that is in a contaminated portion of an aquifer with another portion that is in an uncontaminated portion of the aquifer. However, shorter well screens would minimize this concern.

When the pump intake is positioned within the well screen, its location is recommended to be opposite the most contaminated zone in the well screen interval. This method is known as the low-flow, low-stress, micropurge, millipurge, or minimal drawdown method. The well is then purged with a minimal drawdown (usually 0.33 feet (0.1 meters) based on Puls and Barcelona, 1996) until selected water-quality-indicator parameters have stabilized. Use of this method may result in the vertical portion of the sampled aquifer being smaller than the well screen length. This method is applicable primarily for short well-screen

lengths (less than 5 feet (1.6 meters)) to better characterize the vertical distribution of contaminants (Puls and Barcelona, 1996). This method should not be used with well-screen lengths greater than 10 feet (3 meters). By using this method, the volume of purge water can be reduced, sometimes significantly, over other purging methods.

However, two potential disadvantages of this method exist. The first potential disadvantage may involve the lower reproducibility of the sampling results. The position of the sampling pump intake may vary between sampling rounds (unless adequate precautions are taken to lower the pump into the exact position in previous sampling rounds, or a dedicated system is used), which can result in potentially different zones within the aquifer being sampled. This potential problem can be overcome by using dedicated sampling pumps and the problem may be minimized by the use of short well screens. The second potential disadvantage, or advantage, depending on the DQOs, may be that the sample which is collected may be taken from a small portion of the aquifer volume.

PURGE CRITERIA

"Low-Stress Approach"

The first method for purging a well, known as the low-stress approach, requires the use of a variable-speed, low-flow sampling pump. This method offers the advantage that the amount of water to be containerized, treated, or stored will be minimized. The low-stress method is based on the assumption that pumping at a low rate within the screened zone will not draw stagnant water down, as long as drawdown is minimized during pumping. Drawdown should not exceed 0.33 feet (0.1 meters) (Puls and Barcelona, 1996). The pump is turned on at a low flow rate approximating the estimated recovery rate (based on the drawdown within the monitoring well during sampling). This method requires the location of the pump intake to be within the saturated-screened interval during purging and sampling. The water-quality-indicator parameters (purge parameters), pH, specific electrical conductance, dissolved oxygen concentration, oxidation-reduction potential, temperature and turbidity, are monitored at specific intervals. The specific intervals will depend on the volume within the tubing (include pump and flow-through cell volumes), pump rate and drawdown; commonly every three to five minutes. These parameters should be recorded after a minimum of one tubing volume (include pump and flow-through-cell volumes) has been purged from the well. These water-quality-indicator parameters should be collected by a method or device which prevents air from contacting the sample prior to the reading, such as a flow-through cell (Barcelona et al., 1985; Garske and Schock, 1986; Wilde et al., 1998). Once three successive readings of the water-quality-indicator parameters provided in Table 1 have stabilized, the sampling may begin. The water-quality-indicator parameters that are recommended include pH and temperature, but these are generally insensitive to indicate completion of purging since they tend to stabilize rapidly (Puls and Barcelona, 1996). Oxidation-reduction potential may not always be an appropriate stabilization parameter, and will depend on site-specific conditions. However, readings should be recorded because of its value as a double check for oxidizing conditions, and for some fate and transport issues. When possible, especially when sampling for contaminants that may be biased by the presence of turbidity, the turbidity reading is desired to stabilize at a value below 10 Nephelometric Turbidity Units (NTUs). For final dissolved oxygen measurements, if the readings are less than 1 milligram per liter, they should be collected with the spectrophotometric method (Wilde et al., 1998, Wilkin et al., 2001), colorimetric or Winkler titration (Wilkin et al., 2001). All of these water-quality-indicator parameters should be evaluated against the specifications of the accuracy and resolution of the instruments used.

During purging, water-level measurements must be taken regularly at 30-second to five-minute intervals (depending on the hydraulic conductivity of the aquifer, diameter of the well, and pumping rate) to document the amount of drawdown during purging. The water-level measurements will allow the sampler to control pumping rates to minimize drawdown in the well.

"Well-Volume Approach"

The second method for purging wells is based on proper purging of the stagnant water above the screened interval and the stabilization of water-quality-indicator parameters prior to sampling. Several considerations in this method need to be evaluated before purging. For monitoring wells where the water level is above the screens, the pump should be set

near the top of the water column, and slowly lowered during the purging process. For water columns within the well screen, the pump should be set at a sufficient depth below the water level where drawdown during pumping does not allow air to enter the pump. The pump should not be allowed to touch or draw sediments from the bottom of the well, especially when sampling for parameters that may be impacted by turbidity. The well-purging rate should not be great enough to produce excessive turbulence in the well, commonly no greater than one gallon per minute (3.8 liters per minute) in a 2-inch well. The pump rate during sampling should produce a smooth, constant (laminar) flow rate, and should not produce turbulence during the filling of bottles. As a result, the expected flow rate for most wells will be less than one gallon per minute (3.8 liter per minute), with expected flow rates of about one-quarter gallon per minute (500 milliliter per minute).

The stabilization criteria for a “well-volume approach” may be based on the stabilization of water-quality-indicator parameters or on a pre-determined well volume. Various research indicates that purging criteria based on water-quality-indicator parameter stabilization may not always correlate to stabilization of other parameters, such as volatile organic compounds (Gibs and Imbrigiotta, 1990; Puls et al., 1990). A more technically rigorous sampling approach that would yield more consistent results over time would be a time-sequential sampling program at regular well-volume intervals while measuring water-quality-indicator parameters. However, the cost would be prohibitive for most sites. For comparison of water-quality results, by sampling under the same conditions (same purge volume and rate, same equipment, same wells, etc.) temporal evaluations of trends may be considered.

The stabilization requirements of the water-quality-indicator parameters are consistent with those described above for the low-stress approach. The parameters should be recorded approximately every well volume; when three successive readings have reached stabilization, the sample(s) are taken (Barcelona et al., 1985). If a ground-water monitoring well has been sufficiently sampled and characterized (at least several rounds of water-quality samples obtained, including the field parameters, during several seasonal variations), and if water-quality-indicator parameters are no longer needed as a part of site characterization and/or monitoring, then samples could be obtained based on a specific number of well volumes at the previous pumping rates.

LOW-PERMEABILITY FORMATIONS

Different procedures must be followed in the case of slow-recovery wells installed in low hydraulic conductivity aquifers. The following procedures are not optimum, but may be used to obtain a ground-water sample under less than ideal conditions. One suggested procedure is to remove the stagnant water in the casing to just above the top of the screened interval, in a well screened below the water table, to prevent the exposure of the gravel pack or formation to atmospheric conditions (McAlary and Barker, 1987). At no point should the pump be lowered into the screened interval. The pumping rate should be as low as possible for purging to minimize the drawdown in the well. However, if a well has an open interval across the water table in a low permeability zone, there may be no way to avoid pumping and/or bailing a well dry (especially in those cases with four feet of water or less in the well and at a depth to water greater than 20 to 25 feet (which is the practical limit of a peristaltic pump)). In these cases, the well may be purged dry. The sample should be taken no sooner than two hours after purging and after a sufficient volume for a water-quality sample, or sufficient recovery (commonly 90%) is present (Herzog et al., 1988). In these cases, a bailer with a double check valve with a flow-control, bottom-emptying device may be used, since many sampling pumps may have tubing capacities greater than the volume present within the well. If the depth of well and water column are shallow enough, consideration of a very low-flow device, such as a peristaltic pump, should be considered, especially if constituents are present that are not sensitive to negative pressures that may be created with the use of the peristaltic pump. If such constituents are present and sampled with a peristaltic pump, a negative bias may be introduced into the sampling results. To minimize the bias, thick-walled, non-porous tubing should be used, except for a small section in the pump heads, which require a greater degree of flexibility. As stated earlier in this paper, the DQOs for the sampling should be consulted to consider the potential impact of the sampling device on the potential bias versus the desired detection levels.

Another method to be considered for low-permeability conditions is the use of alternative sampling methods, such as passive diffusion samplers and other in-situ samplers. As more sites are characterized with these alternative sampling methods and devices, the potential bias, if any, can be evaluated with regard to the sampling DQOs. Regional hydrologists/geologists and Regional quality-assurance specialists should be consulted on the applicability of these methods for the site-specific conditions.

DECISION PROCESS FOR DETERMINING APPLICABLE SAMPLING METHODOLOGY

Once the project team has determined the sampling objectives and DQOs, reviewed the existing data, and determined the possible sampling devices that can be used, the team must decide the appropriate sampling methodology to be used. Table 2 provides a summary of considerations and rationale to be used in establishing the proper ground-water-sampling program using site-specific conditions and objectives.

POTENTIAL PROBLEMS

The primary objective is to obtain a sample representative of the ground water moving naturally (including both dissolved and particulate species) through the subsurface. A ground-water sample can be compromised by field personnel in two primary ways: taking an unrepresentative sample and handling the (representative) sample incorrectly. There are numerous ways of introducing foreign contaminants into a sample. These must be avoided by following strict sampling protocols and transportation procedures, and utilizing trained personnel. Common problems with sampling include the use of inappropriate sample containers and field composites, and the filtration of turbid samples.

SAMPLE CONTAINERS

Field samples must be transferred from the sampling equipment to the container that has been specifically prepared for that given parameter. Samples must not be composited in a common container in the field and then split in the lab. The USEPA Regional policy on sample containers should be consulted to determine the appropriate containers for the specified analysis.

FIELD FILTRATION OF TURBID SAMPLES

The USEPA recognizes that in some hydrogeologic environments, even with proper well design, installation, and development, in combination with the low-flow purging and sampling techniques, sample turbidity cannot be reduced to ambient levels. The well construction, development, and sampling information should be reviewed by the Regional geologists or hydrologists to see if the source of the turbidity problems can be resolved or if alternative sampling methodologies should be employed. If the water sample is excessively turbid, the collection of both filtered and unfiltered samples, in combination with turbidity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pumping rate, and drawdown data is recommended. The filter size used to determine TSS and TDS should be the same as used in the field filtration. An in-line filter should be used to minimize contact with air to avoid precipitation of metals. The typical filter media size used is 0.45 µm because this is commonly accepted as the demarcation between dissolved and non-dissolved species. Other filter sizes may be appropriate but their use should be determined based on site-specific criteria (examples include grain-size distribution, ground-water-flow velocities, mineralogy) and project DQOs. Filter sizes up to 10.0 µm may be warranted because larger size filters may allow particulates that are mobile in ground water to pass through (Puls and Powell, 1992). The changing of filter media size may limit the comparability of the data obtained with other data sets and may affect their use in some geochemical models. Filter media size used on previous data sets from a site, region or aquifer and the DQOs should be taken into consideration. The filter media used during the ground-water sampling program should be collected in a suitable container and archived because potential analysis of the media may be helpful for the determination of particulate size, mineralogy, etc.

The first 500 to 1000 milliliters of a ground-water sample (depending on sample turbidity) taken through the in-line filter will not be collected for a sample in order to ensure that the filter media has equilibrated to the sample (manufacturer's recommendations also should be consulted). Because bailers have been shown to increase turbidity while purging and sampling, bailers should be avoided when sampling for trace element, metal, PCB, and pesticide constituents. If portable sampling pumps are used, the

pumps should be gently lowered to the sampling depth desired, carefully avoiding lowering it to the bottom of the well, and allowed to sit in order to allow any particles mobilized by pump placement to settle. Dedicated sampling equipment installed in the well prior to the commencement of the sampling activities is one of the recommended methods to reduce turbidity artifacts (Puls and Powell, 1992; Kearl et al., 1992; Puls et al., 1992; Puls and Barcelona, 1996).

SAMPLER DECONTAMINATION

The specific decontamination protocol for sampling devices is dependent on site-specific conditions, types of equipment used and the types of contaminants encountered. Once removed from the well, non-dedicated sampling equipment should be decontaminated to help ensure that there will be no cross-contamination between wells. Disposable items such as rope and low-grade tubing should be properly disposed between wells. Cleaning thoroughly that portion of the equipment that is going to come into contact with well water is especially important. In addition, a clean plastic sheet should be placed adjacent to or around the well to prevent surface soils from coming in contact with the purging and sampling equipment. The effects of cross-contamination can be minimized by sampling the least contaminated well first and progressing to the more contaminated ones. Equipment blanks should be collected on a regular basis from non-dedicated equipment, the frequency depending on the sampling plan and regional protocols, to document the effectiveness of the decontamination procedures.

The preferred method is to use dedicated sampling equipment whenever possible. Dedicated equipment should still be cleaned on a regular basis to reduce biofouling, and to minimize adsorption effects. Dedicated equipment should have equipment blanks taken after every cleaning.

POST-SAMPLING ACTIVITIES

Specific activities should be completed at monitoring wells at regular intervals to ensure the acquisition of representative ground-water samples. Activities include hydraulic conductivity testing to determine if a monitoring well needs redeveloping and/or replacing. Another activity that needs to be completed is regular surveying of well measuring points impacted by frost heaving and site activities. The schedules of these activities are to be determined on a site-by-site basis in consultation with regional geologists or hydrologists, but at a minimum, should be every five years.

CONCLUSION

This document provides a brief summary of the state-of-the-science to be used for Superfund and RCRA ground-water studies. As additional research is completed, additional sampling experience with other sampling devices and methods and/or additional contaminants are identified, this paper may be revised to include the new information/concerns. Clearly there is no one sampling method that is applicable for all sampling objectives. As new methods and/or equipment are developed, additional standard operating procedures (SOPs) should be developed and attached to this document. These SOPs for ground-water sampling should include, at a minimum: introduction, scope and application, equipment, purging and sampling procedures, field quality control, decontamination procedures and references. Example SOP's for the low-stress/minimal-drawdown and well-volume sampling procedures have been included as Attachments 3 and 4. These example SOPs are to be considered a pattern or starting point for site-specific ground-water-sampling plans. A more detailed discussion of sampling procedures, devices, techniques, etc. is provided in various publications by the USEPA (Barcelona et al., 1985; U.S. Environmental Protection Agency, 1993) and the U.S. Geological Survey (Wilde et al., 1998).

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TABLES:

Stablization Criteria with References for Water-Quality-Indicator Parameters

and

Applicability of Different Approaches for Purging and Sample Monitoring Wells

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TABLE 1: Stabilization Criteria with References for Water-Quality-Indicator Parameters

Parameter	Stabilization Criteria	Reference
pH	+/- 0.1	Puls and Barcelona, 1996; Wilde et al., 1998
specific electrical conductance (SEC)	+/- 3%	Puls and Barcelona, 1996
oxidation-reduction potential (ORP)	+/- 10 millivolts	Puls and Barcelona, 1996
turbidity	+/- 10% (when turbidity is greater than 10 NTUs)	Puls and Barcelona, 1996; Wilde et al., 1998
dissolved oxygen (DO)	+/- 0.3 milligrams per liter	Wilde et al., 1998

TABLE 2: Applicability of Different Approaches for Purging and Sampling Monitoring Wells

	Low-Stress Approach	Well-Volume Approach	**Others** (such as passive diffusion samplers, in-situ samplers, and other non-traditional ground-water sampling pumps)
Applicable Geologic Materials[1]	Materials with moderate to high hydraulic conductivities. May be applicable to some low hydraulic conductivities, if can meet minimal drawdown criteria.	Materials with low to high hydraulic conductivities	Materials with very low to high hydraulic conductivities
Aquifer/Plume Characterization Data Needs prior to Choosing Sampling Method [2]	High definition of vertical hydraulic conductivity distribution and vertical contaminant distribution	Plume and hydraulic conductivity distributions are less critical	May need to consider the degree of hydraulic and contaminant vertical distribution definition dependent on Data Quality Objectives and sampler type.
Constituent Types Method is Applicable	Mainly recommended for constituents which can be biased by turbidity in wells. Applicable for most other contaminants.	Applicable for all sampling parameters. However, if turbidity values are elevated, low-stress approach may be more applicable if constituents of concern are turbidity sensitive.	Constituents of concern will be dependent on the type of sampler.
Data Quality Objectives	1) High resolution of plume definition both vertically and horizontally. 2) Reduce bias from other sampling methods if turbidity is of concern. 3) Target narrow sections of aquifer.	1) Basic site characterization 2) Moderate to high resolution of plume definition (will be dependent on screen length). 3) Target sample composition to represent entire screened/open interval	1) Can be applicable to basic site characterization, depending on sampler and methodology used. 2) Can reduce bias from other sampling methods. 3) May yield high resolution of plume definition.

[1]Hydraulic conductivities of aquifer materials vary from low hydraulic conductivities (clays, silts, very fine sands) to high conductivities (gravels, sands, weathered bedrock zones). This term for the use on this table is subjective, and is more dependent on the drawdown induced in a monitoring well when sampled with a ground-water sampling pump. For instance, in a well being pumped at 4 liters per minute (l/min) with less than 0.1 feet of drawdown, can be considered to have high hydraulic conductivity. A well that can sustain a 0.2 to 0.4 l/min pumping rate, but has more than 0.5 feet of drawdown can be considered to have low hydraulic conductivity. To assign absolute values of hydraulic conductivities to well performance and sustainable pumping rates cannot be completed because of the many factors in monitoring well construction, such as well diameter, screen open area, and length of screen.

[2] See last paragraph under the SAMPLING OBJECTIVES section.

ATTACHMENT 1
Example Sampling Checklist

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SAMPLING CHECKLIST

Well Identification:_____

Map of Site Included: Y or N
Wells Clearly Identified with Roads: Y or N
Well Construction Diagram Attached: Y or N

Well Construction:

Diameter of Borehole:_____ Diameter of Casing:_____
Casing Material:_____ Screen Material:_____
Screen Length:_____ Total Depth:_____

Approximate Depth to Water:_____
Maximum Well Development Pumping Rate:_____
Date of Last Well Development:_____

Previous Sampling Information:

Was the Well Sampled Previously: Y or N
(If Sampled, Fill Out Table Below)

Table of Previous Sampling Information

Parameter	Previously Sampled	Number of Times Sampled	Maximum Concentration	Notes (include previous purge rates)

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ATTACHMENT 2
Example Ground-Water Sampling Field Sheets

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GROUND-WATER SAMPLING RECORD

Well ID:_____

Station #:_____

Facility Name: Date:____/____/____

Well Depth:_____ Depth to Water:_____ Well Diameter:_____

Casing Material.:_____ Volume Of Water per Well Volume:_____

Sampling Crew:_____,_____,_____,_____

Type of Pump:_____ _____ Tubing Material:_____ Pump set at _____ ft.

Weather Conditions:_____ NOTES:_____ _____

_____

GROUND-WATER SAMPLING PARAMETERS

Time	Water Level	Volume Pumped	Pumping Rate	DO (mg/l)	Temp. (°C)	SEC (µS/cm)	pH	ORP (mV)	Turbidity (NTU)

Other Parameters: _____

Sampled at:_____ Parameters taken with :_____

Sample delivered to _____ by _____ at_____.

Sample CRL #:_____ OTR #:_____ ITR #:_____ SAS #:_____

Parameters Collected	Number of Bottles	Bottle Lot Number

Ground Water Sampling Log

Site Name: **Well #:** **Date:**
Well Depth(Ft-BTOC[1]): **Screen Interval**(Ft):

Well Dia.: **Casing Material:** **Sampling Device:**

Pump placement(Ft from TOC[2]):

Measuring Point: **Water level (static)**(Ft):

Water level (pumping)(Ft): **Pump rate**(Liter/min):

Sampling Personnel:

Other info: (such as sample numbers, weather conditions and field notes)

Water Quality Indicator Parameters

Time	Pumping rates (L/Min)	Water level (ft)	DO (mg/L)	ORP (mv)	SEC[3]	Turb. (NTU)	pH	Temp. (C^0)	Volume pumped (L)

Type of Samples collected:

1 casing volume was:
Total volume purged prior to sample collection:
[1]BTOC-Below Top of Casing
[2]TOC-Top of Casing
[3]Specific Electrical Conductance

Stabilization Criteria

D.O.	+/- 0.3 mg/l
Turb.	+/- 10%
S.C.	+/- 3%
ORP	+/- 10 mV
pH	+/- 0.1 unit

ATTACHMENT 3
Example Standard Operating Procedure:

Standard Operating Procedure for Low-Stress (Low Flow)/Minimal Drawdow Ground-Water Sample Collection

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Standard Operating Procedure for Low-Stress (Low-Flow)/ Minimal Drawdown Ground-Water Sample Collection

INTRODUCTION

The collection of "representative" water samples from wells is neither straightforward nor easily accomplished. Ground-water sample collection can be a source of variability through differences in sample personnel and their individual sampling procedures, the equipment used, and ambient temporal variability in subsurface and environmental conditions. Many site inspections and remedial investigations require the sampling at ground-water monitoring wells within a defined criterion of data confidence or data quality, which necessitates that the personnel collecting the samples are trained and aware of proper sample-collection procedures.

The purpose of this standard operating procedure (SOP) is to provide a method that minimizes the impact the purging process has on the ground-water chemistry and the volume of water that is being purged and disposed of during sample collection. This will take place by placing the pump intake within the screen interval and by keeping the drawdown at a minimal level (0.33 feet) (Puls and Barcelona, 1996) until the water quality parameters have stabilized and sample collection is complete. The flow rate at which the pump will be operating will depend upon both hydraulic conductivity of the aquifer and the drawdown with the goal of minimizing the drawdown. The flow rate from the pump during purging and sampling will be at a rate that will not compromise the integrity of the analyte that is being sampled. This sampling procedure may or may not provide a discrete ground-water sample at the location of the pump intake. The flow of ground-water to the pump intake will be dependent on the distribution of the hydraulic conductivity (K) of the aquifer within the screen interval. In order to minimize the drawdown in the monitoring well, a low-flow rate must be used. "Low-Flow" refers to the velocity with which water enters the pump intake from the surrounding formation in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface, which can be affected by flow regulators or restrictions (Puls and Barcelona, 1996). This SOP was developed by the Superfund/RCRA Ground Water Forum and draws from an USEPA's Ground Water Issue Paper, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedure, by Robert W. Puls and Michael J. Barcelona. Also, available USEPA Regional SOPs regarding Low-Stress (Low-Flow) Purging and Sampling were used for this SOP.

SCOPE AND APPLICATION

This SOP should be used primarily at monitoring wells that have a screen or an open interval with a length of ten feet or less and can accept a sampling device that minimizes the disturbance to the aquifer or the water column in the well casing. The screen or open interval should have been optimally located to intercept an existing contaminant plume(s) or along flowpaths of potential contaminant releases. Knowledge of the contaminant distribution within the screen interval is highly recommended and is essential for the success of this sampling procedure. The ground-water samples that are collected using this procedure are acceptable for the analyses of ground-water contaminants that may be found at Superfund and RCRA contamination sites. The analytes may be volatile, semi-volatile organic compounds, pesticides, PCBs, metals, and other inorganic compounds. The screened interval should be located within the contaminant plume(s) and the pump intake should be placed at or near the known source of the contamination within the screened interval. It is critical to place the pump intake in the exact location or depth for each sampling event. This argues for the use of dedicated, permanently installed, sampling devices whenever possible. If this is not possible, then the placement of the pump intake should be positioned with a calibrated sampling pump hose sounded with a weighted-tape or using a pre-measured hose. The pump intake should not be placed near the bottom of the screened interval to avoid disturbing any sediment that may have settled at the bottom of the well.

Water-quality-indicator parameters and water levels must be measured during purging, prior to sample collection. Stabilization of the water-quality-indicator parameters as well as monitoring water levels are a prerequisite to sample collection. The water-quality-indicator parameters that are recommended include the following: specific electrical conductance, dissolved oxygen, turbidity, oxidation-reduction potential, pH, and temperature. The latter two parameters are useful data, but are generally insensitive as purging parameters. Oxidation-reduction potential may not always be appropriate stabilization parameter, and will depend on site-specific conditions. However, readings

should be recorded because of its value as a double check for oxidation conditions and for fate and transport issues.

Also, when samples are collected for metals, semi-volatile organic compounds, and pesticides, every effort must be made to reduce turbidity to 10 NTUs or less (not just the stabilization of turbidity) prior to the collection of the water sample. In addition to the measurement of the above parameters, depth to water must be measured during purging (U.S. Environmental Protection Agency, 1995).

Proper well construction, development, and maintenance are essential for any ground-water sampling procedure. Prior to conducting the field work, information on the construction of the well and well development should be obtained and that information factored into the site specific sampling procedure. The Sampling Checklist at the end of this attachment is an example of the type of information that is useful.

Stabilization of the water-quality-indicator parameters is the criterion for sample collection. But if stabilization is not occurring and the procedure has been strictly followed, then sample collection can take place once three (minimum) to six (maximum) casing volumes have been removed (Schuller et al., 1981 and U.S. Environmental Protection Agency., 1986; Wilde et al., 1998; Gibs and Imbrigiotta., 1990). The specific information on what took place during purging must be recorded in the field notebook or in the ground-water sampling log.

This SOP is not to be used where non-aqueous phase liquids (NAPL) (immiscible fluids) are present in the monitoring well.

EQUIPMENT

- Depth-to-water measuring device - An electronic water-level indicator or steel tape and chalk, with marked intervals of 0.01 foot. Interface probe for determination of liquid products (NAPL) presence, if needed.
- Steel tape and weight - Used for measuring total depth of well. Lead weight should not be used.
- Sampling pump - Submersible or bladder pumps with adjustable rate controls are preferred. Pumps are to be constructed of inert materials, such as stainless steel and Teflon®. Pump types that are acceptable include gear and helical driven, centrifugal (low-flow type), and air-activated piston. An adjustable rate, peristaltic pump can be used when the depth to water is 20 feet or less.
- Tubing - Teflon® or Teflon®-lined polyethylene tubing is preferred when sampling for organic compounds. Polyethylene tubing can be used when sampling inorganics.
- Power source - If a combustion type (gasoline or diesel-driven) generator is used, it must be placed downwind of the sampling area.
- Flow measurement supplies - flow meter, graduated cylinder, and a stop watch.
- Multi-parameter meter with flow-through cell - This can be one instrument or more contained in a flow-through cell. The water-quality-indicator parameters that are monitored are pH, ORP/Eh, (ORP) dissolved oxygen (DO), turbidity, specific conductance, and temperature. Turbidity readings must be collected before the flow cell because of the potential for sediment buildup, which can bias the turbidity measurements. Calibration fluids for all instruments should be NIST-traceable and there should be enough for daily calibration throughout the sampling event. The inlet of the flow cell must be located near the bottom of the flow cell and the outlet near the top. The size of the flow cell should be kept to a minimum and a closed cell is preferred. The flow cell must not contain any air or gas bubbles when monitoring for the water-quality-indicator parameters.
- Decontamination supplies - Including a reliable and documented source of distilled water and any solvents (if used). Pressure sprayers, buckets or decontamination tubes for pumps, brushes and non-phosphate soap will also be needed.
- Sample bottles, sample preservation supplies, sample tags or labels, and chain-of-custody forms.
- Approved Field Sampling and Quality Assurance Project Plan.
- Well construction, field, and water quality data from the previous sampling event.
- Well keys and map of well locations.
- Field notebook, ground-water sampling logs, and calculator. A suggested field data sheet (ground-water sampling record or ground-water sampling log) are provided at the end of this attachment.

- Filtration equipment, if needed. An in-line disposable filter is recommended.
- Polyethylene sheeting placed on ground around the well head.
- Personal protective equipment as specified in the site Health and Safety Plan.
- Air monitoring equipment as specified in the Site Health and Safety Plan.
- Tool box - All needed tools for all site equipment used.
- A 55-gallon drum or container to contain the purged water.

Construction materials of the sampling equipment (bladders, pumps, tubing, and other equipment that comes in contact with the sample) should be limited to stainless steel, Teflon®, glass, and other inert material. This will reduce the chance that sampling materials alter the ground-water where concentrations of the site contaminants are expected to be near the detection limits. The sample tubing diameter should be maximized and the tubing length should be minimized so that the loss of contaminants into and through the tubing walls may be reduced and the rate of stabilization of ground-water parameters is maximized. The tendency of organics to sorb into and out of material makes the appropriate selection of sample tubing material critical for trace analyses (Pohlmann and Alduino, 1992; Parker and Ranney, 1998).

PURGING AND SAMPLING PROCEDURES

The following describes the purging and sampling procedures for the Low-Stress (Low-Flow)/ Minimal Drawdown method for the collection of ground-water samples. These procedures also describe steps for dedicated and non-dedicated systems.

Pre-Sampling Activities (Non-dedicated and dedicated system)

1. Sampling must begin at the monitoring well with the least contamination, generally up-gradient or farthest from the site or suspected source. Then proceed systematically to the monitoring wells with the most contaminated ground water.

2. Check and record the condition of the monitoring well for damage or evidence of tampering. Lay out polyethylene sheeting around the well to minimize the likelihood of contamination of sampling/purging equipment from the soil. Place monitoring, purging and sampling equipment on the sheeting.

3. Unlock well head. Record location, time, date, and appropriate information in a field logbook or on the ground-water sampling log (See attached ground-water sampling record and ground-water sampling log as examples).

4. Remove inner casing cap.

5. Monitor the headspace of the monitoring well at the rim of the casing for volatile organic compounds (VOC) with a photo-ionization detector (PID) or flame ionization detector (FID) and record in the logbook. If the existing monitoring well has a history of positive readings of the headspace, then the sampling must be conducted in accordance with the Health and Safety Plan.

6. Measure the depth to water (water level must be measured to nearest 0.01 feet) relative to a reference measuring point on the well casing with an electronic water level indicator or steel tape and record in logbook or ground-water sampling log. If no reference point is found, measure relative to the top of the inner casing, then mark that reference point and note that location in the field logbook. Record information on depth to ground water in the field logbook or ground-water sampling log. Measure the depth to water a second time to confirm initial measurement; measurement should agree within 0.01 feet or re-measure.

7. Check the available well information or field information for the total depth of the monitoring well. Use the information from the depth of water in step six and the total depth of the monitoring well to calculate the volume of the water in the monitoring well or the volume of one casing. Record information in field logbook or ground-water sampling log.

Purging and Sampling Activities

8A. Non-dedicated system - Place the pump and support equipment at the wellhead and slowly lower the pump and tubing down into the monitoring well until the location of the pump intake is set at a predetermined location within the screen interval. The placement of the pump intake should be positioned

with a calibrated sampling pump hose, sounded with a weighted-tape, or using a pre-measured hose. Refer to the available monitoring well information to determine the depth and length of the screen interval. Measure the depth of the pump intake while lowering the pump into location. Record pump location in field logbook or ground-water sampling log.

8B. Dedicated system - Pump has already been installed, refer to the available monitoring well information and record the depth of the pump intake in the field logbook or ground-water sampling log.

9. Non-dedicated system and dedicated systems - Measure the water level (water level must be measured to nearest 0.01 feet) and record information on the ground-water sampling log, leave water level indicator probe in the monitoring well.

10. Non-dedicated and dedicated systems - Connect the discharge line from the pump to a flow-through cell. A “T” connection is needed prior to the flow-through cell to allow for the collection of water for the turbidity measurements. The discharge line from the flow-through cell must be directed to a container to contain the purge water during the purging and sampling of the monitoring well.

11. Non-dedicated and dedicated systems - Start pumping the well at a low flow rate (0.2 to 0.5 liter per minute) and slowly increase the speed. Check water level. Maintain a steady flow rate while maintaining a drawdown of less than 0.33 feet (Puls and Barcelona, 1996). If drawdown is greater than 0.33 feet, lower the flow rate. 0.33 feet is a goal to help guide with the flow rate adjustment. It should be noted that this goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience (Puls and Barcelona, 1996).

12. Non-dedicated and dedicated systems - Measure the discharge rate of the pump with a graduated cylinder and a stop watch. Also, measure the water level and record both flow rate and water level on the ground-water sampling log. Continue purging, monitor and record water level and pump rate every three to five minutes during purging. Pumping rates should be kept at minimal flow to ensure minimal drawdown in the monitoring well.

13. Non-dedicated and dedicated systems - During the purging, a minimum of one tubing volume (including the volume of water in the pump and flow cell) must be purged prior to recording the water-quality indicator parameters. Then monitor and record the water-quality- indicator parameters every three to five minutes. The water-quality indicator field parameters are turbidity, dissolved oxygen, specific electrical conductance, pH, redox potential, and temperature. Oxidation-reduction potential may not always be an appropriate stabilization parameter, and will depend on site-specific conditions. However, readings should be recorded because of its value as a double check for oxidizing conditions. Also, for the final dissolved oxygen measurement, if the readings are less than 1 milligram per liter, it should be collected and analyze with the spectrophotometric method (Wilde et al., 1998 Wilkin et al., 2001), colorimetric or Winkler titration (Wilkin et al., 2001). The stabilization criterion is based on three successive readings of the water quality field parameters; the following are the criteria which must be used:

Parameter	Stabilization Criteria	Reference
pH	+/- 0.1 pH units	Puls and Barcelona, 1996; Wilde et al., 1998
specific electrical conductance (SEC)	+/- 3% S/cm	Puls and Barcelona, 1996
oxidation-reduction potential (ORP)	+/- 10 millivolts	Puls and Barcelona, 1996
turbidity	+/- 10% NTUs (when turbidity is greater than 10 NTUs)	Puls and Barcelona, 1996; Wilde et al., 1998
dissolved oxygen	+/- 0.3 milligrams per liter	Wilde et al., 1998

Once the criteria have been successfully met indicating that the water quality indicator parameters have stabilized, then sample collection can take place.

14. If a stabilized drawdown in the well can't be maintained at 0.33 feet and the water level is approaching the top of the screened interval, reduce the flow rate or turn the pump off (for 15 minutes) and allow for recovery. It should be noted whether or not the pump has a check valve. A check valve is required if the pump is shut off. Under no circumstances should the well be pumped dry. Begin pumping at a lower flow rate, if the water draws down to the top of the screened interval again, turn pump off and allow for recovery. If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging, then sampling can proceed next time the pump is turned on. This information should be noted in the field notebook or ground-water sampling log with a recommendation for a different purging and sampling procedure.

15. Non-dedicated and dedicated systems - Maintain the same pumping rate or reduce slightly for sampling (0.2 to 0.5 liter per minute) in order to minimize disturbance of the water column. Samples should be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell. Disconnect the pump's tubing from the flow-through cell so that the samples are collected from the pump's discharge tubing. For samples collected for dissolved gases or VOC analyses, the pump tubing needs to be completely full of ground water to prevent the ground water from being aerated as it flows through the tubing. The sequence of the samples is immaterial unless filtered (dissolved) samples are collected and they must be collected last (Puls and Barcelona, 1996). All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container. When filling the VOC samples, a meniscus must be formed over the mouth of the vial to eliminate the formation of air bubbles and head space prior to capping. In the event that the ground water is turbid, (greater then 10 NTUs), a filtered metal (dissolved) sample also should be collected.

If filtered metal sample is to be collected, then an in-line filter is fitted at the end of the discharge tubing and the sample is collected after the filter. The in-line filter must be pre-rinsed following manufacturer's recommendations and if there are no recommendations for rinsing, a minimum of 0.5 to 1 liter of ground water from the monitoring well must pass through the filter prior to sampling.

16A. Non-dedicated system - Remove the pump from the monitoring well. Decontaminate the pump and dispose of the tubing if it is non-dedicated.

16B. Dedicated system - Disconnect the tubing that extends from the plate at the wellhead (or cap) and discard after use.

17. Non-dedicated system - Before locking the monitoring well, measure and record the well depth (to 0.1 feet).

Measure the total depth a second time to confirm initial measurement; measurement should agree within 0.01 feet or re-measure.

18. Non-dedicated and dedicated systems - Close and lock the well.

DECONTAMINATION PROCEDURES

Decontamination procedures for the water level meter and the water quality field parameter sensors.
The electronic water level indicator probe/steel tape and the water-quality field parameter sensors will be decontaminated by the following procedures:

1. The water level meter will be hand washed with phosphate-free detergent and a scrubber, then thoroughly rinsed with distilled water.

2. Water quality field parameter sensors and flow-through cell will be rinsed with distilled water between sampling locations. No other decontamination procedures are necessary or recommended for these probes since they are sensitive. After the sampling event, the flow cell and sensors must be cleaned and maintained per the manufacturer's requirements.

Decontamination Procedure for the Sampling Pump

Upon completion of the ground water sample collection the sampling pump must be properly decontaminated between monitoring wells. The pump and discharge line including support cable and electrical

wires which were in contact with the ground water in the well casing must be decontaminated by the following procedure:

1. The outside of the pump, tubing, support cable and electrical wires must be pressure-sprayed with soapy water, tap water, and distilled water. Spray outside of tubing and pump until water is flowing off of tubing after each rinse. Use bristle brush to help remove visible dirt and contaminants.
2. Place the sampling pump in a bucket or in a short PVC casing (4-in. diameter) with one end capped. The pump placed in this device must be completely submerged in the water. A small amount of phosphate-free detergent must be added to the potable water (tap water).
3. Remove the pump from the bucket or 4-in. casing and scrub the outside of the pump housing and cable.
4. Place pump and discharge line back in the 4-in. casing or bucket, start pump and recirculate this soapy water for 2 minutes (wash).
5. Re-direct discharge line to a 55-gallon drum. Continue to add 5 gallons of potable water (tap water) or until soapy water is no longer visible.
6. Turn pump off and place pump into a second bucket or 4-in. casing that contains tap water. Continue to add 5 gallons of tap water (rinse).
7. Turn pump off and place pump into a third bucket or 4-in. casing which contains distilled/deionized water, continue to add 3 to 5 gallons of distilled/deionized water (final rinse).
8. If a hydrophobic contaminant is present (such as separate phase, high levels of PCBs, etc.), an additional decontamination step, or steps, may be added. For example, an organic solvent, such as reagent-grade isopropanol alcohol may be added as a first spraying/bucket prior to the soapy water rinse/bucket.

FIELD QUALITY CONTROL

Quality control (QC) samples must be collected to verify that sample collection and handling procedures were performed adequately and that they have not compromised the quality of the ground-water samples. The appropriate EPA program guidance must be consulted in preparing the field QC sample requirements for the site-specific Quality Assurance Project Plan (QAPP).

There are five primary areas of concern for quality assurance (QA) in the collection of representative ground-water samples:

1. Obtaining a ground-water sample that is representative of the aquifer or zone of interest in the aquifer. Verification is based on the field log documenting that the field water-quality parameters stabilized during the purging of the well, prior to sample collection.
2. Ensuring that the purging and sampling devices are made of materials, and utilized in a manner that will not interact with or alter the analyses.
3. Ensuring that results generated by these procedures are reproducible; therefore, the sampling scheme should incorporate co-located samples (duplicates).
4. Preventing cross-contamination. Sampling should proceed from least to most contaminated wells, if known. Field equipment blanks should be incorporated for all sampling and purging equipment, and decontamination of the equipment is therefore required.
5. Properly preserving, packaging, and shipping samples.

All field QC samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The chain-of-custody procedures for the QC samples will be identical to the field ground-water samples. The following are QC samples that must be collected during the sampling event:

Sample Type	Frequency
● Field duplicates	1 per 20 samples
● Matrix spike	1 per 20 samples
● Matrix spike duplicate	1 per 20 samples
● Equipment blank	per Regional requirements or policy
● Trip blank (VOCs)	1 per sample cooler
● Temperature blank	1 per sample cooler

HEALTH AND SAFETY CONSIDERATIONS

Depending on the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. The site Health and Safety Plan should be reviewed with specific emphasis placed on the protection program planned for the sampling tasks. Standard safe operating practices should be followed, such as minimizing contact with potential contaminants in both the liquid and vapor phase through the use of appropriate personal protective equipment.

Depending on the type of contaminants expected or determined in previous sampling efforts, the following safe work practices will be employed:

Particulate or metals contaminants

1. Avoid skin contact with, and incidental ingestion of, purge water.
2. Use protective gloves and splash protection.

Volatile organic contaminants

1. Avoid breathing constituents venting from well.
2. Pre-survey the well head space with an appropriate device as specified in the site Health and Safety Plan.
3. If monitoring results indicate elevated organic constituents, sampling activities may be conducted in level C protection. At a minimum, skin protection will be afforded by disposable protective clothing, such as Tyvek®.

General practices should include avoiding skin contact with water from preserved sample bottles, as this water will have pH less than 2 or greater than 10. Also, when filling pre-acidified VOA bottles, hydrochloric acid fumes may be released and should not be inhaled.

POST-SAMPLING ACTIVITIES

Several activities need to be completed and documented once ground-water sampling has been completed. These activities include, but are not limited to the following:

1. Ensuring that all field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
2. Processing all sample paperwork, including copies provided to the Regional Laboratory, Sample Management Office, or other appropriate sample handling and tracking facility.
3. Compiling all field data for site records.
4. Verifying all analytical data processed by the analytical laboratory against field sheets to ensure all data has been returned to sampler.

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SAMPLING CHECKLIST

Well Identification:_____

Map of Site Included: Y or N
Wells Clearly Identified with Roads: Y or N
Well Construction Diagram Attached: Y or N

Well Construction:

Diameter of Borehole:_____ Diameter of Casing:_____
Casing Material:_____ Screen Material:_____
Screen Length:_____ Total Depth:_____

Approximate Depth to Water:_____
Maximum Well Development Pumping Rate:_____
Date of Last Well Development:_____

Previous Sampling Information:

Was the Well Sampled Previously: Y or N
(If Sampled, Fill Out Table Below)

Table of Previous Sampling Information

Parameter	Previously Sampled	Number of Times Sampled	Maximum Concentration	Notes (include previous purge rates)

Ground Water Sampling Log

Site Name: **Well #:** **Date:**
Well Depth(Ft-BTOC[1]): **Screen Interval**(Ft):

Well Dia.: **Casing Material:** **Sampling Device:**

Pump placement(Ft from TOC[2]):

Measuring Point: **Water level (static)**(Ft):

Water level (pumping)(Ft): **Pump rate**(Liter/min):

Sampling Personnel:

Other info: (such as sample numbers, weather conditions and field notes)

Water Quality Indicator Parameters

Time	Pumping rates (L/Min)	Water level (ft)	DO (mg/L)	ORP (mv)	Turb. (NTU)	SEC[3] (S/cm)	pH	Temp. (C^0)	Volume pumped (L)

Type of Samples collected:

1 casing volume was:

Total volume purged prior to sample collection:

[1]**BTOC-Below Top of Casing**
[2]**TOC-Top of Casing**
[3]**Specific Electrical Conductance**

Stabilization Criteria

D.O.	+/- 0.3 mg/l
Turb.	+/- 10%
S.C.	+/- 3%
ORP	+/- 10 mV
pH	+/- 0.1 unit

ATTACHMENT 4
Example Standard Operating Procedure:

Standard Operating Procedure for the Standard/Well-Volume Method for Collecting a Ground-Water Sample

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Standard Operating Procedure for the Well-Volume Method for Collecting a Ground-Water Sample

INTRODUCTION

The collection of "representative" water samples from wells is neither straightforward nor easily accomplished. Ground-water sample collection can be a source of variability through differences in sampling personnel and their individual sampling procedures, the equipment used, and ambient temporal variability in subsurface and environmental conditions. Many site inspections and remedial investigations require the sampling at ground-water monitoring wells within a defined criterion of data confidence or data quality, which necessitates that the personnel collecting the samples are trained and aware of proper sample-collection procedures.

The objectives of the sampling procedures described in this document are to minimize changes in ground-water chemistry during sample collection and transport to the laboratory and to maximize the probability of obtaining a representative, reproducible ground-water sample. Sampling personnel may benefit from a working knowledge of the chemical processes that can influence the concentration of dissolved chemical species.

The well-volume method described in this standard operating procedure (SOP) provides a reproducible sampling technique with the goal that the samples obtained will represent water quality over an entire open interval of a short-screened (ten feet or less) well. This technique is appropriate for long-term and detection monitoring of formation water quality. The resulting sample generally represents a composite of the screened interval, and thus integrates small-scale vertical heterogeneities of ground-water chemistry. This sampling technique also is useful for screening purposes for detection monitoring of contaminants in the subsurface. However, the detection of a low concentration of contaminant in a thin contaminated zone or with long well screens may be difficult and should be determined using detailed vertical profiling techniques.

This method may not be applicable for all ground-water-sampling wells, such as wells with very low yields, fractured rock, and some wells with turbidity problems. As always, site-specific conditions and objectives should be considered prior to the selection of this method for sampling.

SCOPE AND APPLICATION

The objective of a good sampling program should be the collection of a representative sample of the current ground-water conditions over a known or specified volume of aquifer. To meet this objective, the sampling equipment, the sampling method, the monitoring well construction, monitoring well operation and maintenance, and sample-handling procedures should not alter the chemistry of the sample.

An example of how a site's Data Quality Objectives (DQOs) for a characterization sampling effort might vary from those of a remediation monitoring sampling effort could be a difference of how much of the screened interval or aquifer should be sampled. A site characterization objective may be to collect a sample that represents a composite of the entire (or as close as is possible) screened interval of the monitoring well.

Additionally, the site characterization may require a large suite of contaminants to be sampled and analyzed, whereas, the remediation monitoring program may require fewer contaminants sampled and analyzed. These differences may dictate the type of sampling equipment used, the type of information collected, and the sampling protocol.

This sampling method described is for monitoring wells. However, this method should not be used for water-supply wells with a water-supply pump, with long-screened wells in complex hydrogeologic environments (such as fractured rock), or wells with separate phases of liquids (such as a Dense or Light Non-Aqueous Phase Liquids) present within the screened interval.

EQUIPMENT

- Depth-to-water measuring device - An electronic water-level indicator or steel tape and chalk, with marked intervals of 0.01 foot. Interface probe for measuring separate phase liquids, if needed. Pressure transducer and data logger optional for frequent depth-to-water measuring in same well.
- Steel tape and weight - Used for measuring total depth of well. Lead weights should not be used.
- Sampling pump - Submersible or bladder pumps with adjustable rate controls are preferred. Pumps

are to be constructed of inert materials, such as stainless steel and Teflon®. Pump types that are acceptable include gear and helical driven, centrifugal (low-flow type), and air-activated piston. Adjustable rate, peristaltic pumps can be used when the depth to water is 20 feet or less.

- Tubing - Inert tubing should be chosen based on the types and concentrations of contaminants present, or expected to be present in the monitoring well. Generally, Teflon®-based tubing is recommended when sampling for organic compounds. Polyethylene or Teflon® tubing can be used when sampling for inorganic constituents.
- Power source - If a combustion type (gasoline or diesel-driven) device is used, it must be located downwind of the point of sample collection. If possible, it should also be transported to the site and sampling location in a different vehicle from the sampling equipment.
- Flow-measurement equipment - Graduated cylinder or bucket and a stop watch, or a flow meter that can be disconnected prior to sampling.
- Multi-parameter meter with flow-through cell - This can be one instrument or multiple probes/instruments contained in a flow-through cell. The water-quality-indicator parameters that are measured in the field are pH, oxidation/reduction potential (ORP, redox, or Eh), dissolved oxygen (DO), turbidity, specific electrical conductance (SEC), and temperature. Calibration standards for all instruments should be NIST-traceable, within expiration dates of the solutions, and sufficient for daily calibration throughout the sampling collection.
- Decontamination supplies - A reliable and documented source of distilled water and any solvents (if used). Pressure sprayers, buckets or decontamination tubes for pumps, brushes and non-phosphate soap also will be needed.
- Sample bottles, sample preservation supplies and laboratory paperwork. Also, several coolers, and sample packing supplies (absorbing packing material, plastic baggies, etc.).
- Approved plans and background documents - Approved Field Sampling Plan, Quality Assurance Project Plan, well construction data, field and water-quality data from the previous sampling collection.
- Site Access/Permission documentation for site entry.
- Well keys and map showing locations of wells.
- Field notebook, field data sheets and calculator. A suggested field data sheet is provided at the end of this attachment.
- Filtration equipment - If needed, this equipment should be an in-line disposable filter used for the collection of samples for analysis of dissolved constituents.
- Polyethylene sheeting - Used for decontamination stations and during sampling to keep equipment clean.
- Site Health and Safety Plan and required equipment - The health and safety plan along with site sign-in sheet should be on site and be presented by the site health and safety officer. Personnel-protective and air-monitoring equipment specified in the Site Health and Safety Plan should be demonstrated, present and in good working order on site at all times.
- Tool box - All needed tools for all site equipment used.
- A 55-gallon drum or container to contain the purged water.

Construction materials of the sampling equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon®, glass, and other inert materials when concentrations of the site contaminants are expected within the detection limit range. The sample tubing thickness and diameter should be maximized and the tubing length should be minimized so that the loss of contaminants absorbed to and through the tubing walls may be reduced and the rate of stabilization of ground-water parameters is maximized. The tendency of organics to sorb into and out of many materials makes the appropriate selection of sample tubing materials critical for these trace analyses (Pohlmann and Alduino, 1992; Parker and Ranney, 1998).

Generally, wells should be purged and sampled using the same positive-displacement pump and/or a low-flow submersible pump with variable controlled flow rates and constructed of chemically inert materials. If a pump cannot be used because the recovery rate of the well is so low (less than 100 to 200 ml/min) and the volume of the water to be removed is minimal (less than 5 feet of water in a small-diameter well), then a Teflon® bailer, with a double check valve and bottom-emptying device with a control-flow check

valve may be used to obtain the samples. Otherwise, a bailer should not be used when sampling for volatile organics because of the potential bias introduced during sampling (Yeskis et al., 1988; Pohlmann et al., 1990; Tai et al., 1991). Bailers also should be avoided when sampling for metals because repeated bailer deployment has the potential to increase turbidity, which biases concentrations of inorganic constituents. Dedicated sampling pumps are recommended for metals sampling (Puls et al., 1992).

In addition, for wells with long riser pipes above the well screen, the purge volumes may be reduced by using packers above the pumps. The packer materials should be compatible with the parameters to be analyzed. These packers should be used only on wells screened in highly permeable materials, because of the lack of ability to monitor water levels in the packed interval. Otherwise, if pumping rates exceed the natural aquifer recovery rates into the packed zone, a vacuum or negative pressure zone may develop. This may result in a failure of the seal by the packer and/or a gaseous phase may develop, that may bias any sample taken.

PURGING AND SAMPLING PROCEDURE

WATER-LEVEL MEASUREMENTS

The field measurements should include total well depth and depth to water from a permanently marked reference point.

TOTAL WELL DEPTH

The depth of each well should be measured to the nearest one-tenth of a foot when using a steel tape with a weight attached and should be properly recorded. The steel tape should be decontaminated before use in another well according to the site specific protocols. A concern is that when the steel tape and weight hit the bottom of the well, sediment present on the bottom of a well is stirred up, thus increasing turbidity, which will affect the sampling results. In these cases, as much time as possible should be allowed prior to sampling, such as a minimum of 24 hours. If possible, total well depth measurements can be completed after sampling (Puls and Barcelona, 1996). The weight of electric tapes is generally too light to determine accurate total well depth. If the total well depth is greater than 200 feet, stretching of the tape must be taken into consideration.

DEPTH TO WATER

All water levels should be measured from the reference point by use of a weighted steel tape and chalk or an electronic water-level indicator (a detailed discussion of the pros and cons of the different water level devices is provided in Thornhill, 1989). The steel tape is a more accurate method to take water levels, and is recommended where shallow flow gradients (less than 0.05 feet/feet) or deep wells are encountered. However, in those cases where large flow gradients or large fluctuations in water levels are expected, a calibrated electric tape is acceptable. The water level is calculated using the well's surveyed reference point minus the measured depth-to-water and should be measured to the nearest one hundredth of a foot.

The depth-to-water measurement must be made in each well to be sampled prior to any other activities at the well (such as bailing, pumping, and hydraulic testing) to avoid bias to the measurement. All readings are to be recorded to the nearest one hundredth of a foot. When possible, depth-to-water and total well depth measurements should be completed at the beginning of a ground-water sampling program, which will allow any turbidity to settle and allow a more synoptic water-level evaluation. However, if outside influences (such as tidal cycles, nearby pumping effects, or major barometric changes) may result in significant water-level changes in the time between measurement and sampling, a water-level measurement should be completed immediately prior to sampling. In addition, the depth-to-water measurement during purging should be recorded, with the use of a pressure transducer and data logger sometimes more efficient (Barcelona et al., 1985, Wilde et al., 1998).

The time and date of the measurement, point of reference, measurement method, depth-to-water measurement, and any calculations should be properly recorded in field notebook or sampling sheet.

STATIC WATER VOLUME

From the information obtained for casing diameter, total well depth and depth-to-water measurements, the volume of water in the well is calculated. This value is one criteria that may be used to determine the volume of water to be purged from the well before the sample is collected.

The static water volume may be calculated using the following formula:

$$V = r^2h(0.163)$$

Where:

V	=	static volume of water in well (in gallons)
r	=	inner radius of well casing (in inches)
h	=	length of water column (in feet) which is equal to the total well depth minus depth to water.
0.163	=	a constant conversion factor that compensates for the conversion of the casing radius from inches to feet for 2-inch diameter wells and the conversion of cubic feet to gallons, and pi (π). This factor would change for different diameter wells.

Static water volumes also may be obtained from various sources, such as Appendix 11.L in Driscoll (1986).

WELL PURGING

PURGE VOLUMES

In most cases, the standing water in the well casing can be of a different chemical composition than that contained in the aquifer to be sampled. Solutes may be adsorbed or desorbed from the casing material, oxidation may occur, and biological activity is possible. Therefore, the stagnant water within the well must be purged so that water that is representative of the aquifer may enter the well.

The removal of at least three well volumes is suggested (USEPA, 1986; Wilde et al., 1998). The amount of water removed may be determined by collecting it in a graduated pail of known volume to determine pumping rate and time of pumping. A flow meter may also be used, as well as capturing all purged water in a container of known volume.

The actual number of well volumes to be removed is based on the stabilization of water-quality-indicator parameters of pH, ORP, SEC, DO, and turbidity. The water initially pumped is commonly turbid. In order to keep the turbidity and other probes from being clogged with the sediment from the turbid water, the flow-through cell should be bypassed initially for the first well volume. These measurements should be taken and recorded every ½ well volume after the removal of 1 to 1 ½ well volume(s). Once three successive readings of the water-quality-indicator parameters provided in the table have stabilized, sampling may begin. The water-quality-indicator parameters that are recommended include pH and temperature, but these are generally insensitive to indicate completion of purging since they tend to stabilize rapidly (Puls and Barcelona, 1996). ORP may not always be an appropriate stabilization parameter, and will depend on site-specific conditions. However, readings should be recorded because of its value as a double check for oxidizing conditions, and for some fate and transport issues. When possible, especially when sampling for contaminants that may be biased by the presence of turbidity, the turbidity reading is desired to stabilize at a value below 10 Nephelometric Turbidity Units (NTUs). For final DO measurements, if the readings are less than 1 milligram per liter, they should be collected with the spectrophotometric method (Wilde et al., 1998, Wilkin et al., 2001), colorimetric or Winkler titration (Wilkin et al., 2001). All of these water-quality-indicator parameters should be evaluated against the specifications of the accuracy and resolution of the instruments used. No more than six well volumes should be purged, to minimize the over pumping effects described by Gibs and Imbrigiotta (1990).

Purging Methods

In a well that is not being pumped, there will be little or no vertical mixing in the water column between sampling events, and stratification may occur. The water in the screened section may mix with the ground water due to normal flow patterns, but the water above the screened section will remain isolated and become stagnant. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in unrepresentative water quality. To safeguard against collecting nonrepresentative stagnant water in a sample, the following guidelines and techniques should be adhered to during sample collection:

Table of Stabilization Criteria with References for Water-Quality-Indicator Parameters

Parameter	Stabilization Criteria	Reference
pH	+/- 0.1	Puls and Barcelona, 1996; Wilde et al., 1998
specific electrical conductance (SEC)	+/- 3%	Puls and Barcelona, 1996
oxidation-reduction potential (ORP)	+/- 10 millivolts	Puls and Barcelona, 1996
turbidity	+/- 10% (when turbidity is greater than 10 NTUs)	Puls and Barcelona, 1996; Wilde et al., 1998
dissolved oxygen (DO)	+/- 0.3 milligrams per liter	Wilde et al., 1998

1. As a general rule, monitoring wells should be pumped or bailed (although bailing is to be strongly avoided) prior to collecting a sample. Evacuation of a minimum of three volumes of water in the well casing is recommended for a representative sample. In a high-yielding ground-water formation where there is no stagnant water in the well above the screened section (commonly referred to as a water-table well), evacuation prior to sample withdrawal is not as critical but serves to field rinse and condition sampling equipment. The purge criteria has been described previously and will be again in the SAMPLING PROCEDURES section on the following page. The rate of purging should be at a rate and by a method that does not cause aeration of the water column and should not exceed the rate at which well development was completed.

2. For wells that can be pumped or bailed to dryness with the sampling equipment being used, the well should be evacuated to just above the well screen interval and allowed to recover prior to sample withdrawal. (Note: It is important not to completely dewater the zone being sampled, as this may allow air into that zone which could result in negative bias in organic and metal constituents.) If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred.

3. A non-representative sample also can result from excessive prepumping of the monitoring well. Stratification of the contaminant concentrations in the ground-water formation may occur or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can decrease or increase the contaminant concentrations from what is representative of the sampling point of interest, as well as increase turbidity and create large quantities of waste water.

The method used to purge a well depends on the inner diameter, depth-to-water level, volume of water in the well, recovery rate of the aquifer, and accessibility of the well to be sampled. The types of equipment available for well evacuation include hand-operated or motor-driven suction pumps, peristaltic pumps, submersible pumps, and bailers made of various materials, such as stainless steel and Teflon®. Whenever possible, the same device used for purging the well should be left in the well and used for sampling, generally in a continual manner from purging directly to sampling without altering position of the sampling device or turning off the device.

When purging/sampling equipment must be reused in other wells, it should be decontaminated consistent with the decontamination procedures outlined in this document. Purged water should be collected and screened with air-monitoring equipment as outlined in the site health and safety plan, as well as water-quality field instruments. If these parameters and/or the facility background data suggest that the water is hazardous, it should be contained and disposed of properly as determined on a site-specific basis.

During purging, water-level measurements should be recorded regularly for shallow wells, typically at 15- to 30-second intervals. These data may be useful in

computing aquifer transmissivity and other hydraulic characteristics, and for adjusting purging rates. In addition, these data will assure that the water level doesn't fall below the pump intake level

SAMPLING PROCEDURES

Ground-water sample collection should take place immediately following well purging. Preferably, the same device should be used for sample collection as was used for well purging, minimize further disturbance of the water column, and reduce volatilization and turbidity. In addition, this will save time and avoid possible contamination from the introduction of additional equipment into the well, as well as using equipment materials already equilibrated to the ground water. Sampling should occur in a progression from the least to most contaminated well, if known, when the same sampling device is used.

The sampling procedure is as follows:

1) Remove locking well cap. Note location, time of day, and date in field notebook or on an appropriate log form.
2) Note wind direction. Stand upwind from the well to avoid contact with gases/vapors emanating from the well.
3) Remove well casing cap.
4) If required by site-specific conditions, monitor headspace of well with appropriate air-monitoring equipment to determine presence of volatile organic compounds or other compounds of concern and record in field logbook.
5) If not already completed, measure the water level from the reference measuring point on the well casing or protective outer casing (if inner casing not installed or inaccessible) and record it in the field notebook. Alternatively, if no reference point exists, note that the water level measurement is from the top of the outer protective casing, top of inside riser pipe, ground surface, or some other position on the well head. Have a permanent reference point established as soon as possible after sampling. Measure at least twice to confirm measurement; the measurement should agree within 0.01 feet or re-measure. Decontaminate the water-level-measuring device.
6) If not already completed, measure the total depth of the well (at least twice to confirm measurement; the measurement should agree within 0.01 feet or re-measure) and record it in the field notebook or on log form. Decontaminate the device used to measure total depth. If the total well depth has been measured recently (in the past year), then measure it at the conclusion of sampling.
7) Calculate the volume of water in the well and the volume to be purged using the formula previously provided.
8) Lay plastic sheeting around the well to minimize the likelihood of contamination of equipment from soil adjacent to the well.
9) Rinse the outside of sampling pump with distilled water and then, while lowering the pump, dry it with disposable paper towels.
10) Lower the pump (or bailer) and tubing down the well. The sampling equipment should never be dropped into the well because this will cause degassing of the water upon impact. This may also increase turbidity, which may bias the metals analysis. The lowering of the equipment should be slow and smooth!
11) The pump should be lowered to a point just below the water level. If the water level is above the screened interval, the pump should be above the screened interval for the reasons provided in the purging section.
12) Turn the pump on. The submersible pumps should be operated in a continuous, low-flow manner so that they do not produce pulsating flows, which cause aeration in the discharge tubing, aeration upon discharge, or resuspension of sediments at the bottom of the well. The sampling pump flow rates should be lower than or the same as the purging rates. The purging and sampling rates should not be any greater than well development rates.
13) Water levels should be monitored during pumping to ensure that air does not enter the pump and to help determine an appropriate purging rate.
14) After approximately one to two well volumes are removed, a flow-through cell will be hooked up to the discharge tubing of the pump. If the

well discharge water is not expected to be highly turbid, contain separate liquid phases, or minimal bacterial activitiy that may coat or clog the electrodes within the flow-through cell, then the cell can be immediately hooked up to the discharge tubing. This cell will allow measurements of water-quality-indicator parameters without allowing contact with the atmosphere prior to recording the readings for temperature, pH, ORP, SEC, DO and turbidity.

15) Measurements for temperature, pH, ORP, SEC, DO, and turbidity will be made at each one-half well volume removed. Purging may cease when measurements for all five parameters have stabilized (provided in the earlier table) for three consecutive readings.

16) If the water level is lowered to the pump level before three volumes have been removed, the water level will be allowed to recover for 15 minutes, and then pumping can begin at a lower flow rate. If the pump again lowers the water level to below the pump intake, the pump will be turned off and the water level allowed to recover for a longer period of time. This will continue until a minimum of two well volumes are removed prior to taking the ground-water sample.

17) If the water-quality-indicator parameters have stabilized, sample the well. Samples will be collected by lowering the flow rate to a rate that minimizes aeration of the sample while filling the bottles (approximately 300 ml/min). Then a final set of water-quality-indicator parameters is recorded. The pump discharge line is rapidly disconnected from the flow-through cell to allow filling of bottles from the pump discharge line. The bottles should be filled in the order of volatile organic compounds bottles first, followed by semi-volatile organic compound's/pesticides, inorganics, and other unfiltered samples. Once the last set of samples is taken, if filtering is necessary, an in-line disposable filter (with appropriately chosen filter size) will be added to the discharge hose of the pump. Then the filtered samples will be taken. If a bailer is used for obtaining the samples, filtering occurs at the sampling location immediately after the sample is obtained from the bailer by using a suction filter. The first one-half to one liter of sample taken through the filter will not be collected, in order to assure the filter media is acclimated to the sample. If filtered samples are collected, WITHOUT EXCEPTION, filtering should be performed in the field as soon as possible after collection, and not later in a laboratory.

18) All appropriate samples that are to be cooled, are put into a cooler with ice immediately. All of the samples should not be exposed to sunlight after collection. Keep the samples from freezing in the winter when outside temperatures are below freezing. The samples, especially organics, cyanide, nutrients, and other analytes with short holding times, are recommended to be shipped or delivered to the laboratory daily. Ensure that the appropriate samples that are to be cooled remain at 4°C, but do not allow any of the samples to freeze.

19) If a pump cannot be used because the recovery rate is slow and the volume of the water to be removed is minimal (less than 5 feet of water), then a Teflon® bailer, with a double check valve and bottom-emptying device with a control-flow check valve will be used to obtain the samples. The polypropylene rope used with the bailer will be disposed of following the completion of sampling at each well.

20) The pump is removed from the well and decontaminated for the next sampling location.

Additional precautions to ensure accurate and representative sample collection are as follows:

- Check valves on bailers, if bailers are used, should be designed and inspected to ensure that fouling problems do not reduce delivery capabilities or result in aeration of the sample.
- The water should be transferred to a sample container in a way that will minimize agitation and aeration.
- If the sample bottle contains no preservatives, the bottle should be rinsed with sample water, which is discarded before sampling. Bottles for sample analyses that require preservation should be prepared before they are taken to the well. Care should be taken to avoid overfilling bottles so that the preservative is not lost. The pH should be checked and more preservatives added to inor-

ganic sample bottles, if needed. VOA bottles that do not meet the ph requirements need to be discarded and new sample bottles with more preservative added should be prepared immediately.

- Clean sampling equipment should not be placed directly on the ground or other contaminated surfaces either prior to sampling or during storage and transport.

Special Consideration for Volatile Organic Compound Sampling

The proper collection of a sample for dissolved volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the samples. Preferred retrieval systems for the collection of un-biased volatile organic samples include positive displacement pumps, low-flow centrifugal pumps, and some in-situ sampling devices. Field conditions and other constraints will limit the choice of appropriate systems. The principal objective is to provide a valid sample for analysis, one that has been subjected to the least amount of turbulence possible.

1) Fill each vial to just overflowing. Do not rinse the vial, nor excessively overflow it, as this will effect the pH by diluting the acid preservative previously placed in the bottle. Another option is to add the acid at the well, after the sample has been collected. There should be a convex meniscus on the top of the vial.
2) Do not over tighten and break the cap.
3) Invert the vial and tap gently. Observe the vial closely. If an air bubble appears, discard the sample and collect another. It is imperative that no entrapped air remains in the sample vial. Bottles with bubbles should be discarded, unless a new sample cannot be collected, and then the presence of the bubble should be noted in the field notes or field data sheet. If an open sample bottle is dropped, the bottle should be discarded.
4) Orient the VOC vial in the cooler so that it is lying on its side, not straight up.
5) The holding time for VOCs is 14 days. It is recommended that samples be shipped or delivered to the laboratory daily. Ensure that the samples remain at 4°C, but do not allow the samples to freeze.

Field Filtration of Turbid Samples

The USEPA recognizes that in some hydrogeologic environments, even with proper well design, installation, and development, in combination with the low-flow rate purging and sampling techniques, sample turbidity cannot be reduced to ambient levels. The well construction, development, and sampling information should be reviewed by the Regional geologists or hydrologists to see if the source of the turbidity problems can be resolved or if alternative sampling methods should be employed. If the water sample is excessively turbid, the collection of both filtered and unfiltered samples, in combination with turbidity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pumping rate, and drawdown data is recommended. The filter size used to determine TSS and TDS should be the same as used in the field filtration. An in-line filter should be used to minimize contact with air to avoid precipitation of metals. The typical filter media size used is 0.45 µm because this is commonly accepted as the demarcation between dissolved and non-dissolved species. Other filter sizes may be appropriate, but their use should be determined based on site-specific criteria (examples include grain-size distribution, ground-water flow velocities, mineralogy) and project DQOs. Filter sizes up to 10.0 µm may be warranted because larger size filters may allow particulates that are mobile in ground water to pass through (Puls and Powell, 1992). The changing of filter media size may limit the comparability of the data obtained with other data sets and may affect their use in some geochemical models. Filter media size used on previous data sets from a site, region, or aquifer and the DQOs should be taken into consideration. The filter media used during the ground-water sampling program should be collected in a suitable container and archived because potential analysis of the media may be helpful for the determination of particulate size, mineralogy, etc.

The first 500 to 1000 milliliters of sample taken through the filter, depending on sample turbidity, will not be collected for a sample, in order to ensure that the filter media has equilibrated to the sample. Manufacturers' recommendations also should be consulted. Because bailers have been shown to increase

turbidity while purging and sampling, they should be avoided when sampling for trace element, metal, PCB, and pesticide constituents. If portable sampling pumps are used, the pumps should be gently lowered to the sampling depth desired, carefully avoiding being lowered to the bottom of the well. The pumps, once placed in the well, should not be moved to allow any particles mobilized by pump placement to settle. Dedicated sampling equipment installed in the well prior to the commencement of the sampling activities is one of the recommended methods to reduce turbidity artifacts (Puls and Powell, 1992; Kearl et al., 1992; Puls et al., 1992; Puls and Barcelona, 1996).

DECONTAMINATION PROCEDURES

Once removed from the well, the purging and sampling pumps should be decontaminated by scrubbing with a brush and a non-phosphate soapy-water wash, rinsed with water, and rinsed with distilled water to help ensure that there is no cross-contamination between wells. The step-by-step procedure is:

1) Pull pump out of previously sampled well (or out of vehicle) and use three pressure sprayers filled with soapy water, tap water, and distilled water. Spray outside of tubing and pump until water is flowing off of tubing after each rinse. Use bristle brush to help remove visible dirt, contaminants, etc.
2) Have three long PVC tubes with caps or buckets filled with soapy water, tap water and distilled water. Run pump in each until approximately 2 to 3 gallons of each decon solution is pumped through tubing. Pump at low rate to increase contact time between the decon solutions and the tubing.
3) Try to pump decon solutions out of tubing prior to next well. If this cannot be done, compressed air may be used to purge lines. Another option is to install a check valve in the pump line (usually just above the pump head) so that the decon solutions do not run back down the well as the pump is lowered down the next well.
4) Prior to lowering the pump down the next well, spray the outside of the pump and tubing with distilled water. Use disposable paper towels to dry the pump and tubing.
5) If a hydrophobic contaminant is present (such as separate phase, high levels of PCBs, etc.), an additional decon step, or steps, may be added. For example, an organic solvent such as reagent-grade isopropanol alcohol may be added as a first rinse prior to the soapy water rinse.

If the well has been sampled with a bailer that is not disposable, the bailer should be cleaned by washing with soapy water, rinsing with tap water, and finally rinsing with distilled water. Bailers are most easily cleaned using a long-handled bottle brush.

It is especially important to clean thoroughly the portion of the equipment that will be in contact with sample water. In addition, a clean plastic sheet should be placed adjacent to or around the well to prevent surface soils from coming in contact with the purging equipment. The effects of cross-contamination also can be minimized by sampling the least contaminated well first and progressing to the more contaminated ones. The bailer cable/rope (if a bailer is used) and plastic sheet should be properly discarded, as provided in the site health and safety plan, and new materials provided for the next well.

FIELD QUALITY CONTROL

The quality assurance (QA) targets for precision and accuracy of sampling programs are based on accuracy and precision guidelines established by the USEPA. When setting targets, keep in mind that all measurements must be made so that the results are representative of the sample water and site-specific conditions. Various types of blanks are used to check the cleanliness of the field-handling methods. These are known as field blanks, and include field equipment blanks and transport blanks. Other QA samples include spike samples and duplicates.

There are five primary areas of concern for QA in the collection of representative ground-water samples:

1. Obtaining a sample that is representative of water in the aquifer or targeted zone of the aquifer. Verify log documentation that the well was purged of the required volume or that the temperature, pH, ORP, SEC, DO and turbidity stabilized before samples were extracted.

2. Ensuring that the purging and sampling devices are made of materials and utilized in a manner that will not interact with or alter the analyses.
3. Generating results that are reproducible. Therefore, the sampling scheme should incorporate co-located samples (duplicates).
4. Preventing cross-contamination. Sampling should proceed from least to most contaminated wells, if known. Field equipment blanks should be incorporated for all sampling and purging equipment; decontamination of the equipment is therefore required.
5. Ensuring that samples are properly preserved, packaged, and shipped.

FIELD EQUIPMENT BLANKS

To ensure QA and quality control, a field equipment blank must be included in each sampling run, or for every twenty samples taken with the sampling device. Equiptment blanks allow for a cross check and, in some cases, quantitative correction for imprecision that could arise due to handling, preservation, or improper cleaning procedures.

Equipment blanks should be taken for each sample bottle type that is filled. Distilled water is run through the sampling equipment and placed in a sample bottle (the blank), and the contents are analyzed in the lab like any other sample. Following the collection of each set of twenty samples, a field equipment blank will be obtained. It is generally desirable to collect this field equipment blank after sampling a relatively highly contaminated well. These blanks may be obtained through the following procedure:

a) Following the sampling event, decontaminate all sampling equipment according to the site decontamination procedures and before collecting the blank.
b) VOA field blanks should be collected first, prior to water collected for other TAL/TCL analyses. A field blank must be taken for all analyses.
c) Be sure that there is enough distilled water in the pump so that the field equipment blank can be collected for each analysis.
d) The water used for the field equipment blank should be from a reliable source, documented in the field notebooks, and analyzed as a separate water-quality sample.

TRIP BLANKS

A trip blank should be included in each sample shipment and, at a minimum, one per 20 samples. Bottles, identical to those used in the field, are filled with reagent-grade water. The source of the reagent-grade water should be documented in the field notebooks, including lot number and manufacture. This sample is labeled and stored as though it is a sample. The sample is shipped back to the laboratory with the other samples and analysis is carried out for all the same constituents.

DUPLICATE SAMPLES

Duplicate samples are collected by taking separate samples as close to each other in time and space as practical, and should be taken for every 20 samples collected. Duplicate samples are used to develop criteria for acceptable variations in the physical and chemical composition of samples that could result from the sampling procedure. Duplicate results are utilized by the QA officer and the project manager to give an indication of the precision of the sampling and analytical methods.

HEALTH AND SAFETY CONSIDERATIONS

Depending on the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the sampling tasks. Standard safe operating practices should be followed, such as minimizing contact with potential contaminants in both the liquid and vapor phases through the use of appropriate personal protective equipment.

Depending on the type of contaminant expected or determined in previous sampling efforts, the following safe work practices will be employed:

Particulate or metals contaminants

1. Avoid skin contact with, and accidental ingestion of, purge water.
2. Wear protective gloves and splash protection.

Volatile organic contaminants

1. Avoid breathing constituents venting from well.
2. Pre-survey the well head space with an appropriate device as specified in the Site Health and Safety Plan.
3. If air monitoring results indicate elevated organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing, such as Tyvek®.

General practices should include avoiding skin contact with water from preserved sample bottles, as this water will have pH less than 2 or greater than 10. Also, when filling, pre-preserved VOA bottles, hydrochloric acid fumes may be released and should not be inhaled.

POST-SAMPLING ACTIVITIES

Several activities need to be completed and documented once ground-water sampling has been completed. These activities include, but are not limited to:

- Ensuring that all field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing all sample paperwork, including copies provided to Central Regional Laboratory, Sample Management Office, or other appropriate sample handling and tracking facility.
- Compiling all field data for site records.
- Verifying all analytical data processed by the analytical laboratory against field sheets to ensure all data has been returned to sampler.

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GROUND-WATER SAMPLING RECORD

Well ID:_____

Station #:_____

Facility Name: Date:____/____/____

Well Depth:_____ Depth to Water:_____ Well Diameter:_____

Casing Material.:_____ Volume Of Water per Well Volume:_____

Sampling Crew:_____,_____,_____,_____

Type of Pump:_____ _____ Tubing Material:_____ Pump set at _____ ft.

Weather Conditions:_____ NOTES:_____ _____

_____

GROUND-WATER SAMPLING PARAMETERS

Time	Water Level	Volume Pumped	Pumping Rate	DO (mg/l)	Temp. (^{0}C)	SEC (µS/cm)	pH	ORP (mV)	Turbidity (NTU)

Other Parameters: _____

Sampled at:_____ Parameters taken with :_____

Sample delivered to _____ by _____ at_____.

Sample CRL #:_____ OTR #:_____ ITR #:_____ SAS #:_____

Parameters Collected	Number of Bottles	Bottle Lot Number

Appendix D

Geomatrix Consultants, Inc. Field Record Forms (QAPP)

PROJECT:	Log of Boring No.	
BORING LOCATION:	ELEVATION AND DATUM:	
DRILLING CONTRACTOR:	DATE STARTED:	DATE FINISHED:
DRILLING METHOD:	TOTAL DEPTH:	MEASURING POINT:
DRILLING EQUIPMENT:	DEPTH TO WATER: FIRST COMPL	
SAMPLING METHOD:	LOGGED BY:	
HAMMER WEIGHT: DROP:	RESPONSIBLE PROFESSIONAL: REG. NO.	

DEPTH (feet)	SAMPLES			OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter. Surface Elevation:	REMARKS
	Sample No.	Sample	Blows/ Foot			
1						OVM=Thermo Environmental Instruments calibrated with 100 ppm isobutylene standard.
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Project No.	**Geomatrix Consultants**	Figure

PROJECT:

Log of Boring No.

DEPTH (feet)	SAMPLES			OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist. % by weight, plast., consistency, structure, cementation, react. W/HCl, geo. inter.	REMARKS
	Sample No.	Sample	Blows/ Foot			

Project No.	**Geomatrix Consultants**	Figure

DAILY FIELD RECORD

GEOMATRIX

Project and Task Number:	Date:
Project Name:	Field Activity:
Location:	Weather:

PERSONNEL: Name	Company	Time In	Time Out

PERSONAL SAFETY CHECKLIST

	Steel-toed Boots		Hard Hat		Tyvek Coveralls
	Rubber Gloves		Safety Goggles		1/2-Face Respirator

DRUM I.D.	DESCRIPTION OF CONTENTS AND QUANTITY	LOCATION

TIME	DESCRIPTION OF WORK PERFORMED

DAILY FIELD RECORD (continued)

Geomatrix

Page ____ of ____

Project and Task Number:	Date:

TIME	DESCRIPTION OF WORK PERFORMED

EQUIPMENT MAINTENANCE LOG

Project Name: _____ **Project Number:** _____

Equipment Name: _____ **Vendor/Part Number:** _____

Date: _____ **Performed By:** _____

CAUSE/REASON	Indicate the reason for equipment repair or replacement:
WORK PERFORMED	Describe the equipment maintenance work performed including the hours to perform work and the parts and service costs:
COMMENTS	Describe any follow up needed:

FIELD INSTRUMENT CALIBRATION SHEET

GEOMATRIX

Project Name: _____ **Project Number:** _____

_____ _____

_____

Date: _____

Equipment Type: _____

Manufacturer: _____

Model Number: _____ **Serial Number:** _____

Calibration (as necessary, minimum twice per day):

Calibration #1 **Time:** _____

Calibration Standard: _____

Instrument Reading: _____

Calibration #2 **Time:** _____

Calibration Standard: _____

Instrument Reading: _____

Calibration #3 **Time:** _____

Calibration Standard: _____

Instrument Reading: _____

Calibration #4 **Time:** _____

Calibration Standard: _____

Instrument Reading: _____

Date of Last Calibration: _____ Date(s) Instrument Used: _____

Name of person(s) who calibrated instruments: _____

Calibration Standards Used:

(1) _____

(2) _____

(3) _____

(4) _____

Source of Calibration Standards: _____

Misc. Comments:

_____

_____

Calibrated by: _____

Appendix E

General Calibration Procedures for Field Equipment (QAPP)

Appendix E
General Calibration Procedures for Field Equipment
Quality Assurance Project Plan
Cedar Chemical Corporation Facility
Helena-West Helena, AR

Instrument or Equipment	Description	Field Calibration Procedures	Performance Criteria	Responsible Personnel
Multi-Parameter Groundwater Meter (pH, Conductivity, Temperature, Dissolved Oxygen [DO], Oxidation/Reduction Potential [ORP]	Meter designed for field use with battery operation. Can be YSI Model 600 XL probe with YSI Model 610-D display instrumentation or QED FC4000 or Horiba U-22 probe with Horiba U-2000 display instrumentation. The probes must contain separate pH, temperature, conductivity, DO and ORP probes in one unit	Each day prior to use and at the end of the day. Parameters to be calibrated include: pH, conductivity, DO and ORP. All probes will be calibrated in accordance with manufacturers recommendations. The pH probe will be calibrated using two buffers (pH 7.00, then pH 4.00). The ORP probe will be calibrated with the ORP standard solution (Zobell). The DO probe will be checked with saturated air in accordance with manufacturers guidelines. All probes will be rinsed with deionized water between each calibration solution and following calibration. Used calibration solution is to be discarded. The conductivity probe is checked with a solution of known conductivity.	Turbidity and DO - +/- 10% pH +/- 0.01 s.u. Conductivity at +/- 2% FSD The instrument calibration will be verified at the beginning and end of every day. For pH, if the calibration check is greater than + 0.2 s.u. from the true value, complete calibration will be conducted.	Project Geologist, Sample Collection Personel
Turbidimeter	Nephelometer designed for field use with battery operation. Range 0.01 to 1000 NTU	Unit is factory calibrated. Unit responsiveness will be checked prior to use each day with appropriate standards. The responsiveness is checked on the 0 to 10 range, 1 to 100 range, and 0 to 1000 range.	+/-10%	Sample Collection Personnel
Photoionization Detector (PID)/Flame Ionization Detector (FID)	A portable trace gas analyzer. Units must be Class I, Division 2, Grade A,B,C, and D. Unit must have rechargable battery.	The PIDs and/or FIDs will be calibrated at the start of each day in accordance with manufacturers specifications. If a significant change in weather occurs during the day (i.e. change in humidity or temperature) or if the unit is turned off for an extended period, the instrument will be recalibrated prior to re-use. When the PID and/or FID is used to screen samples in the field, periodic ambient readings will also be recorded in the field notes.	Meter must be able to adjust properly using the span knob or the lamp may require cleaning. During calibration, the readings must be allowed to stabilize over a period of time before accepting the calibration.	Project Geologist, Sample Collection Personnel, Site Safety Officer

Site Health and Safety Plan

Cedar Chemical Corporation Investigation and Remediation Activities

Helena - West Helena, Arkansas

Prepared for:

Exxon Mobil Corporation and Helena Chemical Company

Prepared by:

Geomatrix Consultants, Inc.
5725 Highway. 290 West, Suite 200B
Austin, Texas 78735

January 2008

Project No. 13636

Geomatrix

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SITE HEALTH AND SAFETY PLAN

1.0 PURPOSE

This site Health and Safety Plan outlines the health and safety procedures that shall be followed during field work conducted at the Cedar Chemical Corporation Site located in Helena-West Helena, Arkansas. The observance and practice of the procedures in this plan are mandatory for all Geomatrix employees at the site. All subcontractors shall be made aware of the requirements of this plan; however, subcontractors are responsible for the health and safety of their own employees and for following all applicable federal, state, and local regulations.

This plan has been reviewed by the Project Manager and Project Health and Safety Officer. Prior to entering the site, Geomatrix personnel shall read this plan and be familiar with health and safety procedures it describes. A copy of the plan shall be available on site during all work activities for inspection and review.

SITE HEALTH AND SAFETY PLAN

2.0 ADMINISTRATIVE INFORMATION

Project Name: Cedar Chemical Corporation Facility Investigation & Remediation Activities

Project Start Date: May 2008 Project Number: 13636.000.0

Project Address: Cedar Chemical Corporation

Helena-West Helena, Arkansas

Client: Exxon Mobil Chemical Company and Helena Chemical Company which comprise the current membership of the Cedar Chemical Corporation Site Joint Defense Group.

Client Contact: Dave Roberson

Telephone No.: (281) 363-8733 (Work)

Project Manager: Kelly Beck

Telephone No.: (512) 494-0333 (Work) (512) 569-1536 (Home)

Project Health & Safety Officer: Don Kubik Jr., PG, CIH

Telephone Nos.: (510) 663-4100 (Work) (510) 368-6433 (Cell)

Site Safety Officer: Charles Young (or Field Supervisor, if Mr. Young is not present)

Telephone No.: (713) 356-2221 (Work)

SITE HEALTH AND SAFETY PLAN

3.0 PROJECT DESCRIPTION

3.1 SITE HISTORY

The Cedar Chemical Corporation site (Site) operated as a former chemical manufacturing plant from 1970 until 2002. During this time, the Site was used for the production of various herbicides, pesticides, organic chemicals, and inorganic chemicals in production units at the facility. In addition to chemical production, plant activities included product formulation and packaging. Chemical production occurred in batched and fluctuated based on the season.

Cedar Chemical Corporation abandoned the Site in 2002 after filing for bankruptcy, and the Arkansas Department of Environmental Quality (ADEQ) assumed control of the Site in October 2002.

3.2 SITE PHYSICAL DESCRIPTION

The Site is relatively flat with some gentle sloping toward the southeast, and site soils consists clay, sand and silt alluvial deposits. Groundwater is present in some areas in a shallow perched zone, and across the site in a deeper alluvial aquifer. Figure 1 shows the site location.

3.3 TYPE OF FIELD WORK

The project work will be conducted in accordance with the "Site Work Plan." The project work will consist of drilling, well installation, soil and groundwater sampling, soil removal, wipe sampling, assessment and possible removal of drums, and long-term remedial actions that have yet to be defined.

3.4 SCOPE OF FIELD ACTIVITIES

Geomatrix will be on-site to perform certain of the investigation and remediation work activities, and oversee others as the client representative. The scope of work currently includes the following:

1. Rotosonic, cone penetrometer testing and direct push investigations;
2. Soil and groundwater sampling;
3. Monitoring well installation;
4. Sampling monitoring, agricultural, and domestic wells;
5. Soil excavation;
6. Drum assessment and possible removal;

7. Waste sampling; and

8. Wipe sampling.

Geomatrix will oversee the following field tasks to be subcontracted by Geomatrix for the project:

1. Rotasonic, DPT, and CPT drilling.

2. Opening of the drum vault and assessment and possible removal of drum vault content;

3. Demolish pavement, slabs, foundations and other surface and subsurface improvements within the planned excavation area;

4. Excavation of chemically-impacted soil;

5. Stockpiling the excavated soil in separate stockpiles; and

6. Loading, transporting, and disposition of demolition debris and stockpiled soil at an appropriate recycling or disposal facility.

7. Waste disposition in general.

4.0 PRIMARY RESPONSIBILITIES

4.1 PROJECT MANAGER

The Project Manager (PM) shall:

1. direct all Geomatrix personnel involved in investigative, monitoring, and remedial activities at the site and vicinity;
2. make the Project Health and Safety Officer aware of all pertinent project developments and plans;
3. make available those resources that are necessary for a safe working environment; and
4. maintain communications with the client, as necessary.

4.2 PROJECT HEALTH AND SAFETY OFFICER

The Project Health and Safety Officer (PHSO) shall:

1. review all health and safety aspects of investigative, monitoring, and remedial activities conducted by Geomatrix personnel at the site and vicinity;
2. ensure that all Geomatrix personnel have received required training, are aware of the potential hazards associated with site operations, have been instructed in the work practices necessary for personal health and safety, and are familiar with the site Health and Safety Plan's procedures for all scheduled activities and for dealing with emergencies;
3. review any accident/incident reports;
4. modify the site Health and Safety Plan as required based on accidents/incidents and findings regarding personnel exposures and work practices; and
5. report all accidents/incidents and findings regarding personnel exposure and work practices to the Project Manager, and manage any associated required regulatory reporting.

4.3 SITE SAFETY OFFICER

The Site Safety Officer (SSO) shall:

1. ensure that appropriate personal protective equipment is available for Geomatrix site personnel and enforce proper utilization of personal protective equipment by all on-site Geomatrix personnel;

2. with guidance from the PHSO, observe subcontractor's procedures with respect to health and safety. If the SSO believes that a subcontractor's personnel are or may be exposed to an immediate health hazard, the SSO shall suspend the subcontractor's site work. If the subcontractor's personnel do not have required protective equipment, the SSO shall consult with the PM or PHSO before proceeding with the work;

3. implement the site Health and Safety Plan and report any observed deviations from site conditions anticipated in the plan;

4. conduct site safety tailgate briefings each day;

5. calibrate monitoring equipment daily and properly record and file results;

6. under direction of the PHSO perform required exposure monitoring;

7. maintain monitoring equipment or arrange maintenance as necessary;

8. assume other duties as directed by the PM or PHSO; and

9. report observed accidents/incidents or inadequate work practices to the PHSO and the PM.

4.4 PROJECT PERSONNEL

Project personnel involved in on-site investigations and operations shall:

1. take reasonable precautions to prevent injury to themselves and to their fellow employees;

2. perform only those tasks that they can do safely and immediately report accidents and/or unsafe conditions to the SSO or PHSO;

3. follow the procedures set forth in the site Health and Safety Plan and report to the SSO or PHSO any observed deviations from the procedures described in the plan on the part of Geomatrix or subcontractor personnel; and

4. inform the PM and PHSO of any physical conditions that might affect their ability to perform the planned field tasks.

4.5 TRAINING REQUIREMENTS

All project personnel must comply with OSHA regulations specified in 29 CFR 1910.. These include completion of a 40-hour health and safety training course, an annual 8-hour refresher training, and participation in Geomatrix Consultants' medical surveillance program and respiratory protection program.

Additional site-specific training that covers on-site hazards, personal protection requirements, decontamination procedures, and emergency response information as outlined in this site Health and Safety Plan will be given by the PHSO or SSO before beginning on-site work. Site-specific training briefings will be documented on Geomatrix's "ESE Project Health and Safety Field Meeting Form" provided at the end of this plan. We do not anticipate that field staff will be occupationally exposed to blood or potentially infectious materials during the course of this project.

4.6 MEDICAL SURVEILLANCE

All Geomatrix project site personnel shall participate in the Geomatrix medical surveillance program, which includes annual audiometric and physical examinations for employees involved in hazardous waste or materials projects. It requires that all such personnel have medical clearance before being issued a respirator and participating in field activities. Frequency of medical examinations which complies with 29 CFR § 1910.120(f3), occurs:

1. prior to employee's first performance of field work;
2. at least once every 12 months;
3. at termination of employment;
4. upon occurrence of possible overexposure;
5. more frequently if deemed necessary by a physician.

SITE HEALTH AND SAFETY PLAN

5.0 HAZARD ASSESSMENT

This section of the HASP identifies and describes safety and health hazards associated with site work. The purpose of characterization and job safety analysis is to identify and quantify the health and safety hazards associated with each site task and operation, and to evaluate the risks to workers. With this information, risks are then eliminated if possible, or effectively controlled.

The Job Safety Analysis identifies physical, biological, and chemical hazards for each task and/or operation performed on the project. A Job Safety Analysis must be completed by each Task Manager for their respective resource task/operation. The hazards identified for the task/operation are based on the best available knowledge of how that task/operation will be performed and the likelihood of exposure is indicated. Control measures implemented to protect employees from the hazards identified are also listed. The information provided here is designed to satisfy the job hazard analysis requirements of 1910.120(b)(4)(ii)(A) and the workplace hazard assessment requirements of 1910.132(d). A template for Job Safety Analysis reports is contained in **Appendix A**.

In addition, a "Tailgate Safety Meeting Form" (**Appendix B**) which documents daily work objectives, potential hazards, personal protective equipment, and emergency response information pertinent to specific daily work tasks is required. All Geomatrix personnel shall attend a "Tailgate Safety Meeting," at the beginning of each daily work shift. The Task Manager is responsible for conducting the tailgate safety meeting and completing the form documenting the names of attendees.

An assessment of the potential hazards that may be encountered during field activities at the site are designated by field task in Table 5.0 and are discussed below.

SITE HEALTH AND SAFETY PLAN

TABLE 5.0

ANTICIPATED HAZARDS

TASK	HAZARDS															
		PHYSICAL														
	Chemical	Trip/Fall	Heavy Equipment	Underground Utilities	Overhead Power Lines	Noise	Heat Stress	Cold Stress	Sunburn	Drilling	Trench/Excavation	Confined Space	Traffic	Biological	Explosive	General Safety
1. Rotosonic, cone penetrometer testing and direct push investigations;	X	X	X	X	X	X	X	X	X	X			X			X
2. Soil and groundwater sampling;	X	X	X	X	X	X	X	X	X	X			X			X
3. Monitoring well installation;	X	X	X	X	X	X	X	X	X	X			X			X
4. Sampling monitoring, agricultural, and domestic wells;	X	X				X	X	X	X				X			X
5. Soil excavation;	X	X	X	X	X	X	X	X	X		X		X			X
6. Drum assessment and possible removal;	X	X					X	X	X				X		X	X
7. Waste sampling; and	X	X					X	X	X							X
8. Wipe sampling.	X	X					X	X	X							X

SITE HEALTH AND SAFETY PLAN

5.1 POTENTIAL CHEMICAL HAZARDS AT SITE

The site being a formal chemical facility has the potential have having a numerous potential contaminants including VOCs, SVOCs, metals, and pesticides. Based on the available, it appears that the highest concentrations of the chemicals of concern (COCs) are in the dissolved or separate phase in groundwater with relatively low concentrations in soil. Listed below, alphabetically, are some of the COCs that have been found or are suspected to be present at the site. Controls of exposure to the COCs are discussed in the following sections and will be further expanded on when the jobs safety analyses are prepared for each task. Additional information on these chemicals, including their acute effects, is included in the chemical information sheets attached at the end of this plan as Appendix C.

Hazardous Substances Known or Suspect at Site:

CAS	CHEMICAL	EXPOSURE LIMITS		LEL %	IP eV	KNOWN or EXPECTED CONCENTRATIONS	HEALTH HAZARDS
		OSHA	ACGIH				
67-64-1	Acetone (ppm)	1,000/ I2,500	500/S750	2.5	9.69	In soil ranges from 0.84 to 200 µg/kg	*RISE*; Irritation eyes, nose, throat; headache, dizziness, central nervous system depression; dermatitis
7440-38-2	Arsenic -- inorganic (mg/m3)	0.01 /I5	0.01			Soils: 4 to 10 mg/kg GW: Highest noted was 603 ug/l in the area of the process area and former surface impoundments.	*RISE*; Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin, [potential occupational carcinogen]
71-43-2	Benzene (ppm)	1/S5/ I500	0.5/S2.5	1.2	9.24	Low in soils, may be high in groundwater.	*RISE*; Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen]
67-66-3	Chloroform (Trichloromethane) (ppm)	C50/ I500	10		11.42	Low in soils, may be high in groundwater	*RISE*; Irritation eyes, skin; dizziness, mental dullness, nausea, confusion; headache, lassitude (weakness, exhaustion); anesthesia; enlarged liver; [potential occupational carcinogen]
7440-47-3	Chromium metal & insoluble salts (mg/m3)	1/I250	0.5			Shallow soils range from 8 to 25 mg/kg. Not detected in groundwater	*RISE*; Irritation eyes, skin; lung fibrosis (histologic)

CAS	CHEMICAL	EXPOSURE LIMITS		LEL %	IP eV	KNOWN or EXPECTED CONCENTRATIONS	HEALTH HAZARDS
		OSHA	ACGIH				
106-46-7	Dichlorobenzene, 1,4- (p-DBC, para-dichlorobenzene) (ppm)	75/I150	10	2.5	8.98	Low to medium in soils near railroad unloading area and former surface impoundments	RISE; Eye irritation, swelling periorbital (situated around the eye); profuse rhinitis; headache, anorexia, nausea, vomiting; weight loss, jaundice, cirrhosis; in animals: liver, kidney injury; [potential occupational carcinogen]
107-06-2	Dichloroethane, 1,2- (Ethylene dichloride) (ppm)	50/ C100/ I50	10	6.2	11.05	Low concentrations in soils. Elevated concentrations up to 8,900 ug/l is perched groundwater. Concentrations up to 24,000 µg/l in Alluvial groundwater.	RISE; Irritation eyes, corneal opacity; central nervous system depression; nausea, vomiting; dermatitis; liver, kidney, cardiovascular system damage; [potential occupational carcinogen]
60-57-1	Dieldrin (mg/m3)	0.25/I50	0.25			Low concentrations in soils across facility. Low concentrations (24ug/l) in perched zone groundwater.	*RISE;* SKIN; Headache, dizziness; nausea, vomiting, malaise (vague feeling of discomfort), sweating; myoclonic limb jerks; clonic, tonic convulsions; coma; [potential occupational carcinogen]; in animals: liver, kidney damage
88-85-7	Dinoseb					Present in shallow soils up to a concentration of 29,000 mg/kg. Not observed in the perched aquifer. In the alluvial aquifer, up to 54,000 µg/l.	RISE; SKIN; Blue skin, convulsions, headache, labored breathing, eye irritation, abdominal pain, vomiting, avoid exposure of pregnant woman.
72-43-5	Methoxychlor (mg/m3)	15/ I5000	10			Low concentrations in soils. Detected in groundwater at 0.13 ug/l	*RISE*; fasciculation, trembling, convulsions; kidney, liver damage; [potential occupational carcinogen]
75-09-2	Methylene chloride (Dichloromethane) (mg/m3)	25/S125 /I2,300	50	13	11.32	In soils ranges up to 35 mg/kg. In perched groundwater up to 140,000 µg/l at specific locations. In alluvial groundwater at a maximum detection of 460 µg/l at specific areas.	RISE; Irritation eyes, skin; lassitude (weakness, exhaustion), drowsiness, dizziness; numbness, tingle limbs; nausea; [potential occupational carcinogen]

-Exposure Limits –If not specified, exposure limit is the PEL or the TLV-TWA, Exposure limit preceded by a "S" is a Short Term Exposure Limit, by a "C" is the Ceiling Limit, and by an I is the NIOSH IDLH.

CAS – Chemical Abstracts Number

Health Hazards: Letters in italics represent exposure routes: R – Respiratory; I- Ingestion; S-Skin Absorption; & E – Eye Absorption

SKIN – Chemical represents a significant skin absorption hazard.

5.2 POTENTIAL PHYSICAL HAZARDS AT SITE

Potential physical hazards, as those listed in Table 3.0, are discussed below.

5.2.1 Underground Utility Hazards

An underground utility check shall be performed prior to initiating any subsurface investigation or work. The check will include:

X Arkansas One Call System (800-482-8998) Note: Arkansas One Call System must be notified at least 2 working days before any subsurface work begins. Record confirmation number in project field notes.

X Private Locator: _____

X Hand boring or air knifing each drilling location;

X Plans Check (If provided by client)

_____ Geophysical Survey

5.2.2 Overhead Power Lines

Whenever possible, avoid working under overhead high voltage lines. The following are minimum clearances for overhead high voltage lines.

Normal Voltage (phase to phase)				Minimum Required Clearance (feet)
more than	750	-	50,000	10
more than	50,000	-	75,000	11
more than	75,000	-	125,000	13
more than	125,000	-	175,000	15
more than	250,000	-	379,000	21
more than	370,000	-	550,000	27
more than	550,000	-	1,000,000	42

(Reference: CCR Title 8, Section 2946, Table II)

5.2.3 Noise Hazards

Wear hearing protection when working near large heavy equipment, such as drill rigs or earth movers, or in other noisy conditions. As a general rule, hearing protection should be worn when two people standing within 2 feet of each other cannot communicate at normal conversational voice levels.

5.2.4 Heat Stress Hazards

Heat stress is a major hazard, especially for workers wearing protective clothing. To avoid heat stress, drink plenty of fluids and take periodic work breaks.

The signs, symptoms, and treatment of heat stress include:

- Heat rash, which may result from exposure to heat or humid air.
- Heat cramps, which are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include: muscle spasms and pain in the hands, feet, and abdomen. Persons experiencing these symptoms should rest in a cooler area, drink cool (not cold) liquids and gently massage cramped muscles.
- Heat exhaustion, which occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include: pale, cool, moist skin; heavy sweating; dizziness; nausea; and fainting. Persons experiencing these symptoms should lie down in a cooler area, drink cool liquids with electrolytes (Gatorade, etc.), remove any protective clothing, and cool body with wet compresses at forehead, back and neck, and/or armpits.
- Heat stroke is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are: red, hot, usually dry skin; lack of or reduced perspiration; nausea; dizziness and confusion; strong, rapid pulse; and coma.

5.2.5 Cold Stress Hazards

Exposure to cold can cause the body's internal temperature to drop to a dangerously low level. This is called hypothermia. Exposure to temperatures below freezing can cause frostbite of hands, feet, and face.

Symptoms of hypothermia include:

- vague, slow, slurred speech
- forgetfulness, memory lapses
- inability to use hands
- frequent stumbling
- drowsiness

To prevent hypothermia, stay dry and avoid exposure. Wear sufficient clothing in layers such that outer clothing is wind- and waterproof and inner layers retain warmth (wool or polypropylene). Keep hands and feet well protected at all times.

5.2.6 Sunburn Hazards

Skin exposure to ultraviolet radiation can result in sunburn. Use long-sleeved shirts, hats, and sunscreen to protect against sunburn.

5.2.7 Drilling Hazards

Drilling hazards include noise, heavy equipment operation, rotative/moving parts, and trip/fall hazards. Non-drilling personnel should stay away from the area around the borehole during drilling. Hard hats and safety glasses shall be worn by all personnel within 30 feet of the raised mast of an operating drill rig. All personnel will be instructed as to the location of the "kill switch" on the drill rig. During drilling, all equipment will be kept well ventilated to prevent the build-up of vapors inside the truck canopy area.

5.2.8 Trench/Excavation Hazards

OSHA requires that in all excavations, workers exposed to potential cave-ins must be protected by shoring, sloping, or benching the sides of the excavation, or placing a shield between the side of the excavation and the work area. Any excavation 4 feet deep or deeper must have adequate means of access/egress and must be tested by a competent person for oxygen deficiency or hazardous atmosphere before anyone enters. Entry into excavations/trenches 5 feet deep or deeper requires an OSHA permit and compliance with OSHA regulations for trenching and excavation.

During the work for this project, no one will enter trenches/excavations deeper than 4 feet. If soil is not inherently stable at this depth, appropriate protective measures (sloping, shoring, etc.) will be used. Care will be taken when sampling the excavation area from above to be sure the ground is stable and not undercut.

5.2.9 Confined Space

A confined space is any space a person can bodily enter that has limited egress and is not designed for continuous human occupancy. Confined spaces can pose many potential hazards including hazardous atmosphere, poor natural ventilation, engulfment, entrapment, and restricted entry for rescue purposes. All confined spaces must be considered immediately dangerous to life or health unless proven otherwise.

If entry into a confined space is required, the PHSO must be consulted and a confined space entry plan prepared and followed prior to anyone entering the space.

Confined spaces are not anticipated to be encountered on this project.

5.2.10 Heavy Equipment

Personnel working on site in the vicinity of operating equipment should maintain safe distances from the equipment to avoid contact with moving equipment parts such as backhoe/excavator arms and buckets (be aware of swing radius), tires, tracks, etc. Be sure heavy equipment operators can see you or know where you are.

5.2.11 Traffic Hazards

Personnel will wear orange or yellow safety vests and hard hats when working near roadways, and be observant in traffic areas. Vehicles will only be operated in authorized areas by trained personnel.

5.2.12 Biohazards

None anticipated

5.2.13 Other Hazards

5.2.13.1 Slipping, Tripping and Falling

Work zone surfaces will be maintained in a neat and orderly manner to minimize the possibility of slips, trips, or falls. Materials will not be stored on the ground in foot-traffic routes. Tools and materials will not be randomly left on surfaces when not in direct use. The Site supervisor will ensure that the work areas are maintained in a neat and orderly state. When hoses or cables must be left in place for more than one work shift, such materials will be grouped, routed to minimize hazards, and covered with a ramp or bridge and/or clearly marked with hazard tape or flags.

5.2.13.2 Manual Lifting Techniques

Personnel will be trained in safe lifting techniques for all manual material handling tasks. When heavy objects, i.e., greater than 45 pounds, must be lifted manually, workers will keep the load close to the body and avoid any twisting or turning motions to minimize stress on the lower back. An adequate number of personnel or an appropriate mechanical device must be used to safely lift or handle heavy equipment.

5.2.13.3 Fire and Explosion Hazards

Despite a low potential for fire and explosion hazards, the air quality in the excavation areas will need to be monitoring for potentially explosive conditions when field personnel are working in excavation areas and with utilities (e.g. sanitary sewer piping) that could contain methane or other potentially flammable or toxic substances. Appropriate precautions must be taken to control or eliminate ignition sources at any locations where there is a fire or explosion hazard.

5.2.13.4 Drum Sampling

The sampling of drums presents a number of hazards including chemical exposure, unknown chemicals, contents under pressure, as well as the potential physical hazards associated with the physical opening. Before any drum sampling is attempted, the situation will be assessed and a separate procedure/job safety analysis will be prepared and approved of before beginning work. It may be necessary to utilize personnel with expertise in the area.

5.3 GENERAL HAZARDS

In working with or around any hazardous or potentially hazardous substances or situations, site personnel should plan all activities before starting any task. Site personnel shall identify health and safety hazards involved with the work planned and consult with the PHSO or SSO as to how the task can be performed in the safest manner, if he/she has any uncertainties.

Common safety hazards include trip/fall hazards and those associated with working around heavy equipment. All field personnel will adhere to the following general safety rules.

1. Wear protective equipment and clothing provided, when required.

2. Wear a hard hat and safety glasses in all construction areas and during drilling activities.

3. Wear sturdy work boots or shoes at the site. Steel-toed boots are required during drilling activities.

4. Do not eat, drink, or use tobacco in restricted work areas.

5. Prevent splashing of materials containing chemicals.

6. Prevent back injury by never lifting or carrying a load that is heavier than you can comfortably handle. When lifting heavy objects, bend the knees and use the leg muscles.

7. Keep all heat sources away from combustible liquids, gases, or any flammable materials. When working in areas where combustible gases are present, use only intrinsically safe (non-sparking) equipment.

8. Field personnel shall be familiar with the physical characteristics of investigations, including:

    - wind direction in relation to restricted work areas
    - accessibility of other personnel, equipment, and vehicles
    - areas of known or suspected chemicals in soil and groundwater

- site access
- nearest water sources
- location of communication devices.

9. Personnel and equipment in restricted work areas should be limited to the number necessary to perform the task at hand.

10. All wastes generated during investigative activities at the site shall be disposed of as directed by the PM.

11. Inspect power cords for damage such as cuts and frays. Suspend cords only with nylon rope or plastic ties.

12. When in doubt of your safety, it is better to overprotect.

13. Practice defensive driving.

14. If site activities include the use of a drill rig, all on-site personnel should know the location of the "kill switch."

15. A first-aid kit and a type ABC fire extinguisher shall be kept at the site and/or in a field vehicle when performing field work.

6.0 AIR MONITORING

The following air monitoring equipment will be used.

_X_ Photoionization Detector (PID)
____ Flame Ionization Detector (FID)
_X_ Draeger Pump and Tubes (Benzene, Methylene Chloride, Vinyl Chloride)
_X_ Combustible Gas Indicator with oxygen (CGI)
____ Oxygen Meter (O2)
_X_ Dust (Particle) Meter

The type and frequency of air monitoring for each work task will be determined by the SSO after consultation with the PM and PHSO. Generally, however, it is anticipated that a PID will be used for regular (typically 15 minute interval) monitoring of work areas, for activities like drilling that have a potential for generating particulates or vapors. Colorimetric tubes will be used for verifying the presence of benzene, methylene chloride and vinylchloride, when sustained exceedances of action levels, and for periodic checks of the PID monitoring results. The use of dust, and CGI meters will be on an as-needed basis, depending on the activities being performed. Air monitoring instruments will be calibrated and maintained according to manufacturer's specifications. Calibration information and air monitoring results will be recorded in project field notes.

6.1 ACTION LEVELS

If organic vapors are detected in the breathing zone with the PID , the colormetic tube samples for benzene, methylene chloride and vinylchloride will be collected. If the concentrations of these chemical are detected at concentrations at or above their respective PELs the work will stop and the situation will be assessed on the best engineering controls to be implemented. If the chemicals are not detected, the work can proceed with the following action limits.
If these activities are not effective in reducing the volatile or particulate levels, then the following protocols shall be followed for the use of respiratory protection:

- Wear respirator if PID reads greater than 5 ppm (sustained reading in the breathing zone)

- Stop work if PID reads greater than 25 ppm (sustained reading in the breathing zone)

With respect to explosion hazard, the following protocol will be followed when use of the LEL is required.

- Stop work and notify the PM or PHSO if Combustible Gas Meter reads greater than 10% LEL.

- Evacuate area and notify appropriate emergency services if Combustible Gas Meter reads greater than 25% LEL.

7.0 PERSONAL PROTECTIVE EQUIPMENT

The personal protective equipment (PPE) that will be used is specified below:

PERSONAL PROTECTIVE EQUIPMENT
Environmental Site Health & Safety Plan
Cedar Chemical Corporation Investigation and Remediation Activities
Helena-West Helena, Arkansas

PPE Required	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Task 6**	**Task 7**	**Task 8**
Describe Task	Rotosonic, cone penetrometer testing and direct push investigations	Soil and groundwater sampling	Monitoring well installation	Sampling monitoring, agricultural, and domestic wells	Soil excavation	Drum assessment and possible removal	Waste sampling	Wipe sampling
Steel-Toed Boots (Rubber)								
Steel-Toed Boots (Leather)	X	X	X	X	X	X	X	X
Hard Hat	X	X	X	X	X	X	X	X
Safety Glasses/Goggles	X	X	X	X	X	X	X	X
Ear Plugs	X	Av	X	X	X	Av	X	Av
Gloves Nitrile	X	X	X	X	X	X	X	X
Tyvek Coverall	Av	Av	Av	Av	Av	Av	X	X
Saranex Coverall								
Half-Face Respirator	Av	Av	Av	Av	Av	Av	X	X
Full-Face Respirator	Av	Av	Av	Av	Av	Av	X	X
Respirator Cartridge (specify type):	Comb.	Comb.	Comb.	Comb.	Comb.	Comb.	Comb.	Comb.

Orange or Yellow Safety Vests	X	X	X	X	X	X	X	X
Other (specify)								

Key:

X = PPE Required
Av = Have available at work site
Glove Types = Nitrile, Vinyl, Neoprene, Butyl

Cartridge Types = Organic Vapor (OV)
HEPA Filter (HEPA)
Combination OV and HEPA (Comb.)

Nitrile gloves shall be used when the activity carries a risk of hand contact with contaminated media, such as soil or groundwater sampling. Hard hats shall be used for activities near heavy equipment or when a bump hazard exists. Tyveks and rubber boots shall be used when the activity carries a risk of foot or body contact with contaminated media. Use of respirators is discussed above.

SITE HEALTH AND SAFETY PLAN

8.0 SITE CONTROL

The purpose of site control is to minimize the potential exposure to site hazards, to prevent vandalism at the site, and to provide adequate facilities for workers. Work area controls and decontamination areas will be provided to limit the potential for chemical exposure associated with site activities.

8.1 WORK AREA

Only authorized personnel shall be permitted access to the work areas. If necessary, this area will be cordoned with barriers, cones, or fencing to limit unauthorized access. No eating, drinking, or tobacco use are allowed in the work area.

8.2 DECONTAMINATION AREAS

Equipment and personnel decontamination areas will be set up adjacent to the work exclusion zones. All equipment and tools used during work activities shall be decontaminated in the designated decontamination area. Decontamination procedures are described in Section 9.0 of this plan.

8.3 COMMUNICATIONS

A field representative should contact the project manager or office at least once a day while in the field. The closest telephone is a personal cell phone.

9.0 DECONTAMINATION

9.1 PERSONNEL DECONTAMINATION PROCEDURES

Remove disposable gloves and clothing and place in plastic bags. Wash hands and face before eating, drinking, or smoking and at the end of the work day. Showers are available in the main building on site.

9.2 DECONTAMINATION PROCEDURES FOR EQUIPMENT/SAMPLING GEAR

Decontamination of equipment will be performed at the Site prior to sampling, between sampling intervals and following sampling to minimize potential migration of chemicals of concerns. Decontamination actions will be taken before the equipment leaves the Contamination Reduction Zone of the work site. Decontamination procedures for equipment includes:

- All equipment will be steam cleaned or washed with soap, as appropriate. Visible soil and grease will be removed by brushing or scraping.
- If a vehicle has been in contact with contaminated soil and/or groundwater, its wheels need to be cleaned prior to exiting the Site.

9.3 STORAGE OF INVESTIGATION-DERIVED MATERIALS

Investigation-derived materials (PPE/expendables, decon waste, soil cuttings, purged ground-water, etc.) will be handled and stored as follows:
Disposable materials will be placed in large plastic trash bags (double-bagged) and stored in 55-gallon drums on-Site.

10.0 EMERGENCY RESPONSE

In the event of an accident or emergency condition, the procedures specified below shall be followed.

10.1 MEDICAL EMERGENCIES

In the event of a medical emergency, the following procedures should be used.

1. Remove injured or exposed person(s) from immediate danger if possible.

2. Evacuate other on-site personnel to a safe place in an upwind direction until it is safe for work to resume.

3. If serious injury or life-threatening condition exists, call

   911 - Paramedics, fire department, police
   Hospital emergency room

   Clearly describe location, injury and conditions to dispatcher/hospital. Designate a person to direct emergency equipment to the injured person(s).

4. Provide first aid if necessary. Remove contaminated clothing only if this can be done without endangering the injured person.

5. Call the project manager and/or project health and safety officer.

6. Immediately implement steps to prevent recurrence of the accident.

A map showing the nearest hospital location is provided in Appendix D.

Hospital Helena Regional Medical Center
Address 1801 Martin Luther King Jr. Dr.
Helena, Arkansas
Telephone (870) 338-5800

Telephone number of nearest Poison Control Center: (800) 222-1222

Other emergency notifications and phone numbers:

10.2 ACCIDENTAL RELEASE OF HAZARDOUS MATERIALS OR WASTES

1. Evacuate all on-site personnel to a safe place in an upwind direction until the PM or PHSO determines that it is safe for work to resume.

2. Immediately instruct a designated person to contact the PM or PHSO.

3. Contain spill, if it is possible and it can be done safely.

4. Initiate cleanup.

10.3 GENERAL EMERGENCIES

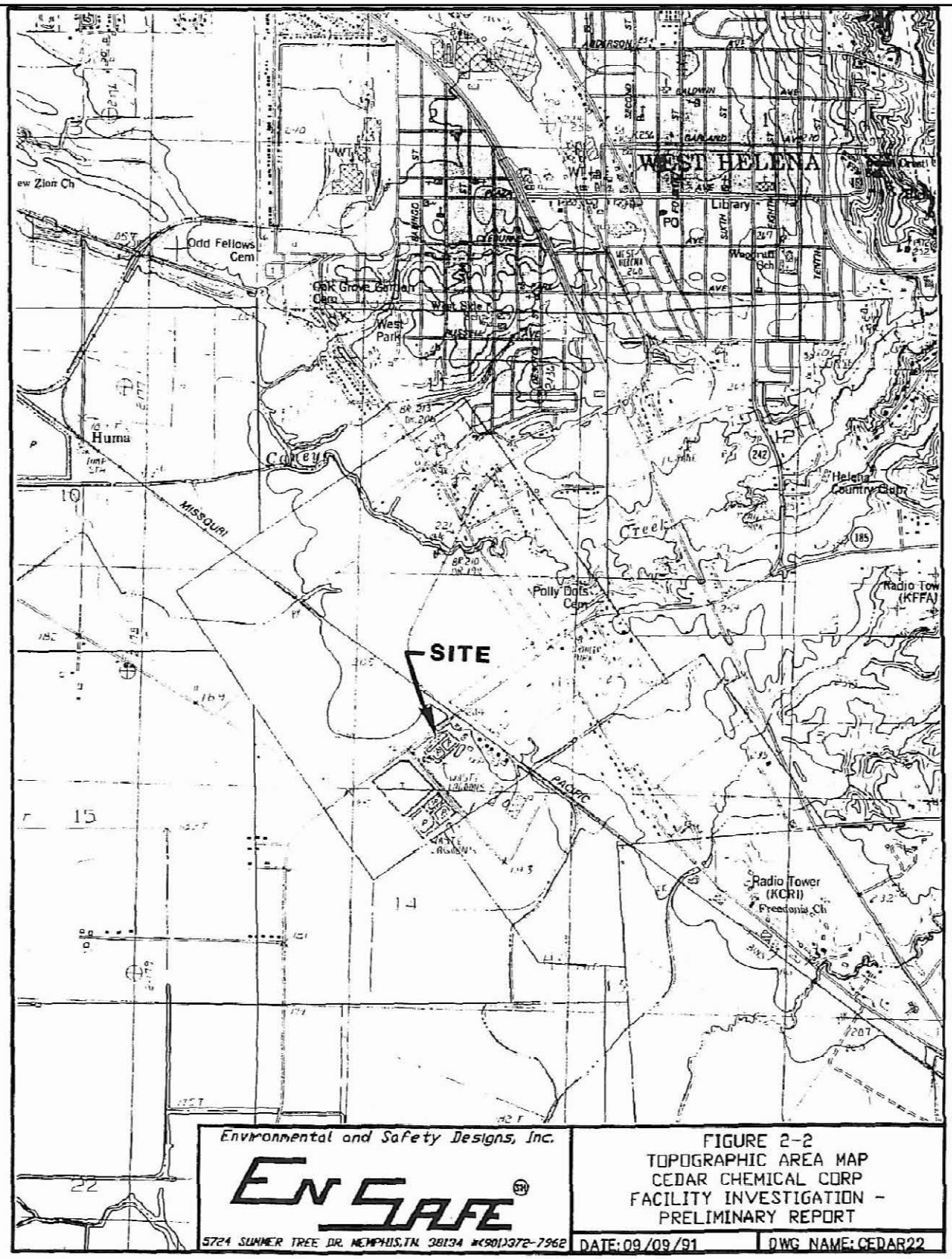
In the case of fire, flood, explosion, or other hazard, work shall be halted and the local police/ fire department shall be notified by calling 911. All on-site personnel will be immediately evacuated to a safe place.

11.0 APPROVALS

Project Manager	Date
Project Health & Safety Officer	Date
Site Safety Officer	Date

Figures

(HASP)



SOURCE: EnSafe, Phase II Investigation Report, 1995

SITE LOCATION MAP

Cedar Chemical
Helena-West Helena, Arkansas

Geomatrix | Project 13636 | Figure 1

I:\13636 - Arkansas Helena-West Helena\2007 CCR\FINAL FIGURES\ FIG 1 Site Location Map\FIG 1.dwg

APPENDIX A

Job Safety Analysis

Geomatrix

JOB SAFETY ANALYSIS

Project Name:		***Project No:***		***Date:***	
Task:		***Task Location:***			
For this Project and Task, this document is a Certification of Hazard Assessment					
Completed by:		***Reviewed by:***			
Notes:					

Task	Hazard	Risk Control Method
		❒
		❒
		❒
		❒
		❒
		❒
		❒
		❒
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APPENDIX B

Tailgate Safety Meeting Form

SITE HEALTH AND SAFETY PLAN

TAILGATE SAFETY MEETING FORM

GEOMATRIX PROJECT HEALTH AND SAFETY PLAN

Date: _____ Time: _____ Project No.: _____

Project Name: _____

Location: _____

Meeting Conducted by: _____

Topics Discussed:

Work Objectives for Shift:

_____

_____

Physical Hazards: _____

Chemical Hazards: _____

Personal Protection: _____

Decontamination: _____

Special Site Considerations: _____

Emergency Information: _____

Hospital Location: _____

Attendees

Name/Company (printed)	Signature

Meeting Conducted by: _____

Signature

APPENDIX C

Chemical Information Sheets

NIOSH Publication No. 2005-149: September 2005

NIOSH Pocket Guide to Chemical Hazards

Arsenic (inorganic compounds, as As)

CAS 7440-38-2 (metal)

As (metal)

RTECS CG0525000 (metal)

Synonyms & Trade Names
Arsenic metal: Arsenia
Other synonyms vary depending upon the specific As compound. [Note: OSHA considers "Inorganic Arsenic" to mean copper acetoarsenite & all inorganic compounds containing arsenic except ARSINE.]

DOT ID & Guide
1558 152 (metal)
1562 152 (dust)

Exposure Limits
NIOSH REL: Ca C 0.002 mg/m^3 [15-minute] See Appendix A
OSHA PEL: [1910.1018] TWA 0.010 mg/m^3

IDLH Ca [5 mg/m^3 (as As)] See: 7440382

Conversion

Physical Description
Metal: Silver-gray or tin-white, brittle, odorless solid.

MW: 74.9	BP: Sublimes	MLT: 1135°F (Sublimes)	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 5.73 (metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Noncombustible Solid in bulk form, but a slight explosion hazard in the form of dust when exposed to flame.

Incompatibilities & Reactivities
Strong oxidizers, bromine azide [Note: Hydrogen gas can react with inorganic arsenic to form the highly toxic gas arsine.]

Measurement Methods
NIOSH 7300, 7301, 7303, 7900, 9102; OSHA ID105
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated/Daily
Remove: When wet or contaminated
Change: Daily
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations (See Appendix E) NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin absorption, skin and/or eye contact ingestion

Symptoms Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin, [potential occupational carcinogen]

Target Organs Liver, kidneys, skin, lungs, lymphatic system

Cancer Site [lung & lymphatic cancer]

See also: INTRODUCTION See ICSC CARD: 0013 See MEDICAL TESTS: 0017

NIOSH Publication No. 2005-149: September 2005

NIOSH Pocket Guide to Chemical Hazards

Benzene	**CAS** 71-43-2
C_6H_6	**RTECS** CY1400000
Synonyms & Trade Names Benzol, Phenyl hydride	**DOT ID & Guide** 1114 130

Exposure Limits	**NIOSH REL:** Ca TWA 0.1 ppm ST 1 ppm See Appendix A
	OSHA PEL: [1910.1028] TWA 1 ppm ST 5 ppm See Appendix F

IDLH Ca [500 ppm] See: 71432	**Conversion** 1 ppm = 3.19 mg/m^3

Physical Description
Colorless to light-yellow liquid with an aromatic odor. [Note: A solid below 42°F.]

MW: 78.1	BP: 176°F	FRZ: 42°F	Sol: 0.07%
VP: 75 mmHg	IP: 9.24 eV		Sp.Gr: 0.88
Fl.P: 12°F	UEL: 7.8%	LEL: 1.2%	

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

Incompatibilities & Reactivities
Strong oxidizers, many fluorides & perchlorates, nitric acid

Measurement Methods
NIOSH 1500, 1501, 3700, 3800; OSHA 12, 1005
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations (See Appendix E) NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen]

Target Organs Eyes, skin, respiratory system, blood, central nervous system, bone marrow

Cancer Site [leukemia]

See also: INTRODUCTION See ICSC CARD: 0015 See MEDICAL TESTS: 0022

NIOSH Publication No. 2005-149: September 2005

NIOSH Pocket Guide to Chemical Hazards

p-Dichlorobenzene

CAS 106-46-7

$C_6H_4Cl_2$

RTECS CZ4550000

Synonyms & Trade Names
p-DCB; 1,4-Dichlorobenzene; para-Dichlorobenzene; Dichlorocide

DOT ID & Guide

Exposure Limits
NIOSH REL: Ca See Appendix A
OSHA PEL†: TWA 75 ppm (450 mg/m^3)

IDLH Ca [150 ppm] See: 106467

Conversion 1 ppm = 6.01 mg/m^3

Physical Description
Colorless or white crystalline solid with a mothball-like odor. [insecticide]

MW: 147.0	BP: 345°F	MLT: 128°F	Sol: 0.008%
VP: 1.3 mmHg	IP: 8.98 eV		Sp.Gr: 1.25
Fl.P: 150°F	UEL: ?	LEL: 2.5%	

Combustible Solid, but may take some effort to ignite.

Incompatibilities & Reactivities
Strong oxidizers (such as chlorine or permanganate)

Measurement Methods
NIOSH 1003; OSHA 7
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated/Daily
Remove: When wet or contaminated
Change: Daily
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms Eye irritation, swelling periorbital (situated around the eye); profuse rhinitis; headache, anorexia, nausea, vomiting; weight loss, jaundice, cirrhosis; in animals: liver, kidney injury; [potential occupational carcinogen]

Target Organs Liver, respiratory system, eyes, kidneys, skin

Cancer Site [in animals: liver & kidney cancer]

See also: INTRODUCTION See ICSC CARD: 0037 See MEDICAL TESTS: 0073

NIOSH Publication No. 2005-149: September 2005

NIOSH Pocket Guide to Chemical Hazards

Chromium metal	**CAS** 7440-47-3
Cr	**RTECS** GB4200000
Synonyms & Trade Names Chrome, Chromium	**DOT ID & Guide**

Exposure Limits	**NIOSH REL**: TWA 0.5 mg/m^3 See Appendix C
	OSHA PEL*: TWA 1 mg/m^3 See Appendix C [*Note: The PEL also applies to insoluble chromium salts.]
IDLH 250 mg/m^3 (as Cr) See: 7440473	**Conversion**

Physical Description
Blue-white to steel-gray, lustrous, brittle, hard, odorless solid.

MW: 52.0	BP: 4788°F	MLT: 3452°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 7.14
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid in bulk form, but finely divided dust burns rapidly if heated in a flame.

Incompatibilities & Reactivities
Strong oxidizers (such as hydrogen peroxide), alkalis

Measurement Methods
NIOSH 7024, 7300, 7301, 7303, 9102; OSHA ID121, ID125G
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: No recommendation
Eyes: No recommendation
Wash skin: No recommendation
Remove: No recommendation
Change: No recommendation

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH

Up to 2.5 mg/m^3:
(APF = 5) Any quarter-mask respirator. Click here for information on selection of N, R, or P filters.*

Up to 5 mg/m^3:
(APF = 10) Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100, P100. Click here for information on selection of N, R, or P filters.*
(APF = 10) Any supplied-air respirator*

Up to 12.5 mg/m^3:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
(APF = 25) Any powered air-purifying respirator with a high-efficiency particulate filter.*

Up to 25 mg/m^3:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters.
(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece

Up to 250 mg/m^3:
(APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure

mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator with an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms Irritation eyes, skin; lung fibrosis (histologic)

Target Organs Eyes, skin, respiratory system

See also: INTRODUCTION See ICSC CARD: 0029 See MEDICAL TESTS: 0052

NIOSH Publication No. 2005-149: September 2005

NIOSH Pocket Guide to Chemical Hazards

Methoxychlor

CAS 72-43-5

$(C_6H_4OCH_3)_2CHCCl_3$

RTECS KJ3675000

Synonyms & Trade Names
p,p'-Dimethoxydiphenyltrichloroethane; DMDT; Methoxy-DDT; 2,2-bis(p-Methoxyphenyl)-1,1,1-trichloroethane; 1,1,1-Trichloro-2,2-bis-(p-methoxyphenyl)ethane

DOT ID & Guide
2761 151 (organochlorine pesticide, solid, toxic)

Exposure Limits
NIOSH REL: Ca See Appendix A
OSHA PEL†: TWA 15 mg/m^3

IDLH Ca [5000 mg/m^3] See: 72435

Conversion

Physical Description
Colorless to light-yellow crystals with a slight, fruity odor. [insecticide]

MW: 345.7	BP: Decomposes	MLT: 171°F	Sol: 0.00001%
VP: Very low	IP: ?		Sp.Gr: 1.41
Fl.P: ?	UEL: ?	LEL: ?	

Combustible Solid, but difficult to burn.

Incompatibilities & Reactivities
Oxidizers

Measurement Methods
NIOSH S371 (II-4); OSHA PV2038
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: No recommendation
Wash skin: When contaminated/Daily
Remove: When wet or contaminated
Change: Daily

First Aid (See procedures)
Skin: Soap wash
Breathing: Fresh air
Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion

Symptoms In animals: fasciculation, trembling, convulsions; kidney, liver damage; [potential occupational carcinogen]

Target Organs central nervous system, liver, kidneys

Cancer Site [in animals: liver & ovarian cancer]

See also: INTRODUCTION See ICSC CARD: 1306

NIOSH Publication No. 2005-149: September 2005

NIOSH Pocket Guide to Chemical Hazards

Dieldrin

CAS 60-57-1

$C_{12}H_8Cl_6O$

RTECS IO1750000

Synonyms & Trade Names
HEOD; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,exo-5,8-dimethanonaphthalene

DOT ID & Guide
2761 151

Exposure Limits
NIOSH REL: Ca TWA 0.25 mg/m^3 [skin] See Appendix A
OSHA PEL: TWA 0.25 mg/m^3 [skin]

IDLH Ca [50 mg/m^3] See: 60571

Conversion

Physical Description
Colorless to light-tan crystals with a mild, chemical odor. [insecticide]

MW: 380.9	BP: Decomposes	MLT: 349°F	Sol: 0.02%
VP(77°F): 8 x 10-7 mmHg	IP: ?		Sp.Gr: 1.75
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid

Incompatibilities & Reactivities
Strong oxidizers, active metals such as sodium, strong acids, phenols

Measurement Methods
NIOSH S283 (II-3)
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated/Daily
Remove: When wet or contaminated
Change: Daily
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms Headache, dizziness; nausea, vomiting, malaise (vague feeling of discomfort), sweating; myoclonic limb jerks; clonic, tonic convulsions; coma; [potential occupational carcinogen]; in animals: liver, kidney damage

Target Organs central nervous system, liver, kidneys, skin

Cancer Site [in animals: lung, liver, thyroid & adrenal gland tumors]

See also: INTRODUCTION See ICSC CARD: 0787 See MEDICAL TESTS: 0077

NIOSH Publication No. 2005-149: September 2005

NIOSH Pocket Guide to Chemical Hazards

Ethylene dichloride	**CAS** 107-06-2
$ClCH_2CH_2Cl$	**RTECS** KI0525000
Synonyms & Trade Names 1,2-Dichloroethane; Ethylene chloride; Glycol dichloride	**DOT ID & Guide** 1184 131

Exposure Limits	**NIOSH REL**: Ca TWA 1 ppm (4 mg/m^3) ST 2 ppm (8 mg/m^3) See Appendix A See Appendix C (Chloroethanes)
	OSHA PEL†: TWA 50 ppm C 100 ppm 200 ppm [5-minute maximum peak in any 3 hours]
IDLH Ca [50 ppm] See: 107062	**Conversion** 1 ppm = 4.05 mg/m^3

Physical Description
Colorless liquid with a pleasant, chloroform-like odor. [Note: Decomposes slowly, becomes acidic & darkens in color.]

MW: 99.0	BP: 182°F	FRZ: -32°F	Sol: 0.9%
VP: 64 mmHg	IP: 11.05 eV		Sp.Gr: 1.24
Fl.P: 56°F	UEL: 16%	LEL: 6.2%	

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

Incompatibilities & Reactivities
Strong oxidizers & caustics; chemically-active metals such as magnesium or aluminum powder, sodium & potassium; liquid ammonia [Note: Decomposes to vinyl chloride & HCl above 1112°F.]

Measurement Methods
NIOSH 1003; OSHA 3
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin absorption, skin and/or eye contact

Symptoms Irritation eyes, corneal opacity; central nervous system depression; nausea, vomiting; dermatitis; liver, kidney, cardiovascular system damage; [potential occupational carcinogen]

Target Organs Eyes, skin, kidneys, liver, central nervous system, cardiovascular system

Cancer Site [in animals: forestomach, mammary gland & circulatory system cancer]

See also: INTRODUCTION See ICSC CARD: 0250 See MEDICAL TESTS: 0104

NIOSH Publication No. 2005-149: September 2005

NIOSH Pocket Guide to Chemical Hazards

Acetone

CAS 67-64-1

$(CH_3)_2CO$

RTECS AL3150000

Synonyms & Trade Names
Dimethyl ketone, Ketone propane, 2-Propanone

DOT ID & Guide
1090 127

Exposure Limits
NIOSH REL: TWA 250 ppm (590 mg/m^3)
OSHA PEL†: TWA 1000 ppm (2400 mg/m^3)

IDLH 2500 ppm [10%LEL] See: 67641

Conversion 1 ppm = 2.38 mg/m^3

Physical Description
Colorless liquid with a fragrant, mint-like odor.

MW: 58.1	BP: 133°F	FRZ: -140°F	Sol: Miscible
VP: 180 mmHg	IP: 9.69 eV		Sp.Gr: 0.79
Fl.P: 0°F	UEL: 12.8%	LEL: 2.5%	

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

Incompatibilities & Reactivities
Oxidizers, acids

Measurement Methods
NIOSH 1300, 2555, 3800; OSHA 69
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH
Up to 2500 ppm:
(APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*
(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister
(APF = 10) Any supplied-air respirator*
(APF = 50) Any self-contained breathing apparatus with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms Irritation eyes, nose, throat; headache, dizziness, central nervous system depression; dermatitis

Target Organs Eyes, skin, respiratory system, central nervous system

See also: INTRODUCTION See ICSC CARD: 0087 See MEDICAL TESTS: 0002

NIOSH Publication No. 2005-149: September 2005

NIOSH Pocket Guide to Chemical Hazards

Methylene chloride	**CAS** 75-09-2
CH_2Cl_2	**RTECS** PA8050000
Synonyms & Trade Names Dichloromethane, Methylene dichloride	**DOT ID & Guide** 1593 160

Exposure Limits	**NIOSH REL:** Ca See Appendix A
	OSHA PEL: [1910.1052] TWA 25 ppm ST 125 ppm

IDLH Ca [2300 ppm] See: 75092	**Conversion** 1 ppm = 3.47 mg/m^3

Physical Description
Colorless liquid with a chloroform-like odor. [Note: A gas above 104°F.]

MW: 84.9	BP: 104°F	FRZ: -139°F	Sol: 2%
VP: 350 mmHg	IP: 11.32 eV		Sp.Gr: 1.33
Fl.P: ?	UEL: 23%	LEL: 13%	

Combustible Liquid

Incompatibilities & Reactivities
Strong oxidizers; caustics; chemically-active metals such as aluminum, magnesium powders, potassium & sodium; concentrated nitric acid

Measurement Methods
NIOSH 1005, 3800; OSHA 59, 80
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: No recommendation
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations (See Appendix E) NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms Irritation eyes, skin; lassitude (weakness, exhaustion), drowsiness, dizziness; numbness, tingle limbs; nausea; [potential occupational carcinogen]

Target Organs Eyes, skin, cardiovascular system, central nervous system

Cancer Site [in animals: lung, liver, salivary & mammary gland tumors]

See also: INTRODUCTION See ICSC CARD: 0058 See MEDICAL TESTS: 0148

APPENDIX D

Hospital Route Map

Google Maps

Start **Hwy 242 S & CR-324**
Helena, AR 72342

End **1801 Martin Luther King Jr Dr**
Helena, AR 72342

Travel **4.5 mi – about 9 mins**

Hwy 242 S & CR-324
Helena, AR 72342

Drive: 4.5 mi – about 9 mins

1. Head **northeast** on **AR-242** toward **Old Little Rock Rd/ Phillips Road 300**	1.0 mi 2 mins
2. Turn **right** at **US-49 S**	2.9 mi 6 mins
3. Turn **right** at **US-49**	0.6 mi 2 mins

1801 Martin Luther King Jr Dr
Helena, AR 72342

These directions are for planning purposes only. You may find that construction projects, traffic, or other events may cause road conditions to differ from the map results.

Map data ©2007 NAVTEQ™

Overview

Start

End

Map data ©2007 NAVTEQ™

Directions to Helena, AR 72342, United States

YAHOO! LOCAL Maps

Summary and Notes

START **Highway 242 S & Cr-324, Helena, AR 72342, United States**

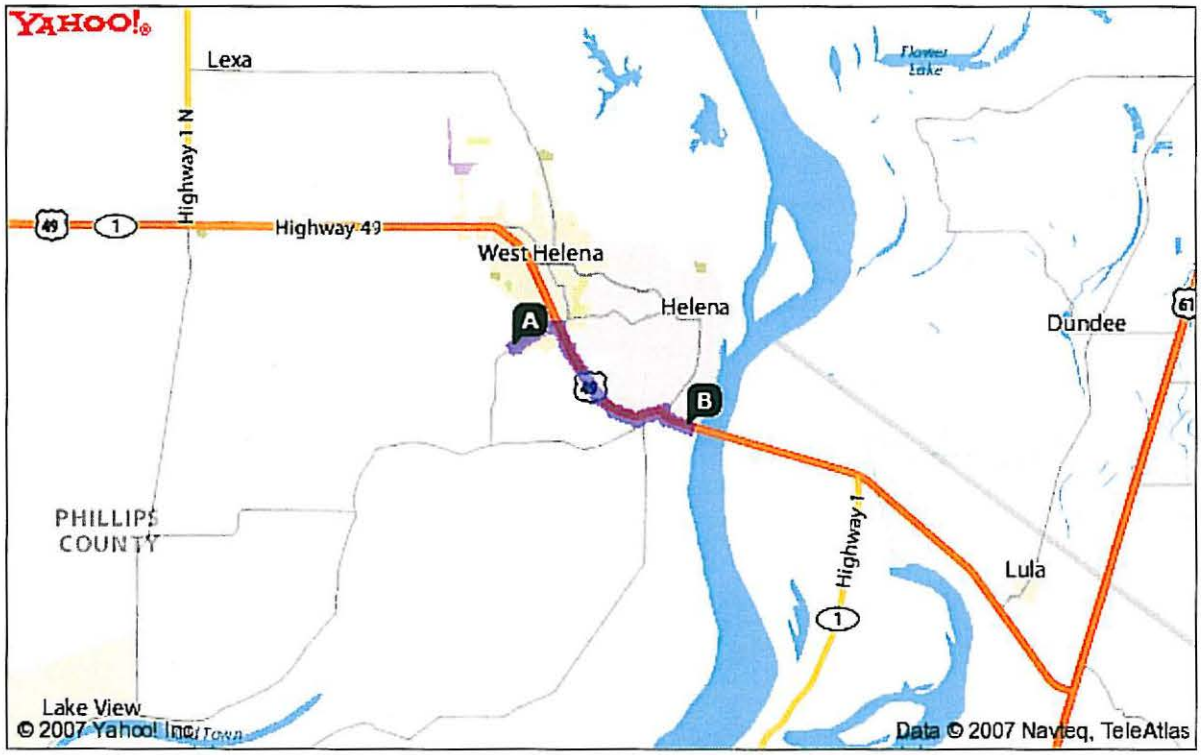
FINISH **1801 Martin Luther King Jr Dr, Helena, AR 72342, United States**

Total Distance: 4.6 miles, Total Time: 7 mins (approx.)

Add your notes here...

	Distance
HIGHWAY 242 S & CR-324, HELENA, AR 72342, UNITED STATES	
1. Start at **HIGHWAY 242 S & CR-324, HELENA**	go **1.0** mi
2. Turn R on **MARTIN LUTHER KING JR DR E(US-49 S)**	go **2.6** mi
3. Continue to follow **US-49 S**	go **0.9** mi
4. Arrive at **1801 MARTIN LUTHER KING JR DR, HELENA**	
1801 MARTIN LUTHER KING JR DR, HELENA, AR 72342, UNITED STATES	

Distance: 4.6 miles, Time: 7 mins



When using any driving directions or map, it's a good idea to do a reality check and make sure the road still exists, watch out for construction, and follow all traffic safety precautions. This is only to be used as an aid in planning.