

**Remedial Investigation/Feasibility
Study of the Soldier Creek/IWTP
Groundwater Operable Unit at
Tinker Air Force Base**

Quality Assurance Project Plan

Final

Prepared for



Oklahoma City Air Logistics Center

Tinker Air Force Base, Oklahoma

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ACRONYMS AND ABBREVIATIONS

| | |
|--------|--|
| AFB | Air Force Base |
| AIHA | American Industrial Hygiene Association |
| ARAR | Applicable, relevant and/or appropriate requirement |
| ASTM | American Society for Testing and Materials |
| BFB | p-bromofluorobenzene |
| CCB | Continuing calibration blank |
| CCC | Calibration check compound |
| CLP | Contract laboratory program |
| COC | Chain-of-custody |
| DCS | Duplicate control sample |
| DF | Dilution factor |
| DFTPP | Decafluorotriphenylphosphine |
| DQO | Data quality objective |
| DQOP | Data quality objectives plan |
| EPA | U.S. Environmental Protection Agency |
| ES | Engineering-Science |
| ESP | Environmentalist's sub-soil probe |
| FAR | Federal Acquisition Rules |
| FS | Feasibility study |
| GC | Gas chromatograph |
| GFAA | Graphite furnace atomic absorption |
| GR | Gamma ray |
| ICB | Initial calibration blank |
| ICP | Inductively coupled plasma |
| IDL | Instrument detection limit |
| IDW | Investigation derived waste |
| IRPIMS | Installation Restoration Program Information Management System |
| LCS | Laboratory control sample |
| LOD | Limit of detection |
| MCL | Maximum contaminant level |
| mg/L | Milligram per liter |
| mg/kg | Milligram per kilogram |
| MQL | Maximum quantitation limit |
| MS | Mass spectrometry |
| NA | Actual number of valid environmental sample analyses |
| NI | Planned number of environmental sample analyses |
| NIOSH | National Institute of Occupational Safety |

NIST National Institute of Standards and Technology
NPL National Priorities List
OVA Organic vapor analyzer
PAH Polyaromatic hydrocarbons
PC Percent completeness
PE Performance evaluation
PID Photoionization detector
PVC Polyvinyl chloride
QA Quality assurance
QAPP Quality Assurance Project Plan
QC Quality control
RF Response factor
RI Remedial Investigation
RPD Relative percent difference
RSD Relative standard deviation
SA Concentration of spike added to sample
SCGW Soldier Creek/IWTP Groundwater Operable Unit
SDL Sample detection limit
SOP Standard operating procedure
SOW Statement of Work
SR Measured concentration in unspiked sample
SSR Measured concentration in spiked sample
TCL Target compound list
TCLP Toxicity Characteristic Leaching Procedure
 $\mu\text{g/l}$ Microgram per liter
USAF United States Air Force
UV Ultraviolet
VOC Volatile organic compound
WP Water pollution
WS Water supply
%M Percent moisture
% Rec Percent recovery
 $^{\circ}\text{C}$ Degrees Celsius

SECTION 1

PROJECT DESCRIPTION

1.1 INTRODUCTION

Tinker Air Force Base (AFB) has contracted Engineering-Science (ES) to provide all services and supplies necessary to perform a Remedial Investigation/Feasibility Study (RI/FS) on the Soldier Creek/IWTP Groundwater (SCGW) Operable Unit. This quality assurance project plan (QAPP) has been prepared for use during this RI/FS under United States Air Force (USAF) contract number F34650-93-D-0106, delivery order number 5001, and the project statement of work (SOW).

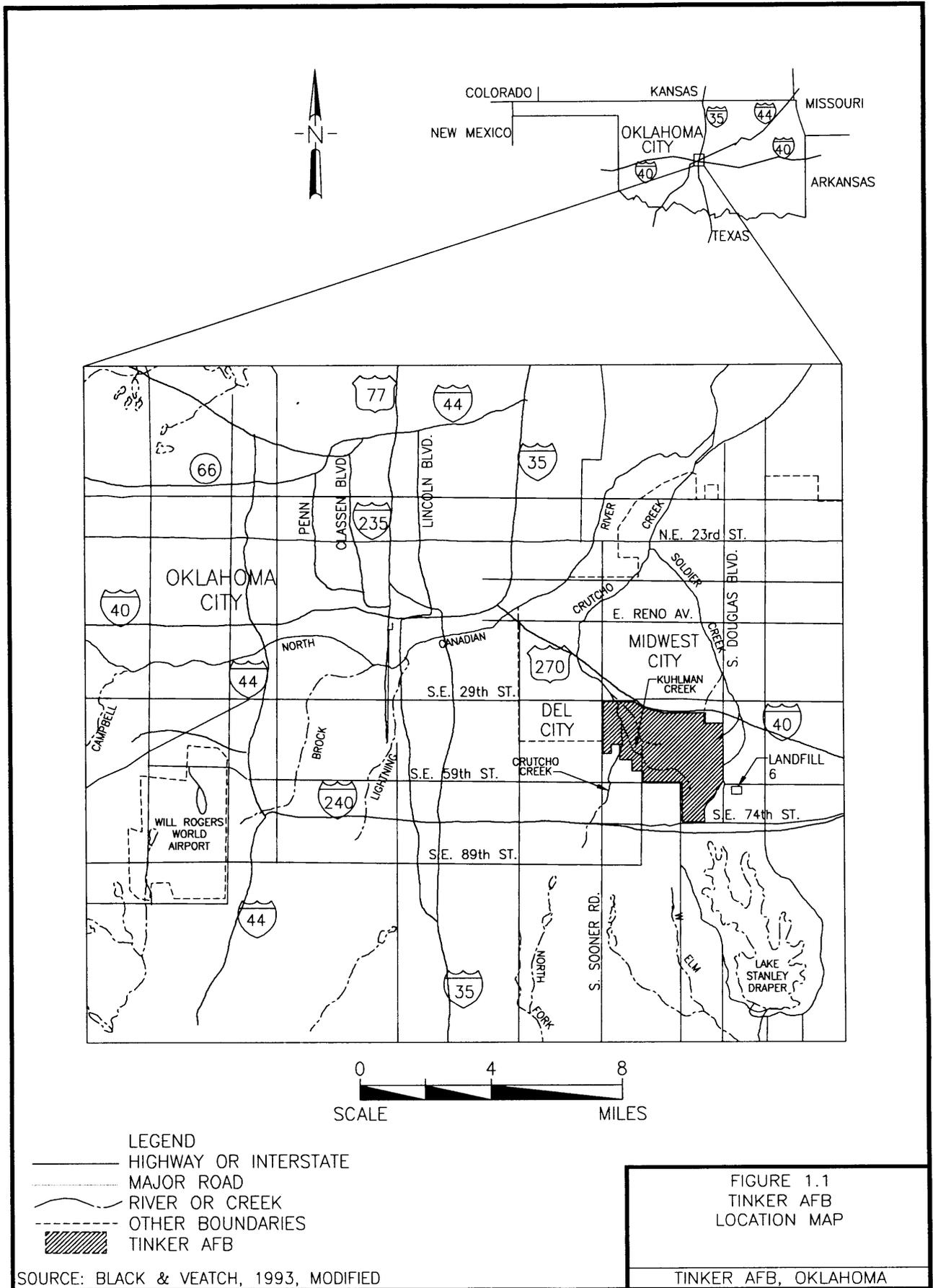
Tinker AFB is located in Oklahoma County in central Oklahoma, approximately 8 miles southeast of downtown Oklahoma City. A site location map is presented in Figure 1.1. The base is bounded by Sooner Road to the west, Douglas Boulevard to the east, Interstate 40 (I-40) to the north, and Southeast 74th Street to the south. The base comprises 5,000 acres.

The majority of the SCGW operable unit is located immediately northeast of the base, with a small portion located within the base boundary. Figure 1.2 is a site map. The SCGW includes the groundwater under and adjacent to Soldier Creek where contamination may have originated from the Building 3001 National Priorities List (NPL) Site. The scope of this RI/FS investigation will extend from the most southern piped outfall from Building 3001 (north of Gate 21) on the south to I-40 on the north, west to West Soldier Creek and east to East Soldier Creek.

1.2 PROJECT OBJECTIVES

Previous investigations of Soldier Creek sediment and surface water and of groundwater northeast of the base did not adequately address off-base contamination. The pertinent findings of the previous investigations are summarized in the project work plan.

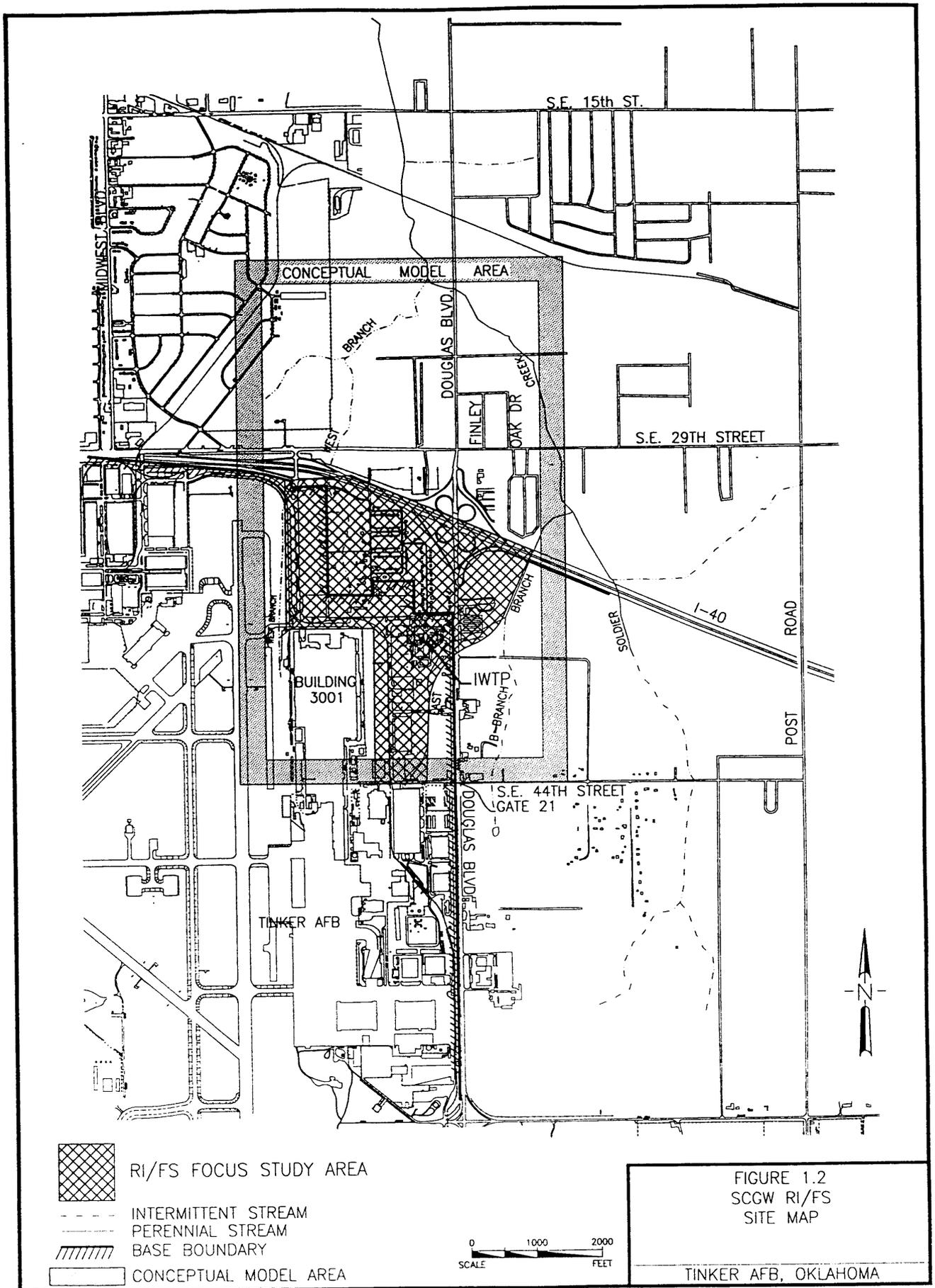
The objectives of the RI/FS are to determine whether contaminant releases to Soldier Creek have occurred at off-base locations and to determine the nature and extent of the contaminant releases. The interaction between the creek and the underlying groundwater reservoirs will also be studied and quantified.



SOURCE: BLACK & VEATCH, 1993, MODIFIED

FIGURE 1.1
TINKER AFB
LOCATION MAP

TINKER AFB, OKLAHOMA



BASF, CO 5/24/94

1.3 PROJECT SCOPE

The scope of work for this RI/FS is described in detail in the project work plan (ES, 1994a). A brief description of the ten tasks is provided below.

1. Perform a historical review of the site.
2. Sample and geophysically log twelve private wells.
3. Determine daily discharge rates for Soldier Creek, and estimate seasonable direction and volume fluctuation of water moving between Soldier Creek and the underlying aquifer.
4. Drill four continuous cores to a depth of up to 200 feet each for detailed lithologic information. Perform geophysical surveys of the coreholes and of the cores.
5. Drill twelve 180-foot-deep pilot holes and install twelve monitoring well clusters, each consisting of 3 wells with approximate depths of 40, 90, and 150 feet. Collect water samples from each of these wells.
6. Develop a conceptual model of the geology and of the groundwater/surface water interactions at the site.
7. Conduct three long-term aquifer pumping tests to determine aquifer parameters for the conceptual flow model. Tests will be performed on the three aquifer zones at approximate depths of 40, 90, and 150 feet.
8. Collect soil samples in the vicinity of each of the twelve sampled private wells.
9. Collect stream sediment samples at twenty locations in Soldier Creek.
10. Analyze groundwater samples for 129 priority pollutants excluding asbestos and dioxin. Analyze soil and sediment samples for U.S. Environmental Protection Agency (EPA) Target Compound List (TCL) analytes (except pesticides), arsenic, barium, chromium (total and hexavalent), cadmium, copper, lead, mercury, nickel, selenium, silver, and zinc.

1.4 PURPOSE OF DOCUMENT

This QAPP contains procedures and specifications that will be followed to assure that the data collected are of satisfactory quality. These procedures will ensure that the integrity of the samples is maintained and that no contamination or cross-contamination will occur.

With this QAPP, there are four companion project plans. These reports are:

- Work plan (WP) (ES, 1994a)
- Field sampling plan (FSP) (ES, 1994b)
- Health and Safety Plan (HSP) (ES, 1994c)
- Data Quality Objective Plan (DQOP) Plan (DQOP) (ES, 1994d).

SECTION 2

PROJECT ORGANIZATION AND RESPONSIBILITIES

Figure 2.1 presents a project organization chart which identifies the project officers, task managers, and quality assurance officer. ES will manage the project work from the office in Austin, Texas, and the program from the office in Oklahoma City, Oklahoma. Appropriate and qualified staff will be drawn from the Austin and Oklahoma City offices and, when necessary, from other ES offices.

The ES personnel assigned to this project are as follows:

Program manager: Edward S. (Sam) Moore II, P.E.

Project manager: John Yu, Ph.D., C.G.W.P., P.G.

Project technical director: Charlie Spiers, P.G.

RI manager: John Osweiler, P.G.

Field team leader: John Osweiler, P.G.

FS manager: Christina Vail, P.E.

Quality assurance (QA) officer: Jay Snow, P.E.

Health and safety officer: Marc Harder, P.G.

The responsibilities of the project manager, QA officer, and other staff are summarized in Table 2.1. The ES project and task managers will be responsible for coordinating the sampling activities and chemical analyses. The QA officer will be responsible for overall quality assurance/quality control (QA/QC) review. The QA officer or his designee will review sample reports upon receipt and assure that the data are valid and within acceptable predetermined standards. The QA officer will also be responsible for assuring that all personnel are fully informed of the project's quality assurance policies and that the elements of the ES QA/QC plan are met.

All subcontractors will be identified after competitive bidding according to Federal Acquisition Rules (FAR). These will include subcontractors for drilling, land surveying, chemical analyses, core photography and gamma ray logging, borehole

Figure 2.1
Project Organization
Tinker AFB SCGW RI/FS

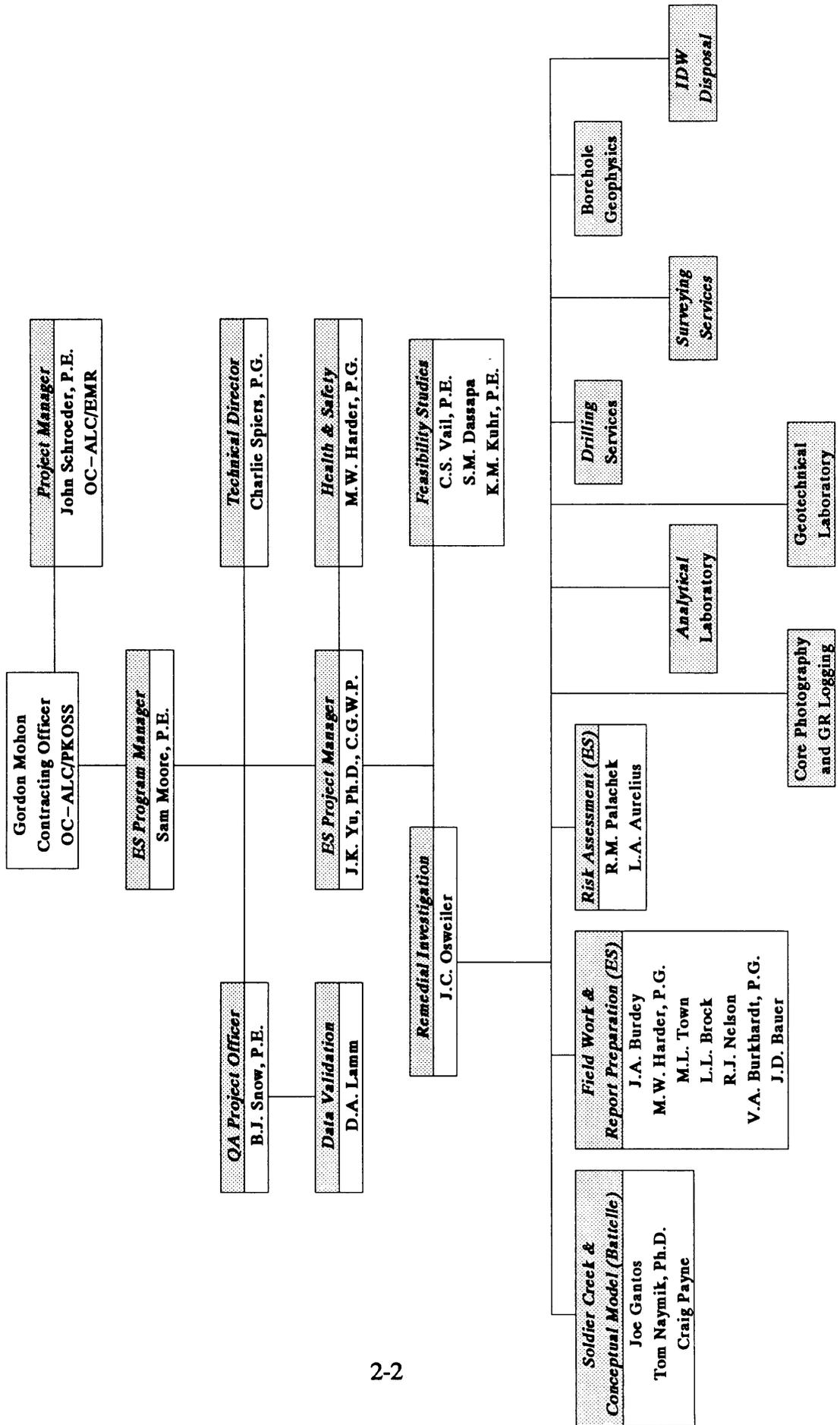


Table 2.1 Responsibility Matrix
Tinker AFB SCGW RI/FS

| Position | Personnel | Organization/ Address/ Telephone | Responsibilities |
|--------------------------------|--------------------------------|---|--|
| Tinker AFB Project Manager | John Schroeder, P.E. | OC-ALC/EMR 8745 Entrance Road A Tinker AFB, OK 73145-3303 (405) 736-2941 | Primary contact. Oversight of SCGW RI/FS activities. Contact for site access and information. |
| Tinker AFB Contracting Officer | Gordon Mohon | OC-ALC/PKOSS 7858 5th Street, Suite 1 Tinker AFB, OK 73145-9106 (405) 739-3367 | Obligate the government. Ensure that ES meets contract specifications and requirements. Consent to subcontracts. |
| ES Project Technical Director | Charlie Spiers, P.G. | Engineering-Science, Inc. 57 Executive Park South, N.E. Suite 590 Atlanta, GA 30329-2265 (404) 235-2300 | Technical review of investigation. |
| ES Project Manager | John Yu, Ph.D., C.G.W.P., P.G. | Engineering-Science, Inc. 8000 Centre Park Drive Suite 200 Austin, TX 78754 (512) 719-6000 | Project administration and personnel coordination. Schedule and budget tracking. |
| ES Tinker AFB Program Manager | Sam Moore, P.E. | Engineering-Science, Inc. 5600 Liberty Parkway Suite 700 Midwest City, OK 73110 (405) 732-9803 | Program administrator. Primary responsibility for ensuring cost, schedule, and quality control are maintained. |

Table 2.1, continued

| Position | Personnel | Organization/ Address/ Telephone | Responsibilities |
|--------------------------------------|-----------------------|--|---|
| ES Program Technical Director | Ernie Schroeder, P.E. | Engineering-Science, Inc. 8000 Centre Park Drive Suite 200 Austin, TX 78754 (512) 719-6000 | ES nationwide IRP technical direction. |
| ES Corporate QA Officer | N.L. Presecan | Engineering-Science, Inc. 100 West Walnut Street Pasadena, CA 91124 (818) 440-6000 | ES nationwide quality assurance. |
| ES Project QA Officer | Jay Snow, P.E. | Engineering-Science, Inc. 8000 Centre Park Drive Suite 200 Austin, TX 78754 (512) 719-6000 | Ensure compliance with QA plan. Review and validation of laboratory data. Review of field records for completeness. |
| ES Project Health and Safety Officer | Marc Harder, P.G. | Engineering-Science, Inc. 8000 Centre Park Drive Suite 200 Austin, TX 78754 (512) 719-6000 | Identification of health and safety protocols. Compliance with health and safety procedures. |
| Laboratory Director | To be determined | To be determined | Oversight of laboratory analytical activities. |
| Laboratory Project Manager | To be determined | To be determined | Coordinate sample analysis and laboratory report generation. |
| Laboratory QC Coordinator | To be determined | To be determined | Implement QC corrective actions and review data packages. |

geophysics, geotechnical analyses, and investigation derived waste (IDW) disposal. All subcontractors will be approved by the Tinker AFB contracting officer. The laboratory shall meet federal and state analytical requirements. After the laboratory has been selected, and before field work starts, an addendum to this QAPP containing laboratory-specific information and standard operating procedures (SOPs) will be prepared and submitted for review.

SECTION 3

QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT

3.1 INTRODUCTION

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of the data required to support the SCGW RI/FS activities. Through the development of DQOs, the objectives and methods to be used in the remedial investigation are clearly defined. Data quality objectives support such activities as site screening, characterization, risk assessment, evaluation of engineering alternatives, selection of decisions, and implementation.

Data quality objectives are specified for each data collection activity associated with the entire remedial response effort. The majority of these activities will take place during the remedial investigation, but additional data needs may be identified during preparation of the feasibility study and the remedial design documents, and during remedial action implementation. DQOs for the remedial investigation field work are described in detail in the DQOP, (ES, 1994d).

Data quality objectives are based on the use of the data, including potential comparisons to concentrations of contaminants of concern. Analytical data quality levels and concentrations of concern are described in this section.

3.2 ANALYTICAL DATA QUALITY LEVELS

Analytical data quality is specified in terms of levels defined in the Data Quality Objectives Guidance Document (EPA, 1987a). Five analytical levels are defined:

- **Level I** – Field screening using portable instruments, such as photoionization detectors. Results are often not compound specific and not quantitative, but results are available in real-time. It is the least costly of the analytical options.
- **Level II** – Field analyses using more sophisticated portable analytical instruments, such as a portable gas chromatograph. In some cases, the instruments may be set up in a mobile laboratory on site. A wide range in the quality of data may be attained, depending on the use of suitable calibration standards, reference materials, sample preparation equipment, and the training of the operator. Results are available in real-time or several hours.

- Level III – All analyses performed in an offsite analytical laboratory using standard, documented procedures, such as those outlined in EPA guidance SW-846. Results can be used for risk assessment.
- Level IV – Analyses performed in off-site laboratories according to EPA contract laboratory program (CLP) protocols, which require stringent QA/QC procedures, documentation, and data validation or laboratory procedures with equivalent QA/QC procedures. Results are for risk assessment and cost recovery litigation.
- Level V – Analyses by non-standard methods performed in an off-site analytical laboratory.

In the Tinker AFB SCGW RI/FS field investigation, the following analytical levels will be used as indicated:

- Level I analytical requirements will be used for the screening of air in the breathing zone for health and safety purposes. Level I may also be used to screen samples in order to select portions for further analysis. For example, soil samples will be screened using headspace analyses.
- Level II analyses will be used to determine field conductance, pH, and temperature.
- Level III analyses will be used to satisfy the requirements for site characterization, risk assessment, disposal of wastes and future site cleanup prioritization.
- Level IV and V analyses will not be required.

An effective QA program addresses quality objectives for both sampling and laboratory methodology. ES field QA efforts are aimed primarily at assuring that samples are representative of the conditions in the various environmental media at the time of sampling. Laboratory QA efforts are aimed primarily at assuring that analytical procedures provide sufficient accuracy and precision to quantify contaminant levels in environmental samples. The laboratory shall also ensure that analyzed portions are representative of each sample, and that the results obtained from analysis of each sample are comparable to those obtained from analysis of other similar samples.

3.2.1 Concentrations of Concern

In order to define data needs, potential contaminant concentrations of concern must be established. The *Guidance for Data Usability in Risk Assessments* (EPA, 1990) specifies that, to the extent possible, the analytical detection limit for a contaminant of concern should be no greater than 20 percent of the concentration of concern. Concentrations of concern are obtained from applicable, relevant and/or appropriate requirements (ARARs), risk-based criterion, etc.

For effects on local groundwater, EPA maximum contaminant levels (MCLs) (EPA, 1991), protective guidelines recommended by the National Academy of Sciences and National Academy of Engineering (National Academy, 1972), and other appropriate ARARs will be used as concentrations of concern. Levels of total

metals detected in well water samples will also be compared to available background concentrations.

3.2.2 Project QA Objectives

The overall QA objectives for the investigation are to develop and implement procedures that will provide data that are of known, documented, and defensible quality. QA/QC is ensured through appropriate sample collection, preservation and transport methods, combined with an evaluation of analytical performance through the analysis of quality control samples.

When analytical data fail to meet the required QC objectives, the technical report will discuss why the objectives were not met. Two major categories of non-compliance need to be considered:

- Requirements that are fully under a laboratory's control
- Requirements limited by the nature of the sample matrix.

Corrective action for non-compliance that is fully under a laboratory's control (laboratory blanks, calibration standards, tuning, and laboratory check or control samples) will be addressed with a thorough reevaluation of the system and all calculations and, where practical, reanalysis of non-compliant samples.

Corrective action for non-compliance that is limited by the nature of the sample matrix (field blanks, matrix spikes, and duplicates) will be addressed with a thorough check of the system and all calculations and the attachment of appropriate data qualifiers to non-compliant data.

Section 9 may be referred to for additional laboratory QA/QC assessment criteria. Field QA/QC procedures and requirements are described in Section 9 and in the project FSP (ES, 1994b).

The quality of data generated by sampling, monitoring, and analyses will be evaluated in terms of accuracy, precision, and completeness as described below and the results of this evaluation will be included in the quality assurance report. Measures to assure that the data are comparable and representative are also described in the following subsections. For ease of reference, the definitions and associated numerical goals for each criteria are discussed together.

3.3 DEFINITION OF CRITERIA AND GOALS

3.3.1 Accuracy

Accuracy is a measure of the difference between a measured value and the "true" or accepted reference value. The accuracy of an analytical procedure is determined by the analysis of a sample containing a known quantity (spike) of material. The accuracy of data for this project will be determined through the use of matrix spikes and sample surrogate spikes (for organic analyses). Matrix spikes are evaluated by analyzing a normal environmental sample along with a spike of that sample.

The objective for laboratory accuracy is to equal or exceed the accuracy demonstrated for the analytical method on samples of similar matrix composition and contaminant concentration. The level of recovery of an analyte and the resulting degree of accuracy expected for the analysis of QA samples and spiked samples are dependent upon the sample matrix, method of analysis, and the contaminant. The concentration of the analyte relative to the detection limit of the method is also a major factor in determining the accuracy of the measurement.

The accuracy of laboratory data will be evaluated by determining the percent recovery (% Rec) of matrix spike samples and surrogates. In addition, method (reagent) blanks will be evaluated to ensure that contamination in the field or laboratory is not introducing a systematic error into the analytical results. The % Rec for spiked samples is calculated as follows:

$$\% \text{ Rec} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100\%$$

where:

% Rec = Percent recovery

SSR = Measured concentration in spiked sample

SR = Measured concentration in unspiked sample

SA = Concentration of spike added to the sample.

In addition to the matrix spikes, blank spikes (laboratory control samples) will be prepared and analyzed by the laboratory. For laboratory control samples (LCSs), the unspiked sample should be free of analytes (e.g., for blank samples, the SR is zero), and the accuracy is thus calculated as follows:

$$\% \text{ Rec} = \frac{\text{SSR}}{\text{SA}} \times 100\%$$

Field spiking of environmental samples will not occur, since the laboratory spiking methods are expected to occur under more controlled conditions and should therefore provide more reliable data than that which could reasonably be implemented in the field. However, field measurements for parameters such as pH will be assessed for accuracy in the field. Specifically, field instruments will be assessed for accuracy by the response to a known sample (such as a calibration standard). The objective for accuracy of field measurements is to achieve and maintain factory equipment specifications for the field equipment.

3.3.2 Precision

Precision is an expression of the agreement between multiple measurements of the same property carried out under similar conditions. Precision thus reflects the reproducibility of the measurement. Precision is evaluated most directly by recording and comparing multiple measurements of the same parameter made on the same sample under similar conditions.

Precision is expressed in terms of the standard deviation or the relative percent difference (RPD) between the values resulting from duplicate analyses. RPD is calculated as follows:

$$\text{RPD} = \frac{|V_1 - V_2|}{(V_1 + V_2)/2} \times 100\%$$

where:

- RPD = Relative Percent Difference
- V₁, V₂ = The two values obtained by making replicate measurements or analyzing duplicate samples.
- |V₁ - V₂| = The absolute value of the difference between the two measurements.
- (V₁ + V₂)/2 = The average value of the two measurements.

Because the concentration of analytes may be below detection limits in many environmental samples, RPD data will be generated by preparing matrix spikes in duplicate. The precision of the analytical method will thus be measured by calculating the RPD between the duplicate spikes, as well as environmental samples. For field duplicate samples, sample values exceeding the detection limit by 5x must meet an RPD criteria of ±40 percent for water and ±70 percent for soils. A control limit of ±2x the detection limit for water and ±4x for soil is applied to sample values less than 5x the detection limit. Section 13 (and Table 9.1) describes the corrective action that will be taken if field precision is not met. Table 3.1 lists the precision objectives for field measurements such as pH, temperature, conductivity, photoionization detector (PID) readings and water level measurements, along with the corrective actions taken if the precision objective is not met.

3.3.3 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system relative to the amount anticipated under ideal conditions. The percent completeness will be calculated as follows:

$$\text{PC} = \frac{N_A}{N_I} \times 100\%$$

where:

- PC = Percent completeness
- N_A = Actual number of valid environmental sample analyses.
- N_I = Planned number of environmental sample analyses.

Valid data will be defined as all data and/or qualified data considered to meet the data quality objectives for this project. The planned number of analyses may vary from the samples proposed, due to site-specific conditions.

**Table 3.1 Precision Objectives for Field Measurements
Tinker AFB SCGW RI/FS**

| Measurement Data | Precision Objective | Corrective Action |
|--------------------------|--|-----------------------------------|
| pH | Consecutive readings agree within ± 0.1 pH units | Recalibrate |
| Temperature* | Visually inspect the instrument before each use | Replace thermometer |
| Conductivity | ± 0.1 mS/cm | Recalibrate |
| HNU readings | ± 15 percent from calibration readings at specified span setting | Return instrument for maintenance |
| Water level measurements | ± 0.01 feet | Return instrument for service |

* No corrective action as no standard measurement is available in the field.

At the end of the data validation process, an assessment of the completeness will be made. If data gaps are apparent, an attempt will be made to collect the required data. A target completeness of 90 percent for each analytical method has been established.

3.3.4 Comparability

Comparability expresses the confidence with which one data set can be compared to another. The comparability of all data collected for this project will be ensured by adherence to the approved sample collection procedures, field measurement procedures, and analytical procedures contained in this plan. Data will be reported as described in Section 8. The comparability of the data will also be ensured through the use of calibration and reference standards, that are traceable to the National Institute of Standards and Technology (NIST) or EPA.

3.3.5 Representativeness

Samples must be representative of the environmental media being sampled. The sample locations and sampling procedures described in Section 4 of this QAPP were designed with the consideration of obtaining samples representative of potentially contaminated areas. Sample handling and analytical procedures also incorporate consideration of obtaining the most representative sample possible. Representativeness of specific samples will thus be achieved by the following:

- Collect samples from locations representing the site conditions
- Use approved sampling methodology and equipment
- Use approved sampling procedures, including equipment decontamination
- Use approved analytical methodologies for the parameters while achieving required detection limits
- Analyze within the designated holding times

Sample representativeness is also affected by the portion of each collected sample which is chosen for analysis. The laboratory shall ensure that the samples are adequately homogenized prior to taking aliquots for analysis. However, it should be recognized that many means of homogenization expose the sample to significant risk of contamination or loss through volatilization. Certain methods of homogenization should thus be avoided or modified to minimize these risks.

Duplicate and replicate samples will be collected to provide information on the variability of the contaminants in the field. Duplicate samples will be collected at a rate of one per ten groundwater samples. Replicate samples will be collected at a rate of one per ten soil samples, and one per ten sediment samples.

To ensure that the sampling equipment has been successfully decontaminated, equipment rinsate blanks will be collected at a rate of one per day of groundwater sampling. The equipment rinsate blanks will be analyzed for the same constituents as the other field samples collected during the field event.

Trip blanks will be used to verify that no volatile cross-contamination of samples occurred during shipment to the laboratory for analysis. A trip blank will accompany all samples shipped to the laboratory for volatile organic analysis.

To ensure that sample chemistry is not affected by the ambient environment, one ambient conditions blank will be collected per round of groundwater sampling for volatile organic analysis. If possible, the ambient conditions blank will be collected when a sample is being collected downwind of possible volatile organic compound (VOC) sources.

SECTION 4

SAMPLING PROCEDURES

This section sets forth guidance for field work by defining the sampling and data gathering procedures to be used during the remedial investigation. These field procedures were developed to incorporate standard procedures, such as those of the American Society for Testing and Materials (ASTM) *Standards on Ground Water and Vadose Zone Investigations* (ASTM, 1992); the EPA guidance document entitled *A Compendium of Superfund Field Operations Methods* (EPA, 1987b); and applicable Engineering-Science standard operating procedures (SOPs) (ES, 1992). Sampling procedures are described in greater detail in the project FSP (ES, 1994b).

4.1 CORE SAMPLING

Four boreholes will be drilled to an approximate depth of 200 feet each. Continuous core samples for gamma ray (GR) logging will be collected from these boreholes. A total of twenty-four samples will be collected from two of the four boreholes for geotechnical analyses.

The core samples will be collected in the following manner. After air or mud has been circulated in the hole to remove as many cuttings as possible, the string of drill pipe will be removed from the hole. The core barrel will then be attached to the drill string and run into the hole. The core barrel will be used to obtain a representative *in situ* sample.

The ES on-site geologist will collect the 24 samples (from two boreholes) for geotechnical analyses. The depth intervals of these samples will be chosen based on changes in lithology. These samples will be analyzed for Atterberg limits (ASTM D4318), soil moisture (ASTM D2216), permeability (ASTM D2216), organic content (ASTM D2974) and particle size distribution (ASTM D422). Undisturbed samples are required to achieve the most accurate results for geotechnical analyses. Therefore, special care will be taken in all sampling, handling, packaging, and shipping of these samples. Samples must be wrapped in plastic and sealed with Teflon tape or wax. Sample volume requirements are listed in Table 4.1.

The sample will be labelled with the project number, project name, date of sampling, and any other pertinent information. In addition, the sample will be marked "Top" and "Bottom" so that the orientation of the sample is known. When

Table 4.1 Sample Containers, Preservatives, and Holding Times for Soil Samples
Tinker AFB SCGW RI/FS

| Parameters | Method | Sample Container | Preservative | Holding Time |
|---|---|---|--------------|--|
| Volatile organic compounds | SW-8260 | One 4-ounce widemouth glass jar with Teflon-lined lid | Cool to 4°C | 14 days |
| Semivolatile organic compounds | SW-3520/ SW-8270 | One 8-ounce widemouth glass jar with Teflon-lined lid | Cool to 4°C | Extract within 14 days of collection, and analyze within 40 days of extraction |
| Total arsenic (recoverable) | SW-3050/ SW-7060 | One 8-ounce glass widemouth jar ² | Cool to 4°C | 180 days |
| Total lead (recoverable) | SW-3020/ SW-7421 | One 8-ounce glass widemouth jar ² | Cool to 4°C | 180 days |
| Total mercury (recoverable) | SW-7471 | One 8-ounce glass widemouth jar ² | Cool to 4°C | 28 days |
| Total selenium (recoverable) | SW-3050/ SW-7740 | One 8-ounce glass widemouth jar ² | Cool to 4°C | 180 days |
| Total ICP metals ¹ (recoverable) | SW-3050/ SW-6010 | One 8-ounce glass widemouth jar | Cool to 4°C | 180 days |
| Chromium (VI) | SW-7195 - SW-7198 ³ | One 4-ounce glass jar | Cool to 4°C | 24 hours |
| Geotechnical parameters | ASTM D4318 ASTM D2434 ASTM D2216 ASTM D422 ASTM D2974 | One to two feet of undisturbed core sample, wrapped air tight in plastic and sealed with Teflon tape or wax | None | NA |

¹ ICP (inductively coupled plasma) metals include antimony, barium, cadmium, chromium, copper, nickel, silver, thallium, and zinc.
² Can be combined with ICP metals sample jar.
³ Specific method for chromium VI analyses will be determined after the laboratory has been selected.

possible, the samples will be hand carried to the laboratory in an upright vertical position to maintain the *in situ* orientation and to minimize sample disaggregation.

After the geotechnical samples have been collected, the core samples will be packaged for transport. The core will be preserved by placing it in split PVC pipe and wrapping it with plastic wrap. This will insure that the friable sections of the core will remain intact and that the core will not dry out prior to analysis. A chain-of-custody (COC) form will accompany the sample at all times. The COC will also indicate depth intervals for analysis of porosity, grain size, and permeability. The continuous core samples will be transported to the laboratory where they will be photographed with sufficient precision to identify lithologic detail. In addition, the geotechnical engineering laboratory will run a surface GR log on each continuous core.

4.2 PILOT HOLE SAMPLING

A pilot hole will be drilled at each monitoring well cluster location to determine screen intervals for each of the wells. Pilot holes will be sampled for lithologic description.

4.3 SOIL SAMPLING

Soil samples for chemical analysis will be collected in the vicinity of each of the twenty private wells logged and sampled during this project (Task 1). Four grab samples will be collected from each location for analysis at depths of 0, 1, 2.5, and 5 feet.

Surface soil samples will be collected from the surface (0 feet below ground level) using a decontaminated hand trowel or shovel. Samples for VOC analyses will be quickly containerized in a manner that minimizes volatilization of potential contaminants. To collect the remaining samples, two to four times the required sample volume will be adequately mixed in a decontaminated stainless steel bowl. Gravel and vegetation will be removed from the soil. The sample containers will be filled and the remaining contents of the bowl will be discarded.

A manually operated subsurface sampler will be used to collect the shallow subsurface (1, 2.5, and 5 feet below ground level) soils. There are two equipment options: the environmentalist's subsoil probe (ESP) subsurface sampler, which pushes a thin plastic-lined sampler into the ground, and a hand auger. Samples collected with the ESP probe will be shipped to the laboratory in the tube. Samples collected with the hand auger will be containerized as described above. The subsurface sampler will be decontaminated prior to each use.

Soil samples will be analyzed for volatile organic compounds (SW-8240); semivolatile organic compounds (SW-8270); total arsenic (SW-7060); total lead (SW-7421); total mercury (SW-7470); total selenium (SW-7740); barium, cadmium, total chromium, copper, nickel, silver, and zinc (SW-6010); chromium VI (to be determined). Sample containers, preservation, and holding times are listed on Table 4.1. Ten percent of all soil samples will be field replicates.

Soil samples for chemical analyses will be marked to identify boring and depth, and cooled on ice to 4°C for preservation. The sample jars will also be marked with analyses to be performed, date and time of collection, and initials of samplers. Care must be taken to minimize volatilization of samples for VOC analyses; these samples will not be homogenized or composited.

4.4 SEDIMENT SAMPLING

Sediment samples for chemical analyses will be collected from twenty locations at Soldier Creek. Sediment samples will be collected at 0, 1, 2, 3, and 5 feet below ground level at each location.

Samples will be collected as described above in Section 4.1.2 or with sediment sampling devices. The 0-foot deep samples may be collected with a decontaminated hand trowel or with a decontaminated sampling dredge. The manually operated subsurface soil sampler described above or a hand core sediment sampler will be used to collect the remaining sediment samples.

Sediment samples will be analyzed for volatile organic compounds (SW-8260); semivolatile organic compounds (SW-8270); total arsenic (SW-7060); total lead (SW-7421); total mercury (SW-7471); total selenium (SW-7740); barium, cadmium, total chromium, copper, nickel, silver, and zinc (SW-6010); chromium VI (to be determined). Sample containers, preservation, and holding times are listed on Table 4.1. Ten percent of all sediment samples will be field replicates.

4.5 GROUNDWATER SAMPLING

Groundwater samples will be collected from up to 56 wells; including up to 20 privately-owned wells and 36 base-owned monitoring wells. As much as is possible, the privately-owned wells will be sampled using the procedures for sampling the base-owned monitoring wells. Abandoned private wells are preferred, but in some cases it may be necessary to remove a pump or to collect a sample from a faucet.

Before sampling begins, sample containers will be prepared with appropriate labels and preservations. Groundwater sample volume and container requirements are shown in Table 4.2.

The initial well purging and sampling will take place at least 24 hours after well development is completed. Private wells will not be developed. Before each well is purged and sampled, the water level will be measured within 0.01 foot with respect to the reference point on the top of the casing.

After the water level is recorded, the well will be purged to remove the stagnant water. Only abandoned private wells will be purged. Either a PVC bailer or a submersible pump will be used to purge the well (EPA, 1992). All purging and sampling equipment will be decontaminated prior to use following the procedure described in the project FSP (ES, 1994b). The equipment will be protected from contamination with aluminum foil if not used immediately following decontamination.

Table 4.2 Sample Containers, Preservatives, and Holding Times for Aqueous Samples

| Parameters | Method | Sample Container | Preservative | Holding Time |
|---|----------------------------------|--|--|---|
| Volatile organic compounds | SW-8260 | Three 40-mL glass vials with Teflon-lined septa | HCl to pH < 2 (approx. 4 drops) Cool to 4°C | 14 days |
| Semivolatile organic compounds | SW-3550/ SW-8270 | Two 1-liter amber glass bottles with Teflon-lined lids | Cool to 4°C | Extract within 7 days of collection, and analyze within 40 days of extraction |
| Total ICP metals ¹ (recoverable) | SW-3050/ SW-6010 | One 1-L plastic bottle | HNO ₃ to pH < 2 Cool to 4°C | 180 days |
| Total arsenic (recoverable) | SW-7060 | One 500-mL plastic bottle ² | HNO ₃ to pH < 2 Cool to 4°C | 180 days |
| Total lead (recoverable) | SW-3020/ SW-7421 | One 500-mL plastic bottle ² | HNO ₃ to pH < 2 Cool to 4°C | 180 days |
| Total mercury (recoverable) | SW-7470 | One 500-mL plastic bottle ² | HNO ₃ to pH < 2 Cool to 4°C | 28 days |
| Total selenium (recoverable) | SW-7740 | One 500-mL plastic bottle ² | HNO ₃ TO pH < 2 Cool to 4°C | 180 days |
| Total chromium (VI) | SW-7195/ SW-7198 ³ | One 500-mL plastic bottle | Cool to 4°C | 24 hours |
| Total cyanide | SW-9010 | One 1-L plastic bottle | 0.6 grams of ascorbic acid NaOH to pH > 12 Cool to 4°C | 14 days |

¹ ICP (inductively coupled plasma) metals include antimony, barium, beryllium, cadmium, chromium, copper, nickel, silver, thallium, and zinc.

² Can be combined with ICP metals sample jar.

³ Specific method for chromium VI analyses will be determined after the laboratory has been selected.

Purging and sampling will be performed in a manner that minimizes the agitation of sediments in the well and formation. Equipment will not be allowed to free-fall into the well.

At least three well casing volumes of groundwater will be removed from each well prior to sampling. The temperature, pH, and conductivity will be measured and recorded after each borehole volume is removed during purging. The sample may be collected after three casing volumes have been removed and the temperature, pH, conductivity, color, and odor have stabilized. These parameters will be considered stable when pH varies to within ± 0.1 unit, temperature varies to within ± 0.5 °C, and conductivity varies to within ± 10 mhos/cm or less during the removal of at least three well volumes. If these parameters do not stabilize, the sample will be taken after six casing volumes have been removed. Calibration of the pH, temperature, and conductivity meters is discussed in the project field sampling plan (ES, 1994b).

Using a PVC bailer, groundwater samples will be collected in order of increasing contamination when possible. The clean well will be sampled first and the most contaminated well will be sampled last. Careful use of the bailer will minimize sample agitation and contact with air. A clean length of nylon cord will be used for raising and lowering the bailer at each well.

Groundwater samples will be analyzed for 129 priority pollutants, excluding dioxin, and asbestos. The samples will be analyzed for volatile organic compounds (SW-8260); semivolatile organic compounds (SW-8270); inductively coupled plasma (ICP) metals (SW-6010); total arsenic (SW-7060); total lead (SW-7421); total mercury (SW-7470); total selenium (SW-7740); hexavalent chromium (to be determined); and total cyanide (SW-9010).

Sampling information will be recorded on groundwater sampling forms and entered into the Installation Restoration Program Information Management System (IRPIMS) database. The sampling form will record the following:

- Site identification and well number
- Time and date
- Sounded total depth of the well, depth to water before and after purging, actual volume of water purged, the thickness of any floating hydrocarbon layer, depth to water before and after sampling
- Field measurements of pH, temperature, turbidity, and conductivity, and equipment calibration information
- Appearance of the purged water, the condition of the well, weather conditions, and other comments.

Required preservatives will be added to the sample bottles before sample collection. The pH of preserved samples will be checked in the field by pouring a small amount of sample onto pH paper. The range of the pH paper will closely bracket the expected pH. The paper must not touch the sample inside the container. The pH of acidified VOC samples will not be checked.

Samples will be collected directly from the bailer. Samples to be analyzed for VOCs will be collected first and immediately sealed in a container so that no headspace exists. Samples for volatile organic analyses will not be composited, homogenized, or filtered. Metals samples will not be filtered. According to EPA Guidance (1992), "data generated from filtered samples provide information on only the dissolved constituents that are present, because suspended materials are removed by the filtration process."

4.7 IDW SAMPLING

Investigation-derived wastes deemed hazardous based on photoionization detector (PID) readings, field observations, and/or historical data will be containerized and sampled for characterization. Samples will be analyzed for toxicity characterization leaching procedure (TCLP), volatile organic compounds, and metals. The extraction method for TCLP is SW-1311.

SECTION 5

SAMPLE CUSTODY

5.1 INTRODUCTION

A sample is physical evidence collected from a site or the environment. As such, handling must be documented in a manner that ensures analytical results are legally defensible. The documentation must provide all information necessary for proper analysis. The following sections describe custody procedures in the field as well as at the laboratories.

5.2 FIELD OPERATIONS

Sample custody documentation procedures described in this section will be followed throughout all sample collection at Tinker AFB during the SCGW RI/FS. Components of sample custody procedures include the use of field logbooks, sample labels, and chain-of-custody forms. ES sampling personnel must complete all proper forms and documents for each sample taken. After collection, containerization, and documentation, samples will be maintained under the custody of field team members until being relinquished to an overnight courier service. The sample shipment container must not be unsealed until the laboratory receives custody and breaks the seal.

A sample is considered under custody if:

- It is in actual possession of the sampling crew
- It is in the view of the sampling crew, after being in their physical possession
- It was in the physical possession of the sampling crew and then was secured to prevent tampering
- It is in a designated and identified secure area, such as in a locked trailer or vehicle.

5.2.1 Field Logbooks

Bound field logbooks will be maintained by the ES field supervisor and other team members to provide a daily record of significant events, observations, and measurements during the field investigation. All entries must be signed and dated.

All information pertinent to the field survey and/or sampling will be recorded in the logbooks or on field forms. The logbooks will be bound books with

consecutively numbered pages. Waterproof ink will be used in making all entries. Entries in the logbook will include at least the following:

General information:

- Names and titles of author and assistant, date and time of entry, and physical/environmental conditions during field activity
- Purpose of sampling activity
- Location of sampling activity
- Names and titles of field crew.

Sampling documentation:

- Sample media (e.g., surface water, soil)
- Description of sampling point
- Date and time of collection
- Sample identification number
- References for photographs of the sampling site

Other information:

- Names and titles of any site visitors
- Field observations and unusual field drilling conditions
- Any measurements made, such as pH, conductivity, temperature, turbidity including specific calibration data and documentation of field equipment (serial number, decontamination, etc.)

All original data recorded in field logbooks, sample labels, sample seals, and chain-of-custody (COC) records will be written with waterproof ink. None of the field logbooks or chain-of-custody documents will be destroyed or discarded, even if they are illegible or contain inaccuracies that require a replacement document.

If a previously recorded value is discovered to be incorrect, the wrong information will be crossed out in such a manner that it is still legible, the correct value will be written in, and the change will be initialed and dated. If the change is made by someone other than the original author, or if the change is made on a subsequent day, a reason for the change will be recorded at the then current active location in the logbook, with cross references.

5.2.2 Sample Labels

All physical samples obtained at the site will be placed in an appropriate sample container for preservation and shipment to the designated laboratory. Each sample will be identified with a separate identification label. The ice chests will be sealed with a custody seal. Example sample identification label and seal are shown in Figure 5.1. The tag should indicate if it is a split sample. The label will document:

- Analyses to be performed

Figure 5.1 Custody Seal and Sample Label

| | |
|------------------------------|------------------------------|
| CUSTODY SEAL | CUSTODY SEAL |
| _____ Signature | _____ Date |
| _____ Date | _____ Signature |
| Engineering- Science Inc. | Engineering- Science Inc. |

| | |
|--|--------------|
| ES ENGINEERING-SCIENCE, INC. AUSTIN, TEXAS | |
| SAMPLE I.D. | DATE |
| | TIME |
| ANALYSIS | SAMPLER |
| | PRESERVATIVE |

CHAIN-OF-CUSTODY
 SEAL AND
 SAMPLE LABEL

TINKER AIR FORCE BASE

- Sample identification number
- Source/location of sample
- Preservatives used
- Date
- Time (a four-digit number indicating the 24-hour-clock time of collection; for example, 1430 for 2:30 P.M.)
- Sampler's initials

5.2.3 Chain-of-Custody (COC) Forms

A COC form will be completed for each cooler of samples to track the samples and provide a written record of all persons contacting the samples. The COC form will list sample information (sample identification, type, date, and time of collection), analyses requested, and the signature of each person receiving and relinquishing the samples. An example COC form is shown in Figure 5.2.

Two copies of this record will accompany the samples to the laboratory. The laboratory will maintain one file copy, and the completed original will be returned to the project manager as a part of the final report. This record will be used to document sample custody transfer from the sampler, and to the laboratory.

Shipments will be sent by common carrier for overnight delivery, and a bill of lading will be prepared. Bills of lading will be retained as part of the permanent documentation. The bill number will be recorded on the chain-of-custody form.

5.2.4 Shipping of Samples

Samples will be shipped and delivered to the designated laboratory analysis daily. During sampling and sample shipment, the ES field team leader (or his designee) will contact the designated laboratory to inform them of shipments.

The samples will typically be shipped in ice chests by overnight carrier such as Federal Express. A chain-of-custody form will be placed within each chest. Each chest will be sealed with tamper-resistant tape and custody seals. The seals will be signed by the sample custodian shipping the samples.

5.3 LABORATORY OPERATIONS

A designated laboratory sample custodian will perform the following procedures in order to maintain a chain-of-custody once the samples have arrived at the laboratory.

- Check the original field prepared chain-of-custody and compare them with the labeled contents of each sample container for correctness and traceability.
- Check the temperature of a water sample enclosed with the environmental samples or check the temperature in the cooler. Record the temperature on the chain-of-custody form. Sample preservation will be documented in the

field. The laboratory shall check the chain-of-custody forms for the preservation noted by the field team.

- If there are no problems with sample integrity or chain-of-custody information, the sample custodian will sign, date, and note the time in the "laboratory receipt box" on the original chain-of-custody form. Pertinent information, such as shipping company name, should be recorded in the remarks section of the original chain-of-custody form.
- Once received, the sample custodian shall assign a laboratory work order number to the samples received from one shipment. The samples shall not be logged if the sample containers are mislabeled, broken, or if custody seals are broken. The project manager and laboratory project manager will be notified of any such situations immediately, and corrective actions will be implemented.
- The laboratory work number is used for identification of samples within the laboratory. Each sample will receive a unique laboratory work number when it is received by the laboratory. The sample custodian shall log the laboratory work number and the field sample identification into a laboratory sample custody log. The laboratory sample custody log may either be hard copy or computerized, depending on the laboratory.
- In addition to correlating laboratory work numbers with field sample identification, the laboratory log shall also contain the laboratory storage cooler number (if applicable) that the sample will be stored in while on the laboratory premises. Samples will be logged when they are removed and returned from storage for analysis.
- Upon analysis, a laboratory lot control number will be assigned to the sample. All samples within a given laboratory analysis group (e.g., samples sharing the same laboratory QC measurement samples) will have identical laboratory lot control numbers.

Laboratory lot control numbers should not be confused with field lot control numbers. The field lot control numbers will be based on associated field shipping cooler, trip blank, equipment blank, and ambient condition blank. As described in the IRPIMS data loading handbook (USAF, 1991), laboratory lot control numbers designate a batch of autonomous group of environmental samples and associated QC samples. This group is equivalent to the EPA SW-846 concept of an analytical batch.

Sample custody within the laboratory is maintained by a secure perimeter in which no unauthorized personnel are allowed entry without proper identification, i.e., visitors badge.

Samples received by the laboratory will be retained until after QA/QC auditing has been performed on the analytical results by both the laboratory and ES. Sample containers and remaining sample material should be disposed of appropriately when all analyses and related quality QA/QC work are completed. Disposal of the sample will be recorded on the sample custody log.

SECTION 6

CALIBRATION PROCEDURES, REFERENCE, AND FREQUENCY

6.1 INTRODUCTION

Instruments and equipment will be used to gather, generate, or measure environmental data both in the field and in the laboratory. These instruments will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications.

Records of calibration, repairs, or replacement will be filed and maintained by the designated laboratory or field personnel performing quality control activities. These records will be filed at the location where the work is performed and will be subject to a QA audit.

6.1.1 Preventive maintenance procedures

Equipment, instruments, tools, gages, and other items requiring preventive maintenance will be serviced in accordance with the manufacturer's specified recommendations and written procedures developed by the operators.

6.1.2 Schedules

Manufacturer's procedures identify the schedule for servicing critical items in order to minimize the downtime of the measurement system. It will be the responsibility of the operator to adhere to this maintenance schedule and to arrange any necessary and prompt service as required. Service to the equipment, instruments, tools, gages, etc., will be performed by qualified personnel. In the absence of any manufacturer's recommended maintenance criteria, a maintenance procedure will be developed by the operator based on experience and previous use of the equipment.

6.1.3 Records

Logs will be established to record maintenance and service procedures and schedules. All maintenance records will be documented and traceable to the specific equipment, instruments, tools, and gauges.

Records produced for laboratory instruments will be reviewed, maintained, and filed by the operators at the laboratories and by field personnel for equipment, instruments, tools, and gauges which are used at the site. The project QA officer will audit these records to verify complete adherence to these procedures.

6.1.4 Spare parts

A list of critical spare parts will be requested from the manufacturer and identified by the operator. These spare parts will be stored for availability and use in order to reduce the downtime.

6.2 FIELD CALIBRATION PROCEDURES

Calibration of the field instruments and equipment will be performed at least daily or at more frequent intervals as specified by the manufacturer. Calibrations will be reinitiated as appropriate after a period of elapsed time due to meals, work shift change, or damage incurred. Calibration standards used as reference standards will be traceable to the NIST or EPA-published standards/protocols. Suggested calibration methods and frequency are listed in Table 6.1.

Field measurements will be made using the following monitoring equipment:

- HNU photoionization detector (PID)
- Organic vapor analyzer (OVA)
- Sensidyne one-stroke pump and tubes
- HMX271 combustible gas indicator
- Hydac conductivity, pH, temperature meter
- Hermit 1000C transducer and datalogger
- Leupold and Stevens Model 420 Recorder
- Staff gage.

6.3 LABORATORY CALIBRATION PROCEDURES

Analysis of laboratory blank samples, duplicate samples, spiked blanks, and matrix blanks will be performed where possible to document the effectiveness of calibration procedures. The number, frequency, and type of these samples will be sufficient to verify the success of the calibration program.

The laboratory will perform instrument calibration consistent with the method and frequency suggested either by the manufacturer or the analysis method. In the event that a standard operating procedure mandates specific preventive maintenance procedures that are more frequent than recommended by the manufacturer, then the frequency specified in the method will be followed.

6.3.1 Lead Atomic Absorption Spectroscopy – Furnace Technique (SW-7421)

Calibration is performed using a minimum of 3 calibration standards and a blank. Standards shall be prepared as noted in the method, and the concentrations of the standards will span the range of concentrations encountered in the samples. The concentration of the lowest standard will be no greater than a factor of 2 above the maximum quantitation limits (MQLs). Fresh calibration standard solutions will be prepared each time the calibration procedure is performed.

Table 6.1 Calibration Methods and Frequency
Tinker AFB SCGW RI/FS

| Parameter | Equipment | Calibration | Source of Calibration Standards | Equipment Maintenance | Equipment Decontamination |
|----------------------------|--|---|---|---|--|
| Volatile organic compounds | Photoionization detector (PID). | Daily according to manufacturer's instructions with ambient air (considered 0 mg/L) and isobutylene gas (100 mg/L). | Commercially available, premixed, in cylinders. | Avoid prolonged use in humid environments; keep probe away from dirt or free water; recharge battery. | Replace instrument filter; clean lamp. |
| VOCs | OVA. | Daily, and every 2-3 hours during use, methane in air. | Scott specialty gases. | Charge batteries, keep probe out of liquids. | Not applicable. |
| Explosive gases | Combustible gas indicator. | Daily with known gas and concentration; daily testing in known explosive environment (gas tank) and zero adjustment in clean environment. | Commercially available, battery. | Keep inlet away from dirt or free liquids, recharge battery. | Not applicable. |
| pH | Hydac pH temperature, and conductivity meter. | Daily with known pH buffer solutions. | Commercially available. | Keep instrument face dry. Keep pH probe moist. Replace battery when necessary. | Squirt pH probe with water after every use. |
| Conductivity | Hydac pH, temperature, and conductivity meter. | Daily with Solution of known conductance. | Commercially available. | Keep instrument face dry. Replace battery when necessary. | Clean sample cup with water and paper towel after every use. |
| Water level | Water level indicator. | Check against steel tape. | Commercially available. | Replace battery when necessary. | Squirt probe with water after every use. |

Calibrations are performed at a minimum frequency of once per day and each time the instrument is set up. From the analysis of the standards, a calibration curve is prepared. The acceptance criteria for the calibration is that the correlation coefficient for the calibration curve be ≥ 0.995 . Failure to meet this requirement will necessitate corrective action to solve the problem and recalibration of the instrument.

Following calibration, a calibration check standard and calibration blank are analyzed. The calibration check standard will be prepared from different source materials than those used to prepare the initial calibration standards. The calibration check standard analysis must agree within 20 percent of the expected value as given by the calibration curve. The calibration blank results must be less than the detection limit. Failure to meet these requirements will necessitate corrective action to solve the problem and recalibration of the instrument.

A calibration check standard and calibration blank are analyzed after every 10 samples, or once every 2 hours, whichever is more frequent. All sample data must be bracketed by calibration check standard data and calibration blank data which meet the criteria specified above. Failure to meet these criteria will necessitate corrective action to solve the problem, recalibration of the instrument, and reanalysis of the associated samples (occurring both before and after the calibration check standard which is out of control). Laboratory control samples (digested standards) will be analyzed in duplicate for every batch of samples (maximum of 20 samples per batch). Laboratory sample control limits will be reported by the laboratory. Failure to meet these criteria will necessitate corrective action to solve the problem and the reanalysis of all samples in the batch. This may necessitate preparing new samples and/or recalibrating the instrument.

6.3.2 Volatile and Semivolatile Organic by Gas Chromatography/Mass Spectrometry (SW-8260, SW-8270)

Calibration for each method will generally follow the guidelines set forth in the method. The following internal standards will be used: bromochloromethane, 1,4-difluorobenzene, and chlorobenzene- d_5 for Method SW-8260; and 1,4-dichlorobenzene- d_4 , naphthalene- d_8 , acenaphthene- d_{10} , phenanthrene- d_{10} , chrysene- d_{12} , and perylene- d_{12} for Method SW-8270. The following instrument performance check compounds will be used for each method: 4-bromofluorobenzene (BFB) for Method SW-8260 and decafluorotriphenylphosphine (DFTPP) for Method SW-8270. The acceptance criteria for frequency of use of these compounds and for their abundance of key ions are specified in the methods (see Tables 6.2 and 6.3).

Calibration for each gas chromatograph/ mass spectrometry (GC/MS) method will involve the use of a minimum of 5 calibration standards. The concentrations of the standards will span the range of concentrations encountered in the samples. The concentration of the lowest standard will be no greater than a factor of 2 above the project reporting level. Acceptance criteria for the initial calibration and for

**Table 6.2 BFB Key Ions and Ion Abundance Criteria
for GC/MS Tuning, Tinker AFB SCGW RI/FS**

| Mass | Ion Abundance Criteria |
|-------------|---|
| 50 | 15.0 - 40.0 percent of mass 95 |
| 75 | 30.0 - 66.0 percent of mass 95 |
| 95 | Base peak, 100 percent relative abundance |
| 96 | 5.0 - 9.0 percent of mass 95 |
| 173 | Less than 2.00 percent of mass 174 |
| 174 | Greater than 50 percent of mass 95 |
| 175 | 5.0 - 9.0 percent of mass 174 |
| 176 | Greater than 95.0 percent but less than 101.0 percent of mass 174 |
| 177 | 5.0 - 9.0 percent of mass 176 |

Notes: All ion abundances must be normalized to m/z 95, the normal base peak, even though the ion abundance of m/z 174 may be up to 120 percent of m/z 95.

BFB = bromofluorobenzene

**Table 6.3 DFTPP Key Ions and Ion Abundance Criteria
for GC/MS Tuning, Tinker AFB SCGW RI/FS**

| Mass | Ion Abundance Criteria |
|------|---|
| 51 | 30.0 - 60.0 percent of mass 198 |
| 68 | Less than 2.0 percent of mass 69 |
| 70 | Less than 2.0 percent of mass 69 |
| 127 | 40.0 - 60.0 percent of mass 198 |
| 197 | Less than 1.0 percent of mass 198 |
| 198 | Base peak, 100 percent relative abundance |
| 199 | 5.0 - 9.0 percent of mass 198 |
| 275 | 10.0 - 30.0 percent of mass 198 |
| 365 | Greater than 1.0 percent of mass 198 |
| 441 | Present, but less than mass 443 |
| 442 | Greater than 40 percent of mass 198 |
| 443 | 17.0 - 23.0 percent of mass 442 |

Notes: All ion abundances must be normalized to m/z 198, the normal base peak, even though the ion abundance of m/z 174 may be up to 120 percent of m/z 95.

DFTPP = decafluorotriphenylphosphine

continuing calibration checks will follow the guidelines and limits set forth in the method.

For the SW-8260 initial calibration, response factors will be calculated for each compound relative to one of the internal standards. The maximum percent relative standard deviation (RSD) for the calibration check compounds is 30 percent.

For the SW-8270 initial calibration, the minimum average response factor for the system performance check compounds is 0.050 and the maximum percent relative standard deviation for the calibration check compounds is 30 percent.

For the SW-8260 continuing calibrations, the minimum response factor for the system performance check compounds are 0.1 for chloromethane and 1,1-dichloroethane, 0.25 for bromoform, and 0.3 for chlorobenzene and 1,1,2,2-tetrachloroethane; and the maximum percent difference is 20 percent. For the continuing calibration for Method SW-8270, the minimum response factor for the system performance check compounds is 0.050 and the maximum percent difference is 30 percent. The guidance for corrective action for not meeting these criteria are described in each method. Initial calibration and continuing calibration checks are performed at intervals as specified in the methods.

6.3.3 Hexavalent Chromium by Coprecipitation (SW-7195)

Calibration procedures will follow the guidelines specified in the SW-846 guidance document, at a minimum. Specific calibration procedures will be determined when a laboratory has been subcontracted. In general, at the time of analysis, a blank and a series of at least four chromium III calibration standards that will adequately bracket the sample will be prepared. Calibration standards will be prepared fresh weekly, or as needed. Calibration curves must be composed of a minimum of a blank and three standards. A calibration curve should be made for every hour of continuous sample analysis. Calibration will be verified with an independently prepared check standard every 15 samples.

6.3.4 Colorimetric Hexavalent Chromium (SW-7196)

Calibration procedures will follow the guidelines specified in the SW-846 guidance document. The chromium standards used in preparation of the calibration curve will be treated by the same procedure as the sample. The color of the standards will also be developed as for the sample. Type II reagent-grade water will be used as reference. The absorbance readings of the standards will be corrected by subtracting the absorbance of a reagent blank carried through the method. The calibration curve will be constructed by plotting corrected absorbance values against concentrations of chromium VI. The calibration will be verified with an independently prepared check standard every fifteen samples. A minimum of one blank per sample will be employed to determine if contamination or any memory effects are occurring.

6.3.5 Metals by Inductively Coupled Plasma (ICP) - Atomic Emission Spectroscopy (SW-6010)

Calibration is performed using a calibration blank and a minimum of one calibration standard solution. Calibration standards will have been initially verified using a quality control sample and will be monitored weekly for stability. The calibration procedure will follow the guidelines specified in the method. Calibration of the instrument is performed daily and each time the instrument is set up. Prior to the analysis of the samples, an instrument check standard and calibration blank are analyzed. The results of the instrument check standard must agree to within 10 percent of the expected value. The results of the calibration blank must agree within three standard deviations of the mean blank value of the initial calibration.

Corrective actions for failure to meet these criteria are described in the SW-846 method. Instrument check standards and calibration blanks are analyzed after every ten samples. All sample data must be bracketed by instrument check standard data and calibration blank data which meet the criteria specified above. Corrective actions for failure to meet these criteria are described in the method. An interference check sample must be analyzed at the beginning and end of each sample analysis run, or a minimum of twice per 8-hour working period, whichever is more frequent. The results for the interference check sample must fall within ± 20 percent of the expected value. Failure to meet this criteria for the interference check sample will necessitate a recalibration of the instrument and reanalysis of the samples included in the sample analysis run.

6.3.6 Arsenic Atomic Absorption Spectroscopy - Furnace Technique (SW-7060)

Elemental arsenic and many of its compounds are volatile; therefore, samples may be subject to losses of arsenic during sample preparation (EPA, 1986). Spike samples and relevant standard reference materials will be processed to determine if the chosen dissolution method is appropriate.

Calibration is performed using a minimum of three calibration standards and a blank. Standards shall be prepared as described in the method. A calibration curve will be prepared for every hour of continuous sample analysis. Samples will be diluted if they are more concentrated than the highest standard or if they fall on the plateau of a calibration curve. A minimum of one blank per sample batch will be used to determine if contamination or any memory effects are occurring.

Following calibration, a calibration check standard and calibration blank will be analyzed. The calibration check standard will be prepared from different source materials than those used to prepare the initial calibration standards. The calibration will be verified every fifteen samples. All sample data must be bracketed by calibration check standard data and calibration blanks data which meet criteria specified in the method. Failure to meet these criteria will necessitate corrective action to solve the problem, recalibration of the instrument, and reanalysis of the associated samples (occurring both before and after the calibration check standard which is out of control).

6.3.7 Mercury by Manual Cold-Vapor Technique (SW-7470, SW-7471)

Method SW-7470 and SW-7471 are cold-vapor atomic absorption techniques. Method SW-7470 is for liquids and SW-7471 is for solids. Calibration for each method will follow the guidelines set forth in the method.

Calibration is performed using a minimum of three calibration standards and a blank. Standards shall be prepared as described in the method. A calibration curve will be prepared for every hour of continuous sample analysis. Samples will be diluted if they are more concentrated than the highest standard or if they fall on the plateau of a calibration curve. A minimum of one blank per sample batch will be used to determine if contamination or any memory effects are occurring.

Following calibration, a calibration check standard and calibration blank will be analyzed. The calibration check standard will be prepared from different source materials than those used to prepare the initial calibration standards. The calibration will be verified every fifteen samples. All sample data must be bracketed by calibration check standard data and calibration blanks data which meet criteria specified in the method. Failure to meet these criteria will necessitate corrective action to solve the problem, recalibration of the instrument, and reanalysis of the associated samples (occurring both before and after the calibration check standard which is out of control).

6.3.8 Selenium Atomic Absorption Spectroscopy-Furnace Technique (SW-7740)

Elemental selenium and many of its compounds are volatile; therefore, samples may be subject to losses of selenium during sample preparation (EPA, 1986). Spike samples and relevant standard reference materials will be processed to determine if the chosen dissolution method is appropriate.

Calibration is performed using a minimum of three calibration standards and a blank. Standards shall be prepared as described in the method. A calibration curve will be prepared for every hour of continuous sample analysis. Samples will be diluted if they are more concentrated than the highest standard or if they fall on the plateau of a calibration curve. A minimum of one blank per sample batch will be used to determine if contamination or any memory effects are occurring.

Following calibration, a calibration check standard and calibration blank will be analyzed. The calibration check standard will be prepared from different source materials than those used to prepare the initial calibration standards. The calibration will be verified every fifteen samples. All sample data must be bracketed by calibration check standard data and calibration blanks data which meet criteria specified in the method. Failure to meet these criteria will necessitate corrective action to solve the problem, recalibration of the instrument, and reanalysis of the associated samples (occurring both before and after the calibration check standard which is out of control).

6.3.9 Colorimetric Total and Amenable Cyanide (SW-9010)

Calibration procedures will follow the guidelines specified in the SW-846 guidance document. The cyanide standards will be distilled in the same manner as the samples. At least two standards (a high and a low) will be distilled and compared with similar values on the curve to ensure that the distillation technique is reliable. If distilled standards do not agree within ± 10 percent of the undistilled standards, the cause of the apparent error will be determined before proceeding. A standard curve will be prepared by plotting absorbances of standards versus cyanide concentrations.

A minimum of one blank per sample batch will be used to determine if contamination or any memory effects are occurring. Calibration will be verified with an independently prepared check standard every fifteen samples. One spike duplicate sample will be run for every ten samples.

SECTION 7

ANALYTICAL PROCEDURES

7.1 INTRODUCTION

The analytical program for this RI/FS consists of laboratory analysis of soil, sediment, and groundwater samples. Analytical methods used shall be approved EPA standard methods and National Institute of Occupational Safety and Health (NIOSH) analytical methods when available. Methods and procedures described in U.S. EPA Guidance SW-846 will be used for all applicable samples.

7.2 IDENTIFICATION OF METHODS

All groundwater samples collected during this investigation will be analyzed for 129 Priority Pollutants (except asbestos and dioxin). Table 7.1 is a list of the 129 Priority Pollutants. In addition, all samples will be analyzed for hexavalent chromium. Sediment samples will be analyzed for cation exchange capacity (CEC), total organic carbon (TOC), and pH. Soil and sediment samples will be analyzed for EPA Target Compound List (TCL) compounds (except pesticides), arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. Some soil samples will be analyzed for geotechnical parameters. Conductivity, pH, temperature, and turbidity of water samples will be measured in the field. The methods for chemical and geotechnical analyses are presented in Table 7.2.

7.3 DETECTION AND QUANTITATION LIMITS

This section describes the terminology, procedures, and laboratory established values for detection and quantitation limits. Definitions for method detection limits, and sample detection limits are described below.

Limit of Detection (LOD)

The limit of detection (LOD) is the measured concentration level using a specific method at which a specific analyte in a sample matrix can be reported as being present with a confidence level of 99 percent. Table 7.3 lists, by method, the analytes and associated contracted maximum LODs for soil and water samples. The selected laboratory shall meet the maximum LODs listed in this table. If the approved LOD for a particular analyte cannot be met due to matrix and/or other interferences, the laboratory will report the actual detection limit achieved and

Table 7.1 The 129 Priority Pollutants

Volatile organic compounds (31)

| | |
|--------------------------|--------------------------|
| Acrolein | 1,1-Dichloroethene |
| Acrylonitrile | 1,2-Dichloroethane |
| Benzene | Ethylbenzene |
| bis (Chloromethyl) ether | Methylene chloride |
| Bromoform | Methyl bromide |
| Carbon tetrachloride | Methyl chloride |
| Chlorobenzene | 1,2-Trans-dichloroethene |
| Chlorodibromomethane | 1,1,2-Tetrachloroethane |
| 2-Chloroethylvinyl ether | Tetrachloroethene |
| Chloroethane | 1,1,1-Trichloroethane |
| Chloroform | 1,1,2-Trichloroethane |
| Dichlorobromomethane | Trichloroethene |
| Dichlorofluoromethane | Trichlorofluoromethane |
| 1,2-Dichloropropane | Toluene |
| 1,3-Dichloropropene | Vinyl chloride |
| 1,1-Dichloroethane | |

Base-neutral extractable organic compounds (46)

| | |
|-------------------------------|---------------------------|
| Acenaphthene | Diethyl phthalate |
| Acenaphthylene | Dimethyl phthalate |
| Anthracene | 2,4-Dinitrotoluene |
| Benzidine | 2,6-Dinitrotoluene |
| Benzo(a)anthracene | Di-n-butyl phthalate |
| Benzo(a)pyrene | Di-n-octyl phthalate |
| 3,4-Benzofluoranthene | 1,2-Diphenylhydrazine |
| Benzo(ghi)perylene | Fluoranthene |
| Benzo(k)fluoranthene | Fluorene |
| bis (2-Chloroethoxy) methane | Hexachlorobenzene |
| bis (2-Chloroethyl) ether | Hexachlorobutadiene |
| bis (2-Chloroisopropyl) ether | Hexachlorocyclopentadiene |
| bis (2-Ethylhexyl) phthalate | Hexachloroethane |
| 4-Bromophenyl phenyl ether | Ideno(1,2,3-cd)pyrene |
| Butyl benzyl phthalate | Isophorone |
| 2-Chloronaphthalene | Naphthalene |
| 4-Chlorophenyl phenyl ether | Nitrobenzene |
| Chrysene | N-nitrosodimethylamine |
| Dibenzo(a,h)anthracene | N-nitrosodi-n-propylamine |
| 1,2-Dichlorobenzene | N-nitrosodiphenylamine |
| 1,3-Dichlorobenzene | Phenanthrene |
| 1,4-Dichlorobenzene | Pyrene |
| 3,3' -Dichlorobenzidine | 1,2,4-Trichlorobenzene |

Acid extractable organic compounds (11)

| | |
|----------------------|-----------------------|
| 2-Chlorophenol | 4-Nitrophenol |
| 2,4-Dichlorophenol | Parachlorometa cresol |
| 2,4-Dimethylphenol | Pentachlorophenol |
| 4,6-Dinitro-o-cresol | Phenol |
| 2,4-Dinitrophenol | 2,4,6-Trichlorophenol |
| 2-Nitrophenol | |

Table 7.1, continued

Pesticides and PCB'S (26)

| | |
|-----------------|-----------------------------|
| Aldrin | Endosulfan sulfate |
| a-BHC | Heptachlor |
| b-BHC | Heptachlor epoxide |
| q-BHC | PCB-1016 |
| w-BHC | PCB-1221 |
| Chlordane | PCB-1232 |
| 4,4' -DDD | PCB-1242 |
| 4,4' -DDE | PCB-1248 |
| 4,4' -DDT | PCB-1254 |
| Dieldrin | PCB-1260 |
| Endrin | 2,3,7,8-Tetrachlorodibenzo- |
| Endrin aldehyde | p-dioxin (TCDD) |
| A-endosulfan | Toxaphene |
| B-endosulfan | |

Metals (13)

| | |
|-----------|----------|
| Antimony | Mercury |
| Arsenic | Nickel |
| Beryllium | Selenium |
| Cadmium | Silver |
| Chromium | Thallium |
| Copper | Zinc |
| Lead | |

Miscellaneous (2)

| | |
|----------|----------------|
| Asbestos | Total cyanides |
|----------|----------------|

Table 7.2 Methods of Chemical and Geotechnical Analysis for Soil and Water Samples
Tinker AFB SCGW RI/FS

| Analysis | Method Number | Matrix | Reference |
|---|---------------------|----------------|-----------|
| Volatile organic compounds | SW-8260 | Soil and water | 1 |
| Semivolatile organic compounds | SW-3520/SW-8270 | Soil | 1 |
| | SW-3550/SW-8270 | Water | 1 |
| ICP metals (antimony, beryllium, cadmium, total chromium, copper, nickel silver, thallium, zinc)* | SW-3050/SW-6010 | Soil | 1 |
| | SW-3005/SW-6010 | Water | 1 |
| Arsenic | SW-3050/SW-7060 | Soil | 1 |
| | SW-7060 | Water | 1 |
| Chromium VI | SW-7195 - SW-7198** | Water | 1 |
| | SW-7195 - SW-7198** | Soil | 1 |
| Lead | SW-3050/SW-7421 | Soil | 1 |
| | SW-3020/SW-7421 | Water | 1 |
| Mercury | SW-7470 | Soil | 1 |
| | SW-7470 | Water | 1 |
| Selenium | SW-3050/SW-7741 | Soil | 1 |
| | SW-7740 | Water | 1 |
| Cation exchange capacity | SW-9080 | Soil | 1 |
| Total organic carbon | SW-9060 | Soil | 1 |
| pH | SW-9045 | Soil | 1 |
| Total cyanide | SW-9010 | Soil | |
| | SW-9010 | Water | 1 |
| Atterberg limits | ASTM D4318 | Soil | 2 |
| Permeability | ASTM D2434 | Soil | 2 |
| Soil moisture | ASTM D2216 | Soil | 2 |
| Particle size distribution | ASTM D422 | Soil | 2 |
| Organic content | ASTM D2974 | Soil | 2 |

References:

1. U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste*, SW-846, 1986.
2. American Society for Testing and Materials, *1993 Annual Book of Standards*.

* Only water samples will be analyzed for antimony, beryllium, and thallium.

** Specific method for chromium VI analyses will be determined after the laboratory has been selected.

Table 7.3 Limits of Detection (LOD)
Tinker AFB SCGW RI/FS

| Method Number and Description/Analyte | Maximum LODs | |
|---|--------------|--------------|
| | Soil (mg/kg) | Water (µg/L) |
| SW-8260 - Volatile organic compounds (priority pollutants and contaminants of concern) | | |
| Acrolein | 10.0 | 0.1 |
| Acrylonitrile | 10.0 | 0.1 |
| Benzene | 3.0 | 0.1 |
| bis(Chloromethyl) ether | NA | NA |
| Bromoform | 5.0 | 0.1 |
| Carbon tetrachloride (Freon 10) | 3.0 | 0.1 |
| Chlorobenzene | 5.0 | 0.1 |
| Chloroethane | 10.0 | 0.1 |
| 2-Chloroethyl vinyl ether | 10.0 | 0.1 |
| Chloroform | 5.0 | 0.1 |
| Chloromethane (methyl chloride) | 10.0 | 0.1 |
| cis-1,2-Dichloroethene | NA | NA |
| Dibromochloromethane (chlorodibromomethane) | 5.0 | 0.1 |
| 1,2-Dichlorobenzene | NA | 0.1 |
| 1,3-Dichlorobenzene | NA | 0.1 |
| 1,4-Dichlorobenzene | NA | 0.1 |
| Dichlorobromomethane (Bromodichloromethane) | 5.0 | 0.1 |
| 1,1-Dichloroethane | 5.0 | 0.1 |
| 1,2-Dichloroethane | 5.0 | 0.1 |
| 1,1-Dichloroethene | 3.0 | 0.1 |
| 1,2-Dichloroethene | NA | NA |
| 1,2-trans-Dichloroethene | 5.0 | 0.1 |
| Dichlorodifluoromethane | NA | NA |
| 1,2-Dichloropropane | 5.0 | 0.1 |
| cis-1,3-Dichloropropene | 5.0 | 0.1 |
| trans-1,3-Dichloropropene | 5.0 | 0.1 |
| Ethylbenzene | 5.0 | 0.1 |
| Methyl bromide | NA | NA |
| Methyl chloride | NA | NA |
| Methylene chloride | 5.0 | 0.1 |
| 1,1,2,2-Tetrachloroethane | 5.0 | 0.1 |
| Tetrachloroethene | 3.0 | 0.1 |
| Toluene | 5.0 | 0.1 |
| 1,1,1-Trichloroethane | 5.0 | 0.1 |
| 1,1,2-Trichloroethane | 5.0 | 0.1 |
| Trichloroethene | NA | NA |
| Trichlorofluoromethane | 10.0 | 0.1 |
| 1,2,4-Trimethylbenzene | NA | NA |
| Vinyl chloride | 10.0 | 0.1 |
| Total xylenes (o) | 5.0 | 0.1 |
| Total xylenes (m, p) | 5.0 | 0.1 |

Table 7.3, continued

| Method Number and Description/Analyte | Maximum LODs | |
|---|--------------|--------------|
| | Soil (mg/kg) | Water (µg/L) |
| SW-8270-Semivolatile organic compounds (priority pollutants and contaminants of concern) | | |
| <u>Base/neutral extractables</u> | | |
| Acenaphthene | 10.0 | 0.5 |
| Acenaphthylene | 10.0 | 0.5 |
| Anthracene | 10.0 | 0.5 |
| Benzidine | 50.0 | 2.5 |
| Benzo(a)anthracene | 10.0 | 0.5 |
| Benzo(b)fluoranthene | 10.0 | 0.5 |
| Benzo(k)fluoranthene (3,4-Benzofluoranthene) | 10.0 | 0.5 |
| Benzo(g,h,i)perylene | 10.0 | 0.5 |
| Benzo(a)pyrene | 10.0 | 0.5 |
| bis(2-Chloroethoxy)methane | 10.0 | 0.5 |
| bis(2-Chloroethyl)ether | 10.0 | 0.5 |
| bis(2-Chloroisopropyl)ether | 10.0 | 0.5 |
| bis(2-Ethylhexyl)phthalate | 10.0 | 0.5 |
| 4-Bromophenyl phenyl ether | 10.0 | 0.5 |
| Butyl benzyl phthalate | 10.0 | 0.5 |
| 2-Chloronaphthalene | 10.0 | 2.5 |
| 4-Chlorophenyl phenyl ether | 10.0 | 0.5 |
| Chrysene | 10.0 | 0.5 |
| Dibenzo(a,h)anthracene | 10.0 | 0.5 |
| Di-n-Butylphthalate | 10.0 | 0.5 |
| 1,2-Dichlorobenzene | 5.0 | 0.5 |
| 1,3-Dichlorobenzene | 5.0 | 0.5 |
| 1,4-Dichlorobenzene | 5.0 | 0.5 |
| 3,3'-Dichlorobenzidine | 20.0 | 0.5 |
| Diethyl phthalate | 20.0 | 0.5 |
| Dimethyl phthalate | 10.0 | 0.5 |
| 2,4-Dinitrotoluene | 10.0 | 0.5 |
| 2,6-Dinitrotoluene | 10.0 | 0.5 |
| Di-n-octyl phthalate | 10.0 | 0.5 |
| 1,2-Diphenylhydrazine | 50.0 | 2.5 |
| Fluoranthene | 10.0 | 0.5 |
| Fluorene | 10.0 | 0.5 |
| Hexachlorobenzene | 10.0 | 0.5 |
| Hexachlorobutadiene | 10.0 | 0.5 |
| Hexachlorocyclopentadiene | 10.0 | 0.5 |
| Hexachloroethane | 10.0 | 0.5 |
| Indeno(1,2,3-cd)pyrene | 10.0 | 0.5 |
| Isophorone | 10.0 | 0.5 |
| Naphthalene | 10.0 | 0.5 |

Table 7.3, continued

| Method Number and Description/Analyte | Maximum LODs | |
|--|--------------|---------------------------|
| | Soil (mg/kg) | Water ($\mu\text{g/L}$) |
| <u>Base/neutral extractables, continued</u> | | |
| Nitrobenzene | 10.0 | 0.5 |
| n-Nitrosodimethylamine | NA | NA |
| n-Nitroso-di-n-propylamine | 10.0 | 0.5 |
| n-Nitrosodiphenylamine | 10.0 | 0.5 |
| Phenanthrene | 10.0 | 0.5 |
| Pyrene | 10.0 | 0.5 |
| 1,2,4-Trichlorobenzene | 10.0 | 0.5 |
| <u>Acid extractables</u> | | |
| 4-Chloro-3-methylphenol | 10.0 | 0.5 |
| 2-Chlorophenol | 10.0 | 0.5 |
| 2,4-Dichlorophenol | 10.0 | 0.5 |
| 2,4-Dimethylphenol | 10.0 | 0.5 |
| 4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol) | 50.0 | 1.5 |
| 2,4-Dinitrophenol | 50.0 | 1.5 |
| 2-Methylphenol | 10.0 | 0.5 |
| 4-Methylphenol | 10.0 | 0.5 |
| 2-Nitrophenol | 50.0 | 0.5 |
| 4-Nitrophenol | NA | NA |
| Parachlorometa cresol | NA | NA |
| Pentachlorophenol | 30.0 | 1.5 |
| Phenol | 10.0 | 0.5 |
| 2,4,5-Trichlorophenol | 50.0 | 1.5 |
| 2,4,6-Trichlorophenol | 10.0 | 0.5 |
| Pesticides and PCBs | | |
| Aldrin | NA | NA |
| a-BHC | NA | NA |
| b-BHC | NA | NA |
| q-BHC | NA | NA |
| w-BHC | NA | NA |
| Chlorodane | NA | NA |
| 4,4' -DDD | NA | NA |
| 4,4' -DDE | NA | NA |
| 4,4' -DDT | NA | NA |
| Dieldrin | NA | NA |
| a-Endosulfan | NA | NA |
| b-Endosulfan | NA | NA |
| Endosulfan sulfate | NA | NA |
| Endrin | NA | NA |
| Endrin aldehyde | NA | NA |
| Heptachlor | NA | NA |
| Heptachlor epoxide | NA | NA |
| PCB-1242 | NA | NA |
| PCB-1254 | NA | NA |
| PCB-1221 | NA | NA |
| PCB-1232 | NA | NA |
| PCB-1248 | NA | NA |
| PCB-1260 | NA | NA |
| PCB-1016 | NA | NA |
| Toxaphene | NA | NA |

Table 7.3, continued

| Method Number and Description/Analyte | Maximum LODs | |
|--|---------------------|---------------------|
| | Soil (mg/kg) | Water (µg/L) |
| SW-9010 - Total cyanides | 20.0 | 20.0 |
| | <u>Soil (mg/kg)</u> | <u>Water (µg/L)</u> |
| SW-6010 - Metals | | |
| Antimony | NA | 20 |
| Barium | NA | 10 |
| Beryllium | NA | 0.2 |
| Cadmium | NA | 5 |
| Total Chromium | NA | 30 |
| Copper | NA | 3 |
| Nickel | NA | 40 |
| Silver | NA | 3 |
| Thallium | NA | 50 |
| Zinc | NA | 1 |
| SW-7195-7198 - Chromium VI | NA | NA |
| SW-7421 - Lead | NA | 0.5 |
| SW-7060 - Arsenic | NA | 0.5 |
| SW-7470/7471 - Mercury | NA | NA |
| SW-7740 - Selenium | NA | 0.5 |

NA = not applicable (not determined by basic statement of work or analyte will not be analyzed for)

provide documentation to substantiate the matrix interferences (e.g., results of standard additions, QC check sample analyses, etc.) as an attachment to the test report.

Sample Detection Limit (SDL)

Sample detection limits (SDL) are defined as the LOD multiplied by the dilution factor required to analyze the sample, and corrected for moisture or sample size. Procedures for determining LODs and SDLs are described in the following section.

7.4 PROCEDURES

The LOD determinations are performed semi-annually, quarterly, or annually, depending on the method. Seven replicates are prepared by spiking distilled, deionized, organic free water with a concentration at or near the estimated LOD level of an analyte. The replicates are then analyzed. The test measurement's standard deviation is then determined.

The standard deviation is multiplied by the t-distribution that corresponds to a 99 percent confidence level. For this case (seven replicates) there are 6 degrees of freedom, so the t-distribution is 3.143. The resulting value is considered to be the LOD for the analyte.

SDLs will be calculated as follows for all water samples:

$$\text{SDL} = \text{LOD} * \text{DF}$$

where

SDL = sample detection limit

LOD = limit of detection

DF = dilution factor (= 1 for no dilution)

For soil samples requiring a conversion to a dry weight basis, the following calculations will be made:

$$\text{SDL} = \frac{(\text{LOD} * \text{DF}) 100\%}{100 - \% \text{ M}}$$

where

SDL = sample detection limit

LOD = limit of detection

DF = dilution factor (= 1 for no dilution)

%M = percent moisture

Soil samples may also be corrected for actual sample quantity analyzed. These adjustments will be made internally by the laboratory.

SECTION 8

DATA REDUCTION, VALIDATION, AND REPORTING

This section describes the data management, data reduction, data quality assessment, and data validation/reporting functions associated with QA and QC.

8.1 DATA REDUCTION

This section describes both field and laboratory data reduction. Data generated under this project will derive from two sources, field measurement and sampling, and sample analyses will be performed by a contract laboratory.

8.1.1 Field Data Reduction

Field measurements will be made by field geologists, engineers, scientists, and technicians. Field data will be recorded to provide a permanent record of field activities, and the information will be noted in the technical report using standard reporting units.

Stream gage data collection and reduction will follow methods described in *General Procedures for Gaging Streams* (USGS, 1969), *Discharge Measurements at Gaging Stations* (USGS, 1976), and *Computation of Continuous Records of Streamflow* (USGS, 1983).

During processing of field data, validation checks will be performed by individuals designated by the project manager. The purpose of these checks is to identify "outliers" that is, data which do not conform to the pattern established by other observations. Because of the limited number of observations, detailed statistical analysis of the data to be obtained during this program is not feasible and the principal method of validation will be routine checks to assure that data are correctly transcribed and that reported identification codes and sampling information match the corresponding information in the field records. In addition, data will be compared against those obtained in previous investigations (where available) and against applicable standards and guidelines.

Although outliers may be the result of transcription errors or instrumental breakdowns, they may also be manifestations of a greater degree of spatial or temporal variability than expected. Therefore, after an outlier has been identified, a decision must be made concerning its further use. Obvious mistakes in data will be corrected when possible, and the correct value will be inserted. If the correct value cannot be obtained, the data may be excluded. An attempt will be made to explain the existence of the outlier. If no plausible explanation can be found for the outlier,

it may be excluded, but a note to that effect will be included in the report. Also, an attempt will be made to determine the effect of the outlier when both included and excluded in the data set and the results will be discussed in the report.

8.1.2 Laboratory Data Reduction

The first step in laboratory data reduction is data processing. In general, data will be processed by an analyst in one or more of the following ways:

- Manual calculations of instrument calibration and sample results (typically performed on method-specific bench sheets)
- Manual input of raw data for subsequent computer processing
- Direct acquisition and processing of raw data by a computer.

Regardless of how data processing is done, sufficient documentation will be presented to allow another analyst to review and check the work.

Raw data are entered in bound laboratory notebooks. The data entered are sufficient to document all factors used to arrive at the reported value for each sample. Calculations may include factors such as sample dilution ratios or conversion to dry-weight basis for solid samples.

8.2 DATA QUALITY ASSESSMENT

Upon completion of all field and analytical work specified in the Tinker AFB SCGW RI/FS SOW, ES will assess the quality of data generated as a result of these activities. Both field and laboratory data will be assessed.

8.2.1 Review of Field Records

The ES field team leaders, project quality assurance officer, and project manager shall ensure that all field records are evaluated for the following:

- Completeness of field records. The check of field record completeness shall ensure that all requirements for field activities in the SOW have been fulfilled, complete records exist for each field activity, and that the procedures specified in this QAPP (or approved as field change requests) were implemented. Field documentation shall ensure sample integrity and provide sufficient technical information to recreate each field event. The results of the completeness check will be documented and environmental data affected by incomplete records will be identified in the technical report.
- Identification of valid samples. The identification of valid samples involves interpretation and evaluation of the field records to detect problems affecting the representativeness of environmental samples. The lithologic and geophysical logs may be consulted to determine stratigraphic variations within the subsurface. Records should also note sample properties such as clarity, color, odor, etc. Photographs may show the presence or absence of obvious sources of potential contamination, such as operating combustion engines near a well during sampling. Judgments of sample validity shall be

documented in the technical report, and environmental data associated with poor or incorrect field work shall be identified.

- Correlation of data. The results of field tests obtained from similar areas shall be correlated. The findings of these correlations shall be documented and the significance of anomalous data shall be discussed in the technical report.
- Identification of anomalous field test data. Anomalous field data shall be identified and explained to the extent possible. For example, headspace readings obtained at one boring location that are significantly higher than at any other boring shall be explained in the technical report.
- Accuracy and precision of field data and measurements. The assessment of the quality of field measurements shall be based on instrument calibration records and a review of any field corrective actions. The accuracy and precision of field measurements shall be discussed.

Field record review is an ongoing process. Field team leaders will be responsible for ensuring that proper documentation is recorded during each site's sampling activities.

8.2.2 Review of Laboratory Data

All laboratory data shall be reviewed by the laboratory. At a minimum, the review of laboratory data shall focus on the following subjects:

- Chain-of-custody forms
- Holding times
- Method calibration limits
- Method blanks
- Laboratory established detection limits
- Analytical batch control records including spike recoveries and spike replicate results
- Corrective actions
- Formulas used for analyte quantitation
- Calculations supporting analyte quantitation
- Completeness of data.

The establishment of detection and control limits shall be verified. Any control limits outside of the acceptable range specified in the analytical methods shall be identified. Any trends or problems with the data shall be evaluated. The absence of records supporting the establishment of control criteria and detection limits shall also be noted. Analytical batch quality control, calibration check samples, method calibrations, continuing calibration verifications, corrective action reports, the results of reanalysis, sample holding times, sample preservations, and any resampling and analysis shall all be evaluated.

Samples associated with out-of-control QC data will be identified in the technical report, and an assessment of the utility of such analytical results will be made. The check of laboratory data completeness shall ensure that:

- All samples and analyses required by the SOW have been processed
- Complete records exist for each analysis and the associated QC samples
- Procedures specified in this QAPP have been implemented.

The results of the completeness check shall be documented.

An analyst (lab review analyst), other than the original data processor, will be responsible for reviewing all steps of the data processing. All (100 percent of) input parameters, calibrations, and transcriptions shall be checked. At least 20 percent of all calculations will be checked. If errors are found during the 20 percent check, 100 percent of any related calculations will be checked. All computer processed data will have the manually inputted data checked. Each page of checked data shall be signed and dated by the verifier.

Quality control sample results (laboratory control samples, matrix spike, matrix spike duplicates, surrogates, initial calibration standards, and continuing calibration standards) are compared against stated criteria for accuracy and precision. QC data must meet acceptance levels prior to processing the analytical data. If QC standards are not met, the cause is determined. If the cause can be corrected without affecting the integrity of the analytical data, processing of the data will proceed. If the resolution jeopardizes the integrity of the data, reanalysis will occur. If the reanalysis does not resolve the conformance problem, the results of the original run and the reanalysis run shall be reported in the data package. The nonconformance will be noted in the case narrative of the data package and the appropriate laboratory corrective action will be initiated immediately.

8.3 DATA VALIDATION AND REPORTING

This section describes field, laboratory, and ES data validation and reporting activities.

8.3.1 Field Reporting

The following standard reporting units will be used during phases of the project:

- Explosimeter readings will be reported to within 1.0 percent
- Photoionization readings will be reported to 0.2 ppm
- Temperature will be reported to the nearest 1 °F
- Soil sampling depths will be reported to the nearest 0.5 foot
- Water level measurements will be reported to the nearest 0.01 foot.

8.3.2 Laboratory Data Verification and Reporting

All analytical data will be verified prior to being released by the laboratory. Laboratory data verification will consist of reviewing the data for both editorial and

technical validity. The editorial review consists of a check for typographical, transpositional, and omissions errors. This review also includes a proofreading of any text which may accompany the data. The technical review consists of a check to see that all precision, accuracy, and detection limit requirements have been met.

The results of the laboratory analysis will be presented as a completed data package to the laboratory QC coordinator for review and approval. The review will encompass data package completeness, discrepancies, errors, and acceptability of quality control data. Any discrepancies or questions from the reviewer will be addressed by the analyst. Once all approvals have been obtained, the data will be tabulated as a summary of analytical results. This review should be signed by the laboratory QC coordinator.

These reports will be reviewed by project personnel. If questions arise during this review, the report will be rerouted to the appropriate laboratory representative for explanation or clarification of the questions. When all questions have been resolved, the data will be reported. The report must contain a case narrative, data summary, and QC forms.

Reporting of analytical results for this project will include environmental and QC sample analysis data in hard copy format, as well as a computer disk containing IRPIMS formatted data. Laboratory deliverables are described in Table 8.1. Analytical hardcopy reports will contain the following items:

- Case narrative including any special conditions
- Laboratory name
- Client name
- Date of issue
- Project identification
- Field sample number
- Laboratory sample number
- Sample matrix description
- Analytical method and extraction method reference citation
- Individual parameter results (including second column and primary results where appropriate)
- Date and time of analysis (extraction initiated and completed, first run and subsequent runs)
- Detection limits achieved
- Concentration units
- Dilution or concentration factors
- Corresponding QC forms.

**Table 8.1 Required Laboratory Deliverables
Tinker AFB SCGW RI/FS**

| Method Requirements | Laboratory Deliverables |
|---|--|
| Requirements for all methods: | |
| - Project identification | Case narrative |
| - Field sample number | Signed chain-of-custody (COC) forms |
| - Laboratory sample number | Signed COC forms |
| - Sample matrix description | Signed COC forms |
| - Date of sample collection | Signed COC forms |
| - Date of sample receipt at laboratory | Signed COC forms |
| - Analytical method description and reference citation | Case narrative |
| - Dates and times of sample preparation and analysis (including first run and subsequent runs) | Specific deliverable depends upon type of analysis (see below) |
| - Quantitation limits achieved | Specific deliverable depends upon type of analysis (see below) |
| - Dilution or concentration factors | Specific deliverable depends upon type of analysis (see below) |
| - Discussion of unusual circumstances or problems | Case narrative |
| - LCS results | LCS % Recovery form |
| Requirements for organic analytical methods: | |
| - Sample data sheets | SW-846 form or equivalent |
| - Surrogate recoveries. Surrogate to be used in volatiles and semivolatiles analyses | SW-846 form or equivalent |
| - Matrix spike/matrix spike replicate | SW-846 form or equivalent |
| - Method blank analysis | SW-846 form or equivalent |
| - GC/MS instrument performance check. Tuning and mass calibration using BFB for method SW-8240 and DFTPP for method SW-8270 | SW-846 form or equivalent |
| - GC/MS initial calibration data for volatile and semivolatile analyses if relative response factors are used | A form with five columns for multilevel calibration factors |

Table 8.1 continued

| Method Requirements | Laboratory Deliverables |
|--|--|
| Requirements for organic analytical methods, continued | |
| <ul style="list-style-type: none"> - GC/MS continuing calibration data. No chromatograms or mass spectra are presented for calibration. These data should be filed in the laboratory and should be available if problems arise in reviewing/validating the data. The calibration information should be available for checking during on-site audits | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - GC continuing calibration data for volatile and semivolatile analyses. If calibration factors are used, calibration factors and their percent differences from the initial calibration must be reported. Retention time windows and analyte retention times must be included in this form | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - GC/MS internal standard area and retention time summary data | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - GC second column confirmation. To be done for all compounds that are detected above reporting limits | Chromatograms of all confirmations of all samples and the standard lab form for all positive results |
| Requirements for inorganic analytical methods (metals): | |
| <ul style="list-style-type: none"> - Sample data sheets | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - Initial and continuing calibration | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - Method blank, taken through sample preparation | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - ICP interference check sample | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - Spike sample recovery | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - Post-digestion spike sample recovery for ICP metals | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - Post-digestion spike for GFAA | Recovery will be noted |
| <ul style="list-style-type: none"> - Replicate samples | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - Laboratory control sample | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - Standard addition results | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - ICP serial dilutions | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - Instrument detection limits (quarterly) | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - ICP interelement correction factors (annually) | SW-846 form or equivalent |
| <ul style="list-style-type: none"> - ICP linear ranges (quarterly) | SW-846 form or equivalent |

Table 8.1 continued

| Method Requirements | Laboratory Deliverables |
|--|--|
| Requirements for inorganic analytical methods (metals), continued | |
| - Preparation log | SW-846 form or equivalent |
| - Analysis run log | SW-846 form or equivalent |
| Requirements for other methods: | |
| - Preparation and analysis logs | No format |
| - Sample results | No format |
| - Matrix spike/matrix spike replicate results | No format |
| - Laboratory control sample or blank spike if matrix spike/matrix spike replicate is not available | Control chart or percent recovery and relative percent difference results |
| - Method blank results | No format |
| - Initial calibration results | No format |
| - Continuing calibration check | No format. Report percent relative standard deviation or percent difference from initial calibration |

Notes: CLP = Contract Laboratory Program, EPA
 GC = Gas chromatography
 MS = mass spectrometry
 ICP = inductively - coupled plasma
 BFB = p-bromofluorobenzene
 DFTPP = decafluorotriphenylphosphine;
 LCS = laboratory control sample

QC data are recorded on the QC report forms for the appropriate tests and correlated to the analysis results by the laboratory lot control numbers. The QC results are used to prepare control charts for each test and matrix type. QC reports will contain the following items:

- Narrative describing any non-compliant samples
- Initial and continuing calibration results
- Method blank
- Surrogate results
- Matrix spike/matrix spike replicate results.

The quality control report will be submitted with the analytical results report.

The moisture content for each soil and sediment sample will be reported. The equation for moisture content given in ASTM D2216 will be modified as follows:

$$W = [(W1-W2)/(W1-Wc)] * 100\%$$

where, W = moisture content, percent by weight

W1 = weight of container and sample as received

W2 = weight of container and oven-dried sample

WC = weight of container

The project QA officer will review all laboratory data packages. Any reports that are rejected as incomplete or in error will be returned to the laboratory for correction. The laboratory shall submit a revised, corrected report within two weeks of notification of a rejected report. The data qualifiers listed in Appendix A will be used on all laboratory reports.

8.3.3 ES Data Validation and Reporting

Using the reviews of field records and laboratory data, environmental data that are not representative of environmental conditions because they were generated through poor field or laboratory practices shall not be used in the evaluation process. This determination shall be made using the professional judgment of a multidisciplinary team (e.g., chemists, hydrologists, engineers), and other personnel having direct experience with the data collection effort. This coordination is essential for the identification of valid data and the proper evaluation of that data. The usefulness of historical data will also be evaluated. The fundamentals of the EPA functional guidelines for evaluating data shall be used to validate the usability of laboratory data.

After valid data are identified, the following steps shall be implemented to interpret the data:

- Evaluate field replicate and replicate results and field duplicate/duplicate results. Precise field replicate/replicate results indicate reproducible sampling technique and precise laboratory analysis. Field replicate/replicate

results not within control limits could indicate a heterogeneous sample medium, poor sampling technique, or a lack of analytical precision. If laboratory duplicates are precise, the problem may be associated with field activities. If homogenized samples show poor precision, the imprecision is probably in the laboratory analytical process.

- Evaluate field and laboratory blank results. Analyses of blanks shall be assessed to determine sources of contamination and the impact of any contamination on the analytical results for environmental samples. Examples of sources capable of contaminating field blanks (for example, trip blanks) include combustion engine exhaust, container cleaning solvents, pollution from offsite sources, or the water/container used. Method blank results are useful to detect laboratory contamination from reagents, instruments, ambient sources, or sample handling. The presence of a contaminant in a blank requires corrective action to eliminate the source of contamination and re-establish analytical control. Contamination proven to be a constant, low-level systematic error shall be noted in the technical report, and its impact on the results shall be evaluated. Under no circumstances shall the results for environmental samples be “corrected” for blank contamination.
- Evaluate sample matrix effects. Assessment of the sample matrix can help to define the sources of anomalous data. The matrix can cause either a high or low bias to the results of normal environmental samples. High analytical results can be caused by natural background material in the sample. For example, thallium appearing in the ICP analysis of saline waters may be a spectral interference caused by other substances in the sample. Also, high calcium concentrations in water analyzed by ICP may generate spectral interferences for other metals. Potential matrix effects shall be identified through the evaluation of matrix spike and matrix spike replicate samples. The impacts of matrix interferences on results shall be described in the technical report.
- Interpret and integrate environmental data to formulate conclusions and recommendations. The replicate and duplicate results, blank results, and potential matrix interference effects will be considered in evaluating the data.

Following evaluation of the data, a technical report on the site investigation will be prepared and submitted.

SECTION 9

INTERNAL QUALITY CONTROL CHECKS FOR FIELD AND LABORATORY OPERATIONS

This section describes the internal quality control checks for field and laboratory operations. A summary of internal quality control procedures can be found in Table 9.1.

9.1 FIELD QUALITY CONTROL CHECKS

As a check on field QA/QC, ambient conditions blanks, field blanks, equipment blanks, field replicates and duplicates, and trip blanks shall be collected. Matrix spike and matrix spike duplicate samples will be collected in the field, but will be used to check laboratory quality control. Split samples will be collected and provided to the Air Force at their request.

Type II reagent-grade water will be used for field blanks, trip blanks, ambient condition blanks, equipment blanks, and for decontamination. This water must have analytical data or a manufacturer's certification that verifies the quality of the water and shows it to be free of analytes and contaminants that may interfere with the required laboratory analyses. The water's electrical conductivity will be less than 1.0 micromho per centimeter (at 25°C). Type II reagent-grade water will be purchased and stored only in glass or Teflon containers with Teflon caps or cap liners.

9.1.1 Field Blanks

Field blanks will be collected to check the purity of the type II reagent-grade water. Two field blanks will be collected over the course of the project. Field blanks will be analyzed for the same parameters as the environmental samples. The sample identification for field blanks will be FIELDQC. The sample type will be MB1.

9.1.2 Trip Blanks

One trip blank will accompany every cooler shipped to the laboratory which contains soil and/or water samples to be analyzed for volatile organic compounds. A trip blank is a volatile organic compound sample bottle filled in the laboratory with type II reagent-grade water, transported to the site, handled like a sample, and returned to the laboratory for analysis. If there is more than one sampling team, only one team will carry a trip blank to the sampling locations. Trip blanks will not be opened in the field. This blank will be analyzed for volatile organic compounds

Table 9.1 Summary of Internal Quality Control Procedures
Tinker AFB SCGW RI/FS

| Analytical Method | Parameter/Matrix | Quality Control Check | Frequency | Acceptance Criteria | Corrective Action |
|--|----------------------------|--|---|--|--|
| SW-6010, SW-7421, SW-7060, SW-7740, SW-7470, SW-7471 | Metals (Water and Soil) | Field QC: Equipment Blank | One per team per sampling day, per sample media | Concentrations of analytes < the project reporting level. | Check preparation blank; check field blank; flag data. |
| | | Field Duplicate | Ten percent of all water samples | Sample values exceeding the DL by 5x, RPD ≤40 for water and ≤70 for soils. Sample values less than 5x the DL, RPD ≤ 2x DL for water and ≤4x DL for soil. | Review and discuss in technical report; flag data where appropriate. |
| | | Field Replicate | Ten percent of all soil samples. | Sample values exceeding the DL by 5x, RPD ≤40 for water and ≤70 for soils. Sample values less than 5x the DL, RPD ≤ 2x DL for water and ≤4x DL for soil. | Review and discuss in technical report; flag data where appropriate. |
| | | Laboratory QC: Calibration Std. | Daily prior to analysis. | Reference standard must be within 10% of the true value. | Repeat calibration. |
| | | Initial and continuing calibration verification standard. | Initial: immediately before ICB. Continuing: immediately before CCB. | ± 10% of expected value for ICP and ± 20% of expected value for furnace. | Check instrument; recalibrate; reanalyze preceding samples. |
| | | Initial and continuing calibration blank (ICB & CCB). | 10% or every 2 hours during run. | Concentrations of analytes < the project reporting level. | Check instrument; recalibrate; reanalyze preceding samples. |
| | | Interference check samples A and B (omit for mercury and GF metals). | At the beginning and end of each analysis run. | ± 20% of true value for analytes present. | Check instrument; recalibrate; reanalyze preceding samples. |
| | | Preparation Blank | 1 per batch (maximum of 20 samples per batch). | Concentrations of analytes < the project reporting level | Reanalyze sample; flag data. |

Table 9.1, continued

| Analytical Method | Parameter/Matrix | Quality Control Check | Frequency | Acceptance Criteria | Corrective Action |
|-------------------|---|--|--|---|---|
| SW-8260 | Volatile Organic Compounds (Water and Soil) | Matrix spike/spike duplicate | 1 pair per set of 20 samples. | Laboratory specific control limits* | Check LCS; flag data. |
| | | Laboratory Control Sample (LCS, blank spike) | As needed. | Laboratory specific control limits* | Rerun all non compliant analytes; flag data. |
| | | Field QC: Ambient Conditions Blank | One per day per site during sampling | Concentrations of analytes < the project reporting level. | Check method blank for possible laboratory problem; flag sample data. |
| | | Equipment Blank | One per team per sampling day. | Concentrations of analytes < the project reporting level. | Check method blank for possible laboratory problem; flag data. |
| | | Field Duplicate | Ten percent of all water samples | Sample values exceeding the DL by 5x, RPD \leq 40 for water and \leq 70 for soils. Sample values less than 5x the DL, RPD \leq 2x DL for water and \leq 4x DL for soil. | Review and discuss in technical report; flag data where appropriate. |
| | | Field Replicate | Ten percent of all soil samples. | Sample values exceeding the DL by 5x, RPD \leq 40 for water and \leq 70 for soils. Sample values less than 5x the DL, RPD \leq 2x DL for water and \leq 4x DL for soil. | Review and discuss in technical report; flag data where appropriate. |
| | | Laboratory QC: BFB tuning check | Every 12 hours. | See Table 6.2 | Retune as necessary; document corrective action; check GC/MS system. |
| | | Initial calibration. | As dictated by continuing calibration check. | %RSD for CCCs \leq 30% RF calculated for each compound relative to one of the internal standards. | Rerun as needed to meet criteria. |

Table 9.1, continued

| Analytical Method | Parameter/Matrix | Quality Control Check | Frequency | Acceptance Criteria | Corrective Action |
|-------------------|--|---|---|--|--|
| | | Continuing calibration check. | Once every 12 hours. | SPCCs >0.1 for chloromethane and 1,1-dichloroethane, >0.25 for bromoform, and >0.3 for chlorobenzene and 1,1,2,2-tetrachloroethane % D for CCCs ≤25% | Check GC/MS system; run initial calibration. |
| | | Method Blank | 1 per batch (maximum of 20 field or QC samples, excluding blank spikes, per batch) or 1 per day whichever is more frequent. | Concentrations of analytes < the project reporting level. | Step 1: Reanalyze; step 2: If second method blank exceeds criteria, clean the analytical system; step 3: Document corrective action taken. |
| | | Surrogate Spikes | Every sample (field, standards, QC, blank). | Laboratory specific control limits* | Check calculation; reextract and reanalyze; flag data. |
| | | Matrix Spike/Spike Duplicate | 1 pair per 20 project samples. | Laboratory specific control limits* | Check laboratory control sample; discuss in case narrative; flag data. |
| | | Laboratory Control Sample. | As needed. | Laboratory specific control limits* | Check calibration; rerun LCS; discuss in case narrative; flag data. |
| SW-8270 | Semivolatile Organics (Water and Soil) | Field QC; Equipment Blank | One per team per sampling day, per sample media | Concentrations of analytes < the project reporting level. | Check method blank for possible laboratory problem; flag data. |
| | | Field Duplicate | Ten percent of all water samples | Sample values exceeding the DL by 5x, RPD ≤40 for water and ≤70 for soils. Sample values less than 5x the DL, RPD ≤ 2x DL for water and ≤4x DL for soil. | Review and discuss in technical report; flag data where appropriate. |
| | | Field Replicate | Ten percent of all soil samples. | Sample values exceeding the DL by 5x, RPD ≤40 for water and ≤70 for soils. Sample values less than 5x the DL, RPD ≤ 2x DL for water and ≤4x DL for soil. | Review and discuss in technical report; flag data where appropriate. |
| | | <u>Laboratory QC:</u> DFPPP tuning check | Every 12 hours | See Table 6.3. | Retune as necessary; document corrective action. |

Table 9.1, continued

| Analytical Method | Parameter/Matrix | Quality Control Check | Frequency | Acceptance Criteria | Corrective Action |
|-------------------|------------------------------|------------------------------|--|--|--|
| SW-7195/SW-7198 | Chromium VI (soil and water) | Initial calibration | As dictated by continuing calibration check | %RSD for CCCs <30% Average RF for SPCCs ≥0.050. | Check GC/MS system; rerun as needed to meet criteria; document corrective action. |
| | | Continuing calibration check | Once every 12 hours | Average RF for SPCCs 0.050.% RSD for CCCs ≤30% | Check GC/MS system; run initial calibration; document corrective action. |
| | | Method Blank | 1 per batch (maximum of 20 field or QC samples, excluding blank spikes, per batch) or 1 per day, whichever is more frequent. | Concentrations of analytes < the project reporting level. | Step 1: Reanalyze blank; step 2: If second method exceeds the criteria, clean work area and reanalyze samples; step 3: Document corrective action. |
| | | Surrogate Spikes | Every sample (field, standards, QC, blank) | Laboratory specific control limits* | Check calculation; reextract and reanalyze; flag data. |
| | | Matrix Spike/Spike Duplicate | 1 pair per 20 project samples | Laboratory specific control limits* | Check laboratory control sample; discuss in case narrative; flag data. |
| | | Laboratory Control Sample | As needed | Laboratory specific control limits* | Check calibration; rerun LCS; discuss in case narrative; flag data. |
| | | Field QC: Equipment Blank | One per team per sampling day | Concentrations of analytes < the project reporting level. | Check preparation blank; check field blank; flag data. |
| | | Field Duplicate | Ten percent of all water samples | RPD ≤ 50%Sample values exceeding the DL by 5x, RPD ≤40 for water and ≤70 for soils. Sample values less than 5x the DL, RPD ≤ 2x DL for water and ≤4x DL for soil. | Review and discuss in technical report; flag data where appropriate. |
| | | Field Replicate | Ten percent of all soil and sediment samples | RPD ≤ 50%Sample values exceeding the DL by 5x, RPD ≤40 for water and ≤70 for soils. Sample values less than 5x the DL, RPD ≤ 2x DL for water and ≤4x DL for soil. | Review and discuss in technical report; flag data where appropriate. |

Table 9.1, continued

| Analytical Method | Parameter/Matrix | Quality Control Check | Frequency | Acceptance Criteria | Corrective Action |
|---|------------------|-----------------------|-----------|---------------------|-------------------|
| <p><u>Laboratory QC:</u> To be determined.*</p> | | | | | |

*Note: Laboratory control limits will be determined by the laboratory as stated in the method.

- DL = detection limit
- CCC = Calibration check compound
- % RSD = Percent relative standard deviation
- RPD = Relative percent difference
- QC = Quality control
- DCS = Duplicate control sample
- ICB = Initial calibration blank
- CCB = Continuing calibration blank
- ICP = Inductively coupled plasma
- LCS = Laboratory control sample
- RF = Response factor
- BFB = p-Bromofluorobenzene
- DFTPP = Decafluorotriphenylphosphine
- GC/MS = Gas chromatograph/mass spectrometry

only. The sample identification for trip blanks will be FIELDQC. The sample type will be TB1.

9.1.3 Ambient Conditions Blanks

Ambient conditions blanks will be collected during each volatile organic compound groundwater sampling round. An ambient conditions blank is type II reagent-grade water that is poured into a sample container at a sampling site. An ambient conditions blank does not need to be taken at every site. When possible, ambient conditions blanks will be collected when samples are collected downwind of possible volatile organic compound sources such as active runways. This blank will be analyzed for volatile organic compounds only. The sample identification for ambient conditions blanks will be FIELDQC. The sample type will be AB1..

9.1.4 Equipment Blanks

One equipment rinsate blank will be collected per day of groundwater sampling. An equipment blank is type II reagent-grade water that is poured into the sampling device, transferred to a sample bottle, and transported to the laboratory for analysis. This blank will be subjected to all the laboratory analyses requested for environmental samples for each media on the day of sampling. The sample ID will be FIELDQC. The sample type will be EB, numbered sequentially starting with 1 (e.g. EB1) each day.

9.1.5 Field Replicate Samples

Ten percent of all soil and sediment samples will be replicates. A field replicate is a single sample divided into two equal parts for analysis. Field replicates cannot be disguised so that laboratory personnel are unable to distinguish what sample corresponds to the replicate sample due to IRPIMS format. The sample identification for replicate samples will be the same as the identification for the environmental sample. The sample type will be FR1.

9.1.6 Field Duplicate Samples

Ten percent of all water samples will be duplicates. A field duplicate one of two samples collected independently at a sampling location during a single act of sampling. Field duplicates cannot be disguised so that laboratory personnel are unable to distinguish what sample corresponds to the duplicate sample due to IRPIMS format. The sample identification for duplicate samples will be the same as the identification for the environmental sample. The sample type will be FD1.

9.1.7 Split Samples

Ten percent of all samples will be split with the Tinker AFB, at their request. The split samples will be collected in the same manner as field replicate samples and field duplicate samples. ES will provide these samples to the Tinker AFB with a COC form.

9.2 LABORATORY QUALITY CONTROL CHECKS

This section describes the internal quality control checks for laboratory operations. A summary of internal quality control procedures can be found in Table 9.1.

9.2.1 Method Blank Samples

Lab blank samples (also referred to as method blanks) are designed to detect contamination of the environmental samples in the laboratory. Method blanks verify that method interferences caused by contaminants in solvents, reagents, glassware or in other sample processing hardware are known and minimized. The blank shall be deionized, distilled water (ASTM type II or equivalent) for water samples, or a purified solid matrix for soil/sediment samples. One blank will be analyzed every day that samples are analyzed. The concentration of target compounds in the blanks must be less than or equal to project reporting level. If the blank is not under the specified limits, then the source of contamination will be identified and corrective action taken, including reanalysis of the sample group.

9.2.2 Laboratory Replicate Samples

Laboratory replicates will not be conducted. Lab replicates involve splitting a sample in the laboratory in order to check the precision of analytical results. Because most environmental samples are expected to be below detection limits, the precision cannot be evaluated on such samples. As a result, matrix spike and matrix spike duplicates will instead be used to evaluate the precision of analytical results.

9.2.3 Matrix Spike/Matrix Spike Replicate Samples

Laboratory matrix spike samples and laboratory control samples (see Section 9.2.4) are designed to check the accuracy of the analytical procedures by analyzing a normal sample with a known amount of analyte added in the lab. Laboratory matrix spike duplicates are the second of a pair of laboratory matrix spike samples. The matrix spike duplicates are designed to check the precision and accuracy of analytical procedures by analyzing a normal sample with a known amount of analyte added.

In order to evaluate the effect of the sample matrix on analytical data, triplicate volume is collected for one sample out of every group of 20. Matrix spike and matrix spike duplicates will be collected in the field in the same manner that field duplicate samples and field replicate samples are collected. Two portions of the sample (the matrix spike and the matrix spike replicate) are spiked with a standard solution. These spiked samples are analyzed, and the percent recovery and relative percent difference are calculated. The results of the analysis are used to determine accuracy and precision. Field blanks or duplicates are not to be used as matrix spike/matrix spike duplicates.

Laboratory control limits will be provided to the Tinker AFB RI/FS project manager after the laboratory has been selected. The results of the analysis of the matrix spike and replicate spikes will be reviewed. This information will be used to

update the control chart. If the matrix spike and replicate matrix spike results are out of compliance, corrective actions will be instituted.

9.2.4 Laboratory Control Samples

Laboratory control samples include blank spikes and blank spike duplicates. Blank spikes are designed to check the accuracy of the analytical procedure by measuring a known concentration of an analyte of interest. The blank spike replicate is the second of a pair of blank spike samples. The blank spike replicate is designed to check the precision and accuracy of the analytical procedures by measuring a known concentration of an analyte of interest in the pair of blank spikes.

In order to prepare blank spikes or blank spike duplicates, clean laboratory matrices (laboratory water or purified solid matrix) are spiked with the same spiking compounds used for matrix at levels approximately 10 times greater than the LOD. The percent recovery is charted, and non-conformance shall be discussed in the report narrative.

9.2.5 Surrogate Spike Analysis

Surrogate spike analyses are used to determine the efficiency of recovery of analytes in the sample preparations and analyses. All GC and/or GC/MS samples (including laboratory/method blanks, matrix spikes, matrix spike duplicates, normal environmental samples) are fortified with surrogate spiking compounds before purging or extraction. Recoveries will be reported, and, if out of compliance, corrective actions and reanalysis will occur.

9.2.6 Control Limits

Control limits for laboratory QA/QC samples will be in accordance with the applicable method. The quality control checks, their frequency, the acceptance criteria, and the corrective actions if out-of-limits are presented for each analytical method in Table 9.1.

SECTION 10

PERFORMANCE AND SYSTEMS AUDIT

This section describes participation in external and internal systems and performance audits for laboratory work.

10.1 SYSTEM AUDITS

System audits review laboratory operations and the resulting documentation. An on-site audit ensures that the laboratory has all the personnel, equipment, and internal standard operating procedures needed for performance of contract requirements in place and operating. The system audits ensure that proper analysis documentation procedures are followed, that routine laboratory QC samples are analyzed, and that any non-conformances are identified and resolved.

The selected laboratory shall be one that conducts ongoing internal system audits. The results of these audits shall be documented by the laboratory QA manager, and the laboratory shall provide ES with the results of these audits.

Tinker AFB may also conduct audits. The frequency and schedule of any such audits will be established by Tinker AFB and coordinated directly with each laboratory.

10.2 PERFORMANCE AUDITS

Performance audits involve the analysis of "performance samples" by the laboratory. For example, as part of the EPA CLP Performance Evaluation, the laboratory analyzes quarterly performance evaluation (PE) samples. This provides evidence that the laboratory personnel involved fully understand the required analytical methods and that these methods can be performed satisfactorily by laboratory personnel using the laboratory equipment and instrumentation. The samples also provide evidence that the laboratory understands the documentation and reporting requirements of the contract.

Project-specific performance audits will not be conducted, per se. Instead, the results of external audits due to ongoing laboratory certification processes shall be used. Specifically, the results of external performance audits which are conducted during the lifetime of the project shall be reported to the ES project QA officer. In addition, any anomalies identified through the use of field duplicates and field replicates will be investigated. However, these differences may be due either to field or laboratory activities.

Audit frequencies and certifications maintained by the laboratory are described below. The results of all audits (internal or external) which are conducted during the period of the project shall be reported to ES.

The selected laboratory shall be one that participates in EPA CLP Quarterly Performance Evaluations consisting of one to three sets of PE samples. The laboratory shall be one that receives sets of quarterly PE samples for the analyses of water pollution and water supply parameters to provide interlaboratory evaluation of data results for reproducibility and comparability. These EPA Water Pollution (WP)/Water Supply (WS) Performance Evaluations also provide feedback of the QC procedures used by the laboratory.

SECTION 11

PREVENTATIVE MAINTENANCE PROCEDURES AND SCHEDULES

This section describes preventive maintenance procedures for laboratory and field equipment.

11.1 LABORATORY INSTRUMENTS

Laboratory analytical instruments are serviced at intervals recommended by the manufacturer. Service contracts for regular maintenance and emergency service are maintained for major instruments. An instrument repair maintenance log book is kept for each instrument. All logbooks shall be kept in an easily accessible location for ready reference by the laboratory analysts using the instrument. Entries include the date of service, type of problem encountered, corrective action taken, and initials and affiliation of the person providing the service.

The instrument use log book is monitored by the analysts to detect any degradation of instrument performance. Changes in response factors or sensitivity are used as indication of potential problems. These are brought to the attention of the laboratory supervisor and preventative maintenance or service is scheduled to minimize down time. Back-up instrumentation and an inventory of critical spare parts are maintained to minimize delays in completion of analyses.

11.1.1 Service Schedule

Manufacturer's procedures identify the schedule for servicing critical items in order to minimize the downtime of the measurement system. The laboratory assumes the responsibility of adhering to this maintenance schedule, arranging any necessary repairs, and ensuring prompt service as required. Service to all equipment and instruments shall be performed by qualified personnel.

In the absence of any manufacturer's recommended maintenance criteria, a maintenance procedure will be developed by the operator based upon experience and previous use of the equipment. In the event that the analytical method mandates specific preventive maintenance procedures which are more frequent than that recommended by the manufacturer, then the frequency specified in the method shall be followed.

11.2 FIELD INSTRUMENTS

All equipment will be periodically maintained in accordance with the manufacturers' specifications and will be decontaminated if needed on a regular basis. All maintenance activities will be documented in the field logbook. This section describes general maintenance procedures and schedules for field monitoring equipment. Equipment calibration and maintenance is described in detail in the project field sampling plan.

11.2.1 HNU Photoionization Detector

The HNU PID will be periodically maintained according to the following procedures:

1. Wipe down readout unit after each use.
2. Clean ultraviolet (UV) light source windows every month.
3. Clean ionization chamber every month.
4. Recharge battery daily or as use dictates.

11.2.2 Sensidyne One-Stroke Pump and Tubes

The Sensidyne one-stroke pump and tubes require no general maintenance.

Detector tubes are tested according to National Institute of Occupational Safety and Health (NIOSH) method TCA/A-012, "Certification Requirements for Gas Detector Tube Units," for the Safety Equipment Institute certification program. Furthermore, each manufacturer's detector tubes are tested as a unit by an independent third party laboratory accredited by the American Industrial Hygiene Association (AIHA).

11.2.3 HMX271 Combustible Gas Indicator

The HMX271 combustible gas indicator will be maintained in the field by wiping the unit clean after every use, storing the unit in a safe protected case, and recharging the battery on a daily basis or as use dictates.

SECTION 12

DATA ASSESSMENT PROCEDURES

Data will be assessed using the following criteria: accuracy, precision, completeness, comparability, and representativeness. These criteria are described in Section 3.

Control limits for laboratory QA/QC samples will be in accordance with the applicable analytical method. Procedures for establishment of surrogate spike control limits found in *Test Method for Evaluating Solid Waste*, Third Edition SW-846 (EPA, 1986), will be followed. Laboratory established control limits for matrix spike and matrix spike duplicates will be within the QC acceptance criteria and control limits specified by the applicable analytical method.

The laboratory-specific RPD control limits and percent recovery guidelines will be provided to the Tinker AFB project manager after the laboratory has been selected.

SECTION 13

CORRECTIVE ACTIONS

The following procedures have been established to ensure that conditions adverse to quality (e.g., malfunctions, deficiencies, deviations, and errors) are promptly investigated, documented, evaluated, and corrected.

13.1 RESPONSE

When a significant condition adverse to quality is noted, the cause of the condition will be determined and corrective action taken to prevent repetition. Condition identification, cause, reference documents, and corrective action planned to be taken will be documented and reported to the project manager, project QA officer or laboratory QC coordinator. The project QA officer and laboratory QC coordinator are responsible for notifying the ES project manager immediately upon the identification of any significant QA/QC issues requiring corrective action.

The project manager, project QA officer, and laboratory QC coordinator shall ensure that involved field team leaders, field team members, and/or subcontractors are informed of any QA/QC issues affecting their work. The senior individual in charge of the activity found to be deficient will initiate corrective action. The project manager, project QA officer, or laboratory QC coordinator will approve such corrective actions. Following implementation of corrective action, the senior individual in charge will report actions taken and results to the project manager and project QA officer. A record of the action taken and results will be attached to the audit report.

Implementation of corrective action is verified by documented follow-up action. All project personnel have the responsibility, as part of the normal work duties, to identify, report, and solicit approval of corrective actions for conditions adverse to quality.

Corrective actions shall be initiated in the following instances:

- When predetermined acceptance criteria are not attained (objectives for precision, accuracy, and completeness)
- When the prescribed procedure, or any data compiled are faulty
- When equipment or instrumentation is determined to be faulty
- When the traceability of samples, standards, or analysis results are questionable

- When quality assurance requirements have been violated
- When designated approvals have been circumvented
- As a result of systems or performance audits
- As a result of a management assessment
- As a result of intralaboratory or interlaboratory comparison studies and
- At any other instance of conditions significantly adverse to quality.

Project management and staff, such as field investigation teams, QA auditors, document and sample control personnel, and laboratory groups, monitor work performance in the normal course of daily responsibilities.

The project manager, project QA officer, laboratory QC coordinator, or designated alternates may audit work at the sites, laboratory, and office. Items, activities, or documents ascertained to be in noncompliance with QA requirements will be documented and corrective actions mandated through the audit report. The project QA officer or laboratory QC coordinator will log, maintain, and control the audit findings.

13.2 REESTABLISHMENT OF CONTROL

Finding and correcting sampling and analytical problems are the responsibility of all project personnel. Many out-of-control events do not require the immediate action of management; however, it is important to document these occurrences and to take corrective action. The re-establishment of in-control status of the system must also be documented. For example, if a field team member discovers that an OVA is not properly calibrated, the member may simply recalibrate the instrument and note the original out-of-control response. The results of the recalibration shall also be noted. Appropriate management personnel will be notified of these occurrences. For example, the field team leader may be notified of the OVA event. All personnel will be made aware of the need to report and to correct problems promptly.

Any deviation from project requirements as specified in this document requires proper documentation using a field change request form. The field team leader or their designee will complete this form in the field and forward it to the ES project manager. The project manager will communicate the deviation from project requirements and send the Field Change Request form to Tinker AFB as quickly as possible. Upon receipt, Tinker AFB will review and indicate final disposition of the request and return the original document to the author. A copy of the document should be retained for the project file. Changes that require an immediate response will be initiated by telephone and then documented using the procedure described above.

13.3 DOCUMENTATION

The project QA officer and laboratory QC coordinator are responsible for documenting all out-of-control events or non-conformances with QA protocols. The

laboratory shall notify the ES project manager or ES QA officer of any laboratory QA/QC non-conformances upon their discovery. Copies of all field change requests and corrective action forms shall be maintained in the project files.

SECTION 14

QUALITY ASSURANCE REPORTS

Quality assurance reports include reports on audits, reports on corrections of deficiencies found in audits, and the final QA/QC report submitted as part of the technical report on sampling activities.

14.1 INTERNAL QA REPORTS

At monthly intervals beginning with the initiation of sampling activities, the laboratory will submit an internal QA report to the ES QA officer that documents laboratory-related QA/QC issues. These reports will include discussions of any conditions adverse or potentially adverse to quality, such as:

- Responses to the findings of any internal or external systems or performance laboratory audits;
- Any laboratory or sample conditions which necessitate a departure from the methods or procedures specified in this QAPP;
- Any missed holding times or problems with laboratory QC acceptance criteria; and
- The associated corrective actions undertaken.

Such reports shall not prevent notification to project management of such problems when timely notice can reduce the loss or potential loss of quality, time, effort, or expense.

Any field-related QA memos or forms shall be forwarded by field team leaders to the project manager, who will ensure that the project QA officer receives copies. The project technical director and project manager (or designated individual) will review these reports for completeness and the appropriateness of any corrective actions. They will be retained in the project files, and will be summarized in the QA report included in the final project documents. Appropriate steps will be taken to correct any QA/QC concerns as they are identified. The ES project manager will ensure that the Tinker AFB technical project manager and the ES program manager is informed of any significant QA/QC developments.

14.2 FINAL QA REPORT

A QA report will be submitted after the project sampling and analysis as part of the technical report. The laboratory and field change request/corrective action

forms will be used to assist in developing the final QA Report. Analytical and QC data will be included, summarizing data quality information for the project. In the final report, both laboratory and field QC data will be presented, including a summary of QA activities and any problems or comments associated with the analytical and sampling effort. Any corrective actions taken in the field, the results of any audits, and any modifications to laboratory protocols will be discussed.

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APPENDIX A

LABORATORY REPORTING AND DATA VALIDATION QUALIFIERS

Data will be flagged both in laboratory reports as well as during the data validation process. The following describes the laboratory reporting flags and data validation flags.

LABORATORY REPORTING FLAGS

Laboratory flags for organic and inorganic data will be established as follows.

LABORATORY ORGANIC DATA REPORTING QUALIFIERS

The following qualifiers must be used by the laboratory when reporting results of organic analysis.

- Value** - If the result is a value greater than or equal to the IRP maximum quantitation limit (MQL), the value is reported.
- U** - Indicates the compound was analyzed for but not detected. The number is the projected reporting level (e.g., the non-detected level) for the sample.
- J** - Indicates an estimated value. The flag is used to estimate a concentration for tentatively identified compounds where a 1:1 response is assumed or when the mass spectral data indicate identification criteria, but the result is less than the specified detection limit. This flag will also be used to identify values falling between the MDL and the MQL.
- C** - Applies to PCB parameters when the identification has been confirmed by GC/MS.
- B** - Used when the analyte is found in the blank, as well as a sample. It indicates possible/probable blank contamination and warns data user to take appropriate action.
- E** - Identifies compounds whose concentrations exceed the calibration range of the instruments for specific analysis.

- N** - Compound not analyzed.
- D** - Identifies all compounds analyzed at the secondary dilution.
- A** - Indicates that a TIC is a suspected aldol-condensation product.
- X** - Any other specific flags and footnotes that may be required to properly define the results.
- RE** - Analysis performed on a re-extracted sample.

Laboratory Inorganic Data Reporting Qualifiers

The following qualifiers must be used by the laboratory when reporting results or inorganic analyses.

C - (Concentration) qualifier:

- B** - The report value was obtained from a reading that was less than the MQL, but greater than or equal to the Method Detection Limit (MDL) or Instrument Detection Limit (IDL).
- U** - The analyte was analyzed for but not detected. The number is the project reporting level (e.g., the non-detect level) for the sample.

Q - Qualifier for specified entries:

- E** - The reported value is estimate due to the presence of interference(s).
- M** - Duplicate injection precision not met.
- N** - Spike sample recovery no within control limits.
- S** - The reported value was determined by the Method of Standard Additions (MSA).
- W** - Post-digestion spike for Furnace AA analysis is out of control limits (85 to 115 percent), while sample absorbance is less than 50 percent of spike absorbance.
- *** - Duplicate analysis not within control limits.
- +** - Correlation coefficient for the MSA is less than 0.995.
- D** - Spike level under IDL with Dilution.
(The use of "S", "W", or "+" is mutually exclusive. No combination of these qualifiers should appear in the same field for an analyte.)

M - (Method) qualifier:

- P** - ICP.

- A** - Flame AA.
- F** - Furnace AA.
- CV** - Manual Cold Vapor AA.
- AV** - Automated Cold Vapor AA.
- AS** - Semi-Automated Spectrophotometric.
- C** - Manual Spectrophotometric.
- T** - Titrimetric.
- NR** - Analyte not required to be analyzed.

DATA VALIDATION QUALIFIERS

The following definitions provide explanations of the nation qualifiers assigned to analytical results by the data reviewers. If additional qualifiers are used, a complete explanation of those qualifiers should accompany the data review. Both inorganic and organic data validation flags are used.

Organic Data Validation Definitions

- U** - The analyte was analyzed for and is not present above the level of the associated value. The associated numerical value indicates the approximate concentration necessary to detect the analyte in this sample (e.g., the project reporting level).
- J** - The analyte was analyzed for and was positively identified but the associated numerical value may not be consistent with the amount actually present in the environmental sample. The data should be seriously considered for decision-making and are usable for many purposes.

A subscript may be appended to the "J" to indicate which of the following QC criteria were not met:

- 1. Blank contamination. Indicates possible high bias and/or false positives; or*
 - 2. Calibration range exceeded. Indicates possible low bias; or*
 - 3. Holding time exceeded. Bias is dependent on the analyte of concern and the sample preservation used; or*
 - 4. Other QC criteria outside control limits. Bias not readily determined; or*
 - 5. Value falls between the MDL and MQL.*
- R** - The data are unusable for all purposes. The analyte was analyzed for but presence of the analyte has not been verified.

Resampling and reanalysis are necessary to confirm or deny the presence of the analyte.

- UJ** - A combination of the "U" and "J" qualifiers. The analyte analyzed for was not present above the level of the associated value. the associated numerical value may not accurately or precisely represent the concentration necessary to detect the analyte in the sample.
- N** - The analysis indicates that an analyte is present, and there are strong indications that the identity is correct.
- NJ** - A combination of the "N" and the "J" qualifiers. The analysis indicates that the analyte is "tentatively identified" and the associated numerical value may not be consistent with the amount actually present in the environmental sample.

A subscript may be appended to the "NJ" that indicates which of the following situations applies:

- 1. DDT/Endrin breakdown evident; or*
- 2. Interference by other sample components; or*
- 3. Non-Target Compound List (TCL) compounds (confirmation is necessary using specific target compound methodology to accurately determine the concentration and identity of the detected compounds); or*
- 4. A confirmation analysis was missing or QC criteria were not met for the confirmation analysis; or*
- 5. Value falls between the MDL and MQL.*

Inorganic Data Validation Definitions

For the purposes of this document, the following code letters and associated definitions are provided for inorganic data:

- U** - The material was analyzed for, but was not detected above the level of the associated value. The associated value is the project reporting level (e.g., the non-detect level).
- J** - The associated value is an estimated quantity (e.g., the value falls between the MDL and MQL).
- R** - The data are unusable (Note: Analyte may or may not be present).
- UJ** - The material was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.