COLORADO OIL AND GAS CONSERVATION COMMISSION
QUALITY ASSURANCE PROJECT PLAN
FOR
UNDERGROUND INJECTION CONTROL PROGRAM

Revised
September 1, 1996
October 8, 1997

A. PROJECT MANAGEMENTA. PROJECT MANAGEMENT

A1 TITLE AND APPROVALS TITLE AND APPROVALS

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QUALITY ASSURANCE PROJECT PLAN
FOR
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Revised September 1, 1996

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A2 TABLE OF CONTENTS TABLE OF CONTENTS

SECTION PAGE

LIST OF TABLES

LIST OF APPENDICES

APPENDIX A COGCC UIC DISPOSAL WELL APPLICATION

APPENDIX B COGCC 400 SERIES RULES UNIT OPERATIONS, ENHANCED RECOVERY PROJECTS, AND STORAGE OF LIQUID HYDROCARBONS

APPENDIX C COGCC FORM 14A MONTHLY REPORTS OF FLUIDS INJECTED

APPENDIX D COGCC FIELD REPORT

APPENDIX E UNDERGROUND INJECTION CONTROL FIELD PROCEDURES

APPENDIX F DATA QUALIFIERS AND DATA FLAGGING CONVENTIONS

APPENDIX G TYPICAL SAMPLE LABEL

APPENDIX H TYPICAL CHAIN-OF-CUSTODY FORM

APPENDIX I CALIBRATION, QC, CORRECTIVE ACTION, AND DATA FLAGGING REQUIREMENTS FOR LABORATORY ANALYTICAL METHODS

A3 DISTRIBUTION LIST DISTRIBUTION LIST

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A4 PROJECT ORGANIZATION PROJECT ORGANIZATION

Table 1 summarizes the overall responsibilities of the Colorado Oil and Gas Conservation Commission (COGCC) personnel implementing the Underground Injection Control (UIC) program.

In addition, COGCC personnel, operators, and contractors generate, use, and/or make decisions based upon UIC well data:

- As generators they are responsible for the quality of the data, samples collected, and field measurements taken.
- As users they are responsible for reviewing and auditing the quality of the data provided.
- As decision makers they are responsible for assessing results of the data quality review and audits, for evaluating compliance, and, when necessary, for requiring reacquisition of data and for requiring corrective action.

TABLE 1 COGCC UIC PROJECT RESPONSIBILITIES

POSITIONS	RESPONSIBILITIES
Director	Sets policy in UIC related matters.
Deputy Director	UIC Program Manager.
Senior Engineer	Permits injection wells and coordinates day-to-day program operations.
Engineer	Conducts site inspections and witnesses mechanical integrity tests, day-to-day program operations, approves forms and reports.
Administrative Assistant (Well Records Personnel)	Preliminary form processing, maintains UIC files and assists in the public room with UIC information, mails UIC notices to operators.
Administrative Assistant (Production Personnel)	Sorts and inputs into computer database the monthly injection reports, researches delinquency problems, processes operator change and plugging paperwork, compiles statistics for annual reports.
Physical Scientist Technician (Well Permitting Personnel)	Reviews new UIC permit applications and forms for completeness, and bonding for operators.
Environmental Protection Specialist (Environmental & Commission Affairs Personnel)	Performs UIC hearing related work and environmental remediation of UIC related events.
Program Assistant (Fiscal Administrator)	Prepares federal grants.

A5 PROBLEM DEFINITION/BACKGROUND........PROBLEM DEFINITION/BACKGROUND

The UIC Program was established to prevent contamination of underground sources of drinking water (USDWs) that can result from the operation and abandonment of injection wells. Colorado is a primacy state for the UIC Program for Class II wells, as such the COGCC has prepared this Quality Assurance Project Plan (QAPP) to meet the requirements of 40 CFR § 30.503(e) (*What type of quality assurance practices am I required to have ?*) and § 146.23 (*Operating, monitoring, and reporting requirements for Class II wells*).

This QAPP is designed to ensure that all UIC data collection activities are conducted in a manner that: 1) ensures the integrity of the data; 2) provides COGCC the best opportunity to make data-dependent decisions that will minimize the potential for USDW contamination; and 3) allows COGCC to fully enforce and defend its position on any compliance issues.

A list of the acronyms used in this QAPP is included after the list of references at the end of the text.

The COGCC occasionally collects UIC data, but more often uses data that is self-reported by industry as the basis for its regulatory decisions (e.g., permit issuance). It is important that all data collected by either COGCC staff or industry be consistent with this QAPP.

This QAPP provides a Class II UIC-specific blueprint of how quality assurance (QA) and quality control (QC) are applied to UIC data gathering events to assure that the results obtained are of the type and quality needed and expected. "QA" is a system for identifying which data are needed, specifying how accurate the data needs to be, developing the methods for obtaining the data, and evaluating data collection methods. "QC" is a system for ensuring that the data is collected in a manner consist with the QA goals. More specifically:

> **Quality Assurance (QA)** is an integrated system or program of activities involving planning, *quality control*, implementation, quality assessment, reporting, and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.
>
> **Quality Control (QC)** is the overall system of routine technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of the user.

It should be kept in mind that for Class II wells, unlike perhaps other types of injection wells, fluid sampling may include only a few samples analyzed for only a few parameters over the life of the well, unless contamination is suspected or detected; mechanical integrity testing is only required every 5 years; site inspections by COGCC field engineers are conducted once a year; and pressure and volumes are routinely reported once a month; therefore, the effort required for developing and implementing a QA/QC should not be excessive and will be limited by the relatively small number of samples collected and measurements made.

Because injection well practices vary considerably, the means by which an USDW can be contaminated also vary. Class II injection wells are used for enhanced recovery of oil and gas or for disposal of fluids produced as a result of oil and gas production operations. Examples of the potential routes of USDW contamination by Class II injection wells include:

- Leaks in the tubing, packer, or casing of a well.
- Fractures in a confining zone(s).
- Inadequate cementation of the casing to the wellbore.
- Migration of fluids out of the injection formation through abandoned and/or inadequately constructed wells, which are located close to the injection well.

A6 PROJECT/TASK DESCRIPTION .... PROJECT/TASK DESCRIPTION

As discussed in A5, the UIC Program was established to prevent contamination of USDWs that can result from the operation and abandonment of injection wells. This section describes how data, measurements, and standard procedures for field and laboratory methods are used to ensure that potential or actual impacts to USDWs are prevented or detected, and that, if required, corrective actions are implemented.

A6.1 Data.1 Data

The UIC program uses a wide variety of raw data in its efforts to protect USDWs. Typical data collected for use in the UIC program provides information about local geology, quality of injected and formation fluids, operating conditions such as pressure, volume, flow-rate, and well construction.

The sources of this information include:

- Raw data collected by COGCC staff during field inspections and routinely collected by the operators and contractors.
- Historical data compiled in numerous scientific and regulatory sources.
- Analytical data from laboratories.

These data are used during the permit approval process, for assessing compliance, and for initiating enforcement action.

Permitting: Permit applications for Class II injection wells must contain sufficient technical data to enable the reviewer to determine whether an injection facility can be operated so that USDWs will not be contaminated. A permit application form for disposal wells is included in Appendix A. The requirements for applying to the COGCC for authorization for enhanced recovery operations or operations for the storage of gaseous or liquid hydrocarbons are included in the COGCC 400 Series Rules, a copy of which is presented in Appendix B. Technical data required by the COGCC include:

- Location and depth of all USDW which have the potential to be affected by the injection.

- Appropriate geologic data for the injection zone(s) and the confining zone(s).
- Identification of sources of injection fluids and chemical analysis.
- Anticipated daily volume of injected fluids and injection pressures. COGCC sets maximum allowable surface injection pressures based upon known or calculated fracture gradients, injectivity tests, or other known geologic, hydrologic, or engineering data.
- Schematic drawings of surface and subsurface construction details.
- Description of stimulation program.
- Logging and testing data.
- Well evaluation for area of review to determine whether remediation of existing wells is required to ensure protection of USDW.

<u>Compliance:</u> Following the approval of an injection permit, inspections are conducted, tests and surveys of wells may be performed, and reports from operators to the COGCC are reviewed, to determine whether the facility is operating in compliance with the conditions specified in the permit or regulations. Typical compliance data include:

Self-reported data: Operators are required to report the following information to the COGCC:

- Injected volumes and pressures on a monthly basis (COGCC Form 14A included in Appendix C).
- Type and amount of fluids, if any, received from transporters on a monthly basis.
- Drilling, redrilling, deepening, repairing, plugging, or abandonment activities must be reported promptly. This includes information on the formations penetrated, the content and the quality of oil, gas, or water in each well, and any other information obtained in the course of well operation.

COGCC inspection data (COGCC - UIC Field Report Form included in Appendix D):

- Routine inspection to verify operating conditions.
- Witness and/or measure mechanical integrity tests (MITs) and surveys.
- Witness plugging and abandonment, and other cementing operations to verify volumes and placement of cement.

<u>Enforcement:</u> Violations of COGCC regulations or permit terms are detected by COGCC through field inspection observations, reports submitted to the COGCC by operators, and investigated complaints. Violations are tracked on a computerized database until compliance is obtained. Sources for information used include data collected or submitted by:

- COGCC staff
- Operator or operator's contractor
- Other governmental agencies
- Third party contractors and laboratories

A6.2 Measurements.2 Measurements

Environmental data collection, handling, and analysis associated with Class II UIC wells will be basic and straightforward in most cases. Typically operators will provide the COGCC with various data including, injection formation ground water and injectate analyses for total dissolved solids (TDS), fracture gradient, anticipated or actual daily fluid injection rates and pressures, monthly cumulative injection volumes, porosity and permeability values, and surveyed well location. Other measurements, or chemical or physical analysis of samples may be required in cases of suspected or alleged contamination or operation out of compliance, and will be handled on a case-by-case basis.

Depending on the type and use of the data needed, information may be collected as a one-time event, or on a regularly scheduled basis. Also, the time-frame for regularly scheduled events may vary, for example:

- Water quality information for the injection formation may be provided only once as part of the permit application.
- An initial MIT must be performed prior to start up of injection activities. There after, operators must perform additional MITs at least once every five years.
- COGCC's goal is to inspect each active injection well on an annual basis for compliance and to witness at least 25% of all MITs.
- Operators must report injection volumes, pressures, and sources to the COGCC on a monthly basis.

A6.3 Standard Methods.3 Standard Methods

Environmental data submitted to the COGCC must be measured using standard methods. Results of analyses or measurements that are submitted to the COGCC that are not performed in accordance with the methods and procedures listed below may not be accepted by the COGCC. It is the responsibility of the operator to verify whether a laboratory analysis or field measurement performed using non-standard methods will be acceptable to the COGCC prior to sampling, analyzing, and/or measuring. Some examples of acceptable methods are listed below for routine UIC sample analysis and measurements:

- Analysis of inorganic constituents of water by API Method 45 or in conformance with EPA standard methods as specified in 40 CFR § 136.
- Analysis of organic constituents of water in conformance with EPA standard methods as specified in 40 CFR § 136.
- Fracture gradients by step rate injection tests or ISIP from stimulation treatment. If undetermined by testing, then maximum authorized injection pressure will be based on a 0.6 psi/ft gradient.
- Injection rates and pressures using meters and gauges operated per manufacturers specifications.
- Porosity and permeability using a variety of standard industry methods.
- Generally, locations are surveyed by surveyors from nearer north or south and east or west section lines. Verification by GPS may be performed by COGCC staff.

A7 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA .... QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The COGCC UIC Program authorizes injection well operations by permit and/or regulatory requirements. Consequently, all data collection activities are subject to the general data quality objectives (DQO) of proving that no injection activities allow the contamination of any USDW (COGCC Rule 322A and 40 CRF § 144.12)

Data must be of sufficient quality to show that the subject well(s) will not allow contamination of any USDW. For Class II wells the construction of the well and its proper operations prevents the contamination of USDWs.

In addition, data are collected to:

- Verify self-monitoring data.
- Verify compliance with injection permit.
- Support enforcement action.
- Support permit reissuance and/or revision.

It should be kept in mind that for Class II wells routine field measurements are relatively straight forward and standard, and fluid sampling may include only a few samples analyzed for only a few parameters over the life of the well, unless contamination is suspected or detected; therefore, the effort required to develop and document DQOs and adequate QA/QC procedures, which ensure protection of USDWs, should be limited.

The following represents the COGCC's quality objectives for measurement of data:

- Precision - a goal of plus or minus 20 percent is established for sampling precision. Sampling precision may be evaluated using duplicate field samples when organic analysis of water samples is to be performed. When appropriate, splits of the same samples will be collected and analyzed to provide a measure of precision within that sample (sample homogeneity).

- Accuracy - accuracy limits specified for each of the analytical measurement parameters are specified in various EPA methods and procedures.

- Completeness - completeness is a measure of the amount of valid data obtained compared to that which was expected. A goal of 90 percent completeness is established for results obtained under this QAPP. In other words, the loss of 10% of the samples during shipment or due to laboratory handling will not result in resampling. However, the loss of samples, such as representative upgradient samples, which are considered critical data points, will lead to resampling.

- Representativeness - field and laboratory sampling techniques and procedures should be designed to ensure that a representative sample or portion thereof was used to generate the analytical data. In addition, decontaminated sampling equipment should be used to ensure the samples are representative and to prevent cross contamination between sampling sites.

- Comparability - the data reported from the laboratory will be in units of measure equivalent to those reported for other samples collected from the same source and/or reported by other organizations. Data in a particular data set should be obtained by the same methods to ensure comparability of results.

A9 SPECIAL TRAINING REQUIREMENTS ....SPECIAL TRAINING REQUIREMENTS

Two distinct categories of personnel generate data; private industry staff or contractors, and COGCC staff or contractors. COGCC staff who conduct UIC routine field inspections or witness MITs receive both in-house/on the job training and EPA "Basic Inspector Training", as available.

Generally on the job training received by COGCC UIC field staff includes:

- Observe experienced engineer performing the different tasks in the measurement process.
- Perform tasks under direct supervision of an experienced professional.
- Perform tasks independently, but with adequate quality assurance checks.

In addition, standard operating procedures (SOP) have been established for conducting UIC field inspections and MITs. All field inspectors have copies of this SOP for reference during these activities. A copy is included in Appendix E.

It is the operators' responsibility to establish personnel training procedures which ensure that samples are collected and measurements are made that are precise, accurate, complete, and representative of the UIC well or facility conditions.

A10 DOCUMENTATION AND RECORDS ....................DOCUMENTATION AND RECORDS

Data are transmitted to the COGCC in a variety of formats or "report packages". Examples of UIC data report packages received by COGCC include: permit applications (Appendix A), field inspection reports and MIT results (Appendix D), fluid analysis, surveyor plats and notes, etc. A data report package should include not only raw field data, but documentation and records addressing the quality of field measurements, sampling procedures, and results.

Depending upon the content, data reports are stored in the individual injection well files or in facility files by the COGCC. Data records required under the COGCC rules must be maintained by the operator and available for inspection for at least five years. The Director or his authorized deputy is entitled to inspect records and well operations at any time.

Recommended documentation for routine field measurements is shown in Table 2.

TABLE 2 RECOMMENDED DATA DOCUMENTATION

TYPE OF DATA	RECOMMENDED DOCUMENTATION
Pressure	Scale of gauge (measurement should be within approximately 70% of scale range) Location of measurement (pump, tubing, annulus, downhole, etc.) Calibration data
Temperature Specific Conductance pH	Type of gauge Location of easurement Calibration data
Volume	Method of measurement as required by Rule 328.b. Location of measurement Calibration data
Fluid Analysis	Description of sampling procedure including such things as, number and type of samples taken, sampling method, location, preservation, holding times, chain of custody, analytical method Compliance with QAPP required by Rule 322C
Latitude and Longitude	Locations are surveyed from section lines and footage measurements are provided to COGCC by operator. COGCC is currently developing a system known as "Plat Mapping Information System" (PMIS) for converting locations specified by surveyed footage measurements to latitude and longitude. GITI land grid is being used for this conversion.

B. MEASUREMENT/DATA ACQUISITIONB. MEASUREMENT/DATA ACQUISITION

This group of QAPP elements covers various aspects of measurement systems design and implementation, ensuring that appropriate methods for sampling, analysis, data handling, and QC are employed and documented. The following QAPP elements describe the requirements related to the actual methods to be used for the:

- Collection, handling, and analysis of samples.
- Use of measured parameters obtained form other sources.
- Management of data.

B1 SAMPLING PROCESS DESIGN.................................. SAMPLING PROCESS DESIGN

Although the COGCC and industry perform many types of analyses using raw data, the variety of raw data collected in support of Class II UIC projects is limited. Generally these data elements include pressure, volume, and fluid quality sampling, except in instances of suspected, alleged, or confirmed pollution to USDW.

B2 SAMPLING METHODS REQUIREMENTS.... SAMPLING METHODS REQUIREMENTS

This section describes the procedures for collecting routine samples associated with Class II UIC wells. In addition, common sense, good housekeeping procedures should always be followed, including:

- Written instructions on sampling procedures should be available for field personnel.
- Sampling equipment should be checked prior to use to ensure good operating conditions and cleanliness.
- Sampling equipment should be cleaned after each use and stored in a neat and secure place.
- Manufacturer's specifications regarding operation, calibrations, and maintenance should be followed.

B2.1 Wellhead Pressures.1 Wellhead Pressures

The measurement of pressure on the wellhead is the most commonly made in the UIC program. Pressure measurements help to confirm that the well is operating in a way that will not impact USDWs. These measurements are usually made with a standard pressure gauge attached to the tubing or annulus at the wellhead. Measurements are made by both COGCC staff and operators. COGCC field engineers are equipped with a number of gauges covering a range of operating pressures. The COGCC SOP for UIC inspections is included in Appendix E.

Since the well may be operating (injecting) or shut-in at the time a pressure reading is taken, the location of the pressure measurement is very important. Injection wells are usually constructed with one-way valves installed on the injection line. These valves allow fluid to flow only into the well. If a well is injecting during a pressure measurement, these one-way valves will not greatly affect the pressure readings. A pressure reading can be taken at any point between the pumps and the wellhead; however, a point closest to the wellhead will provide the most representative measurement.

If the well is shut-in during a pressure measurement, the point of measurement is very important. Since the one-way valves will be closed and will not allow fluid to "backflow" to the pumps, any pressure reading made between the one-way valves and the pumps should indicate a pressure of 0 psi since the pumps are not operating. To get representative tubing pressures at the wellhead, generally the measurements must be made at a point between the one-way valve and the wellhead.

As with any pressure measurement, all valve(s) should be open if they are located between the pressure gauge and the point of measurement. On an injection well, valves usually exist on the tubing at the wellhead, and on the annulus. If a well is injecting, the tubing valve will be open. If a well is not injecting, check each valve to make sure that the pressure gauge is not isolated from the desired point of measurement. Also, pressure gauges are usually mounted on small "needle valves". These needle valves should be in the open position when the gauge is in place so the desired pressure can be read.

Annulus pressure measurements are used to evaluate the mechanical integrity of the tubing, packer, and casing. These measurements may be made during routine field inspections, or during mechanical integrity tests. Pressure measurements should be made in a manner similar to tubing pressure measurements, checking to ensure that all valves between the pressure gauge and the annulus are open.

It is the operators responsibility to ensure that field personnel are properly trained, and equipment properly maintained and calibrated so that accurate and precise measurements are made, recorded, and submitted to the COGCC.

B2.2 Volumes/Flow Rates.2Volumes/Flow Rates

As required by COGCC Rule 328, the volume of water injected into a Class II injection well is to be computed and reported in terms of barrels on the basis of properly calibrated meter measurements or tank measurements of water level differences, made and recorded to the nearest one-quarter of one hundred percent capacity tables. If water is transported to an injection facility by means other than direct pipeline, then measurement of water is required by a properly calibrated meter. Typically flow meters have an accuracy of ±1% and this level of accuracy is acceptable to the COGCC.

It is the operators responsibility to ensure that field personnel are properly trained, and equipment properly maintained and calibrated so that accurate and precise measurements are made, recorded, and submitted to the COGCC.

B2.3 Fluid Sampling - Formation, Injectate, and Other.3Fluid Sampling - Formation, Injectate, and Other

When sampling fluid or sludge on a routine basis for such parameters as total dissolved solids (TDS), pH, or specific conductance (SC), common oil field methods or EPA approved methods can be used. For other non-routine sampling a site specific sampling and analysis (SAP) should be developed that describes the purpose of the sampling event, the sampling method, sample handling procedures, analytical procedures, and the QA/QC aspects of sampling.

Most water samples will come from drill stem testing, swab testing or directly from injection lines or storage tanks. Commonly accepted methods for taking these samples can be found in the references listed. The minimum standards specified in the "API Recommended Practice for Analyses of Oil Field Waters" API Report 45 must be met.

Some practical and general guidelines for sampling are presented below:

- Prior to sampling, existing information including inspection files, laboratory studies, correspondence, etc. should be reviewed. The nature of the product or contaminants, previous sampling results, the appropriate sampling method will determine the number and location of samples, the analytical parameters, and the necessary equipment for the sampling work.

- Prior to sampling, operators should coordinate with the COGCC staff to confirm the selected approach to sampling and analysis. This should maximize the reliability of the results and help to prevent duplication of work. Communication between the COGCC and the operator should be maintained throughout the project.

- Prior to sampling, the locations should be inspected and field measurements of such parameters as pH, SC, temperature, etc. should be made to verify proposed sampling strategy.

- If sample contamination is known or suspected and if the results are submitted to the COGCC, then this fact must be clearly noted on the analytical report or written report from the operator.

Sampling Strategies:

Wellhead Sampling: Wellhead sampling such as swab testing, must be done in a manner to assure that the source has been sufficiently flushed of foreign waters prior to taking the sample.

When sampling injectate, the goal of sampling investigations is to characterize injectate closest to the point of injection. Practically in the case of Class II wells this point is usually at the wellhead, but depending upon configuration, may be a storage tank.

When sampling formation fluids, the primary concern is to obtain an uncontaminated and representative sample for analysis. Contamination of the sampled formation fluids by drilling or completion fluids may occur either within the wellbore or within the formation. When sampling formation waters, care must be used to minimize sample contamination.

Tanks and Pits: Fluids in tanks and pits often become stratified. If stratification is known or suspected, then samples should be taken in a distribution proportionate to the layered volumes. If access to the tank is restricted, then samples taken should not be considered representative unless the contents are known to be homogeneous, or unless samples are taken in a distribution proportionate to layer volumes while the tank is being emptied.

The stratification in tanks and pits is generally occurs as :

- Surface fluids, i.e., less dense fluids floating or accumulated on the surface of more dense fluid such as oil, grease or emulsions on water;
- An intermediate layer of more dense fluids such as produced water;
- Pit bottom sludges including mixtures of oil and chemical emulsions and soils.

A representative sample of the fluids should be taken using a weighted bottle, pond dipper, or some other appropriate sampling devise. Samples of the bottom sludges should be taken and analyzed separately from liquid portions of the contents.

B2.4 Latitude and Longitude.4 Latitude and Longitude

See Section A10 and Table 2.

B2.5 Temperature, pH, and Specific Conductivity.5Temperature, pH, and Specific Conductivity

Generally, temperature, pH, SC will be measured, during non-routine environmental sampling, such as when contamination of an USDW is suspected or confirmed. There are numerous devices available that can be used in the field to measure any or all of these parameters. The equipment must be operated and calibrated according to manufacturers specifications to ensure accurate measurements. In addition, the sample tested must be representative of the source. Table 3 presents the calibration, QC, corrective action, and data flagging requirements for routinely used field screening methods. An explanation of data qualifiers and data flagging conventions is presented in Appendix F.

B3 SAMPLING HANDLING AND CUSTODY REQUIREMENTSSAMPLING HANDLING AND CUSTODY REQUIREMENTS

All procedures for transferring samples from the field to the laboratory should be specified in a SAP and/or documented and kept with the analytical results in the project or well file. The type of sample containers to be used to collect samples, as well as the procedures to be used to ensure that sample containers are free of contamination prior to use, should be identified. The container type and cleaning procedure depend on the parameters being analyzed. Sample preservation is intended to retard biological action, hydrolysis and reduce sorption effects. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and protection from sunlight. Samples must be kept at low temperatures or at 4^{o} C for best preservation.

An adequate chain-of-custody program will allow for the tracing of possession and handling of individual samples from the time of field collection through laboratory analysis.

B3.1 Sample Labeling.1 Sample Labeling

A sample numbering system should be used that provides a tracking mechanism to allow retrieval of sample information, including sampling locations, date, time, and analytical parameters requested. The method of sample identification to be used depends on the type of sample collected and the type of sample container.

Table 3 Summary of Calibration and QC Procedures for Field Screening and Basic Laboratory Analytical Methods
Page 1 of 3
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Data Flagging Criteria[b]
SW9045	pH (soil)	2-point calibration with pH buffers	1 per 10 samples analyzed	± 0.05 pH unit	Check with new buffers; if still out, repair meter; repeat calibration check	R
		pH 7 buffer	At each sample location	± 0.1 pH unit	Recalibrate	R
		Duplicate sample	10% of field samples	± 0.1 pH unit	Correct problem, repeat measurement. If still out, repeat calibration and reanalyze samples	J
SW9050	Conductance	Calibration with KCl standard	Once per day at beginning of testing	± 5%	If calibration is not achieved, check meter, standards, and probe; recalibrate	R
		Field duplicate	10% of field samples	± 5%	Correct problem, repeat measurement	J
SW9040	pH (water)	2-point calibration with pH buffers	Once per day	± 0.05 pH units for every buffer	If calibration is not achieved, check meter, buffer solutions, and probe; replace if necessary; repeat calibration	R
		pH 7 buffer	At each sample location	± 0.1 pH units	Correct problem, recalibrate	R
		Field duplicate	10% of field samples	± 0.1 pH units	Correct problem, repeat measurement	J
E170.1	Temperature	Field duplicate	10% of field samples	± 1.0°C	Correct problem, repeat measurement	J

a. All corrective actions shall be documented, and the records shall be maintained by the operator.

b. All screening results shall first be flagged with an "S" and also any other appropriate validation flags identified in the Data Flagging Criteria column of the table. For example "SJ", "SB", "SR".

c. Described in method SW3550.

Table 3 Summary of Calibration and QC Procedures for Field Screening and Basic Laboratory Analytical Methods
Page 2 of 3
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Data Flagging Criteria[b]
None	Organic vapor concentrations (FID and PID)	3 point calibration	Monthly	correlation coefficient ≥ 0.995	Recalibrate; check instrument and replace if necessary	R
		Calibration verification and check	Daily at beginning and end of day	Response ± 20% of expected value	Correct problem, recalibrate	R
SW9060	Total organic carbon	Method blank	Daily or one per batch, whichever is more frequent	< RL	Clean system; reanalyze blank. Repeat until analyte < RL	B
		Field duplicate	10% of field samples	RPD < 20%	Repeat measurement	J
E160.1	Filterable residue	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
E160.2	Nonfilterable residue	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
ASTM D1498	Oxidation-reduction potential	Sensitivity verification	Daily	ORP should decrease when pH is increased	If ORP increases, correct the polarity of electrodes. If ORP still does not decrease, clean electrodes and Repeat procedure	R
		Calibration with one standard	Once per day	Two successive readings ± 10 millivolts	Correct problem, recalibrate	R
		Field duplicate	10% of field samples	± 10 millivolts	Correct problem, repeat measurement	J

a. All corrective actions shall be documented, and the records shall be maintained by the operator.

b. All screening results shall first be flagged with an “S” and also any other appropriate validation flags identified in the Data Flagging Criteria column of the table. For example “SJ”, “SB”, “SR”.

Table 3 Summary of Calibration and QC Procedures for Field Screening and Basic Laboratory Analytical Methods
Page 3 of 3
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Data Flagging Criteria[b]
E310.1	Alkalinity	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
E360.1	Dissolved oxygen	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
ASTM D3416	Methane	Single point calibration	Daily, prior to sample analysis	Delineation from database average within ± 20%	Recalibrate	R
		Method blank	Daily or one per batch, whichever is more frequent	< RL	Clean system; reanalyze blank and Repeat until all analytes < RL	B
		Duplicate	1 per batch or 10%	RPD ≤ 20%	Analyze third aliquot: if still out, flag data	J

a. All corrective actions shall be documented, and the records shall be maintained by the operator.

b. All screening results shall first be flagged with an “S” and also any other appropriate validation flags identified in the Data Flagging Criteria column of the table. For example “SJ”, “SB”, “SR”.

Samples collected for specific field analyses or measurements remain in the custody of the sampling personnel. Results should be recorded in a bound field logbook or recorded on field data sheets along with sample identity information.

Samples collected and sent to a third party for analysis should be labeled in the field by sampling personnel. Generally pre-printed sample labels are available from laboratories and should be used. A typical sample label is presented in Appendix G. The sample label should contain the following information:

- Laboratory name
- Project name
- Sample ID (each analytical sample should be assigned a unique number by the sampler)
- Station ID
- Preservation method
- Analysis
- Sampler's initial and signature
- Time and date of sample collection

B3.2 Chain-of-Custody Protocol.2 Chain-of-Custody Protocol

Samples should be shipped in a cooler or other the appropriate container. Chain-of-custody (COC) forms should accompany the sample shipment. COC forms generally are available from the laboratory conducting the analyses. Legal field custody begins when the clean sample containers are obtained from the laboratory and should end when those samples are relinquished to the laboratory for testing. This continuity will be reflected by the appropriate entries on the COC form. A typical COC form is included in Appendix H.

A sample or other physical evidence is said to be under custody if it meets the following conditions:

- It is in the field investigator's physical possession.
- It is in the field investigator's view, after being in his/her possession.
- It was in the field investigator's physical possession and he/she secured it to prevent tampering.
- It is placed in a designated secure area.

Field COC: Each cooler containing samples sent to the analytical laboratory should be accompanied by a COC record. The primary purpose of the COC procedures is to document the possession of the samples from collection through storage, analysis, and reporting. COC forms should become the permanent record of all sample handling and shipment activities.

The sampling person or team that collects the samples should retain sample custody in the field. The samples must remain in the possession of and in view of a member of the sampling team until they are placed in a designated secure area or relinquished. The COC forms and labels must be completed before the samples are shipped or delivered to the laboratory.

Laboratory COC: Laboratory COC procedures, including sample receipt, sample storage, and disbursement for extraction and/or analyses, should be provided in the laboratories' QAPP. If COC procedures are unsatisfactory, then the COGCC has the authority to review, approve, or deny a laboratory's QAPP.

B3.3 Packaging and Shipping.3 Packaging and Shipping

Appropriate procedures and safeguards should be used for all sample packaging and shipping activities. When custody is transferred to a bonded courier for delivery, the COC form will be signed and dated by the individual who relinquishes custody. The shipping documents from the bonded courier will be used in lieu of a signature on the COC while custody is held by the courier.

B4 ANALYTICAL METHODS REQUIREMENTSANALYTICAL METHODS REQUIREMENTS

The analytical method requested is dependent both on the specific result sought for the sampling event and on the compatibility of the analysis method with the sample and matrix. It is important to check with the laboratory prior to the sampling event to confirm that the analytical method(s) requested is compatible for the sample matrix. Analysis methods must be chosen to meet the appropriate DQO. Some standard methods used for routine environmental samples analyses are listed in Table 4. The calibration, QC, corrective action, and data flagging requirements are presented in Appendix I for laboratory analytical methods that might routinely be used for UIC related projects. Methods for non-routine analyses must be specified in a site-specific SAP.

TABLE 4
RECOMMENDED ANALYTICAL METHODS FOR ENVIRONMENTAL SAMPLES

ANALYTICAL PARAMETERS	METHOD
BTEX	EPA METHOD 8020
TOTAL PETROLEUM HYDROCARBONS (TPH)	EPA METHOD 8015 modified or EPA METHOD 418.1
OIL AND GREASE	EPA METHOD 413.1
COMMON ANIONS (chloride, fluoride, bromide, nitrate, nitrite, phosphate, sulfate)	EPA METHOD 300 or API 45
TRACE METALS/CATIONS (calcium, magnesium, sodium, potassium, manganese, iron)	ICP/FLAME AA 6010/200 series or API 45
CARBONATE/BICARBONATE	EPA METHOD 403 or STANDARD METHOD 2320B
ALKALINITY (as carbonate and bicarbonate)	EPA METHOD 310.1
FILTERABLE RESIDUE (TDS)	EPA METHOD 160.1 or API 45
NON-FILTERABLE RESIDUE (TSS)	EPA METHOD 160.2
pH (soil)	EPA METHOD 9045
pH (water)	EPA METHOD 9040 or EPA METHOD 150.1
SPECIFIC CONDUCTANCE	EPA METHOD 120.1
ORGANIC VAPORS	FID or PID SOP

The COGCC or its authorized representative reserves the right to inspect the operation, calibration, and QA program for any laboratory submitting data relevant to the UIC program. Laboratory calibrations are to be conducted per the manufacturer's recommendations or more frequently as deemed necessary for the production of good quality data. A SAP should describe in detail the analytical procedures that will be used to determine the concentrations of constituents or parameters of interest. These procedures will include suitable analytical methods as well as proper QA/QC protocols. The required precision, accuracy, detection limits, and percent recovery (if applicable) specifications will be clearly identified in the plan.

A SAP should identify one method that will be used for each specific parameter or constituent. A SAP should specify an EPA approved method or other standard method acceptable to COGCC, and clearly indicate whether there are going to be any deviations from the stated method and the reasons for such deviations.

Records of sampling analyses should include the methods used, extraction date, and date of actual analysis. Data from samples that are not analyzed within recommended holding times will not be used. Any deviation from an approved method should be adequately tested to ensure that the quality of the results meets the performance specifications such as detection limit, sensitivity, precision, accuracy of the reference method. It is recommended that the operator contact the analytical laboratory to determine the proper sample holding time and to discuss the analytical methodology being used by the laboratory.

B5 QUALITY CONTROL REQUIREMENTS...........QUALITY CONTROL REQUIREMENTS

Quality Control (QC) data is collected to detect errors resulting from improper sampling, analysis, or poor sample preservation. QC data is used to help determine the quality of analysis results. Calibration checks on all laboratory equipment must also be compatible with the DQOs.

Generally for Class II UIC wells only a limited number of fluid samples are collected. These are typically analyzed for TDS and major anions and cations using routine oil field or EPA approved methods. QC requirements for this type of sampling would be limited; however, should a situation occur, such as suspected or detected contamination of a USDW, where samples may be collected from numerous water supply wells or monitoring wells, and when samples are analyzed for more parameters, including organic constituents such as benzene, toluene, ethylbenzene, and xylenes (BTEX), then the QC requirements for the program must become more encompassing.

In cases like these, one of the fundamental responsibilities of the operator is the establishment of continuing programs to ensure the reliability and validity of field and analytical laboratory data gathered as part of the overall sampling program. The operator's SAP should describe the QA/QC program that will be used.

Various types of field blanks might be used in some cases to verify that the sample collection and handling process has not affected the quality of the samples. Field blanks are suggested when analyzing for extremely low concentrations or if unexpected constituents are suspected or detected. If contaminants are found in the blanks, then the source of the contamination must be identified and corrective action, including resampling must be initiated.

Below are recommendations for collecting QC samples at UIC facilities, especially when organic constituents are to be analyzed. To determine the number of QC samples, a sampling event can be defined as sampling several wells in a given geographic area over a short time period (e.g., one week) and should be specified. Certain situations (e.g., enforcement actions) may dictate a QC sampling scheme that goes beyond these requirements and should be documented in a site-specific SAP. If QC sample results detect significant errors, then resampling should be done, as necessary, to ensure data quality

B5.1 Field QC Checks.1 Field QC Checks

Table 3 summarizes acceptable calibration and QC procedures for various field methods.

Field Replicates/Duplicates: These are samples of the same fluid collected at the same time from the same location. These samples are designed to spot check field procedures or the precision of a laboratory's analysis of two identically collected, preserved, stored, and shipped samples. There should be at least one Field Replicate/Duplicate sample analyzed for each sampling event. If more than twenty samples are collected as part of a sampling event, include at least one Field Replicate/Duplicate sample for every twenty investigative samples.

Trip Blanks (applies to volatile organic compound (VOC) investigative samples only): These samples are prepared from analyte-free water and preserved by the laboratory, then transported to the sampling site with the VOC investigative sample bottles. They are kept with the investigative samples throughout the actual sampling and shipment to the laboratory. They must not be opened on site, and are used to evaluate any VOC contamination caused by shipping and handling procedures. A trip blank is prepared in two 40 milliliter (mL) VOC vials with Teflon septum lids, and must be stored in an ice-filled cooler for shipment to the laboratory and handled in the same manner as a water sample for VOC analysis. One trip blank (i.e., two vials) should be included and analyzed for every cooler of VOC investigative samples.

Equipment/Rinseate Blanks (applies to all investigative samples when field decontamination procedures are required for sample collection equipment): In cases where equipment is re-used to collect samples, QC samples are obtained from the last rinse of analyte-free water during equipment decontamination to confirm that decontamination is complete and thus prevent cross-contamination of subsequent samples. The date and time of rinseate blank collection should be noted, as well as the ID number of the investigative sample collected just prior to decontamination, and the ID number of the next sample collected with the decontaminated equipment. There should be one equipment/rinseate blank collected for each decontamination procedure. One out of every twenty equipment/rinseate blanks should be analyzed. If this analysis indicates contamination, analyses should then be performed on each equipment/rinseate blank, and any samples with possible contamination should be identified.

Performance Evaluation (PE) or Spiked Samples: These are samples of a known target analyte concentration that are sent to the laboratory for "blind" analysis. Investigative sample results are validated and accuracy assessed when comparing the known PE values with the laboratory results. There should be at least one PE sample analyzed for each sampling event. If more than ten samples are collected as part of a sampling event, then at least one PE sample for every ten investigative samples should be analyzed.

Field Blanks (generally applies to volatile organic compound (VOC) investigative samples): Field blanks are used to detect contamination resulting from field-related activities or atmospheric conditions. Field blanks check for analytical zero values, any positive bias from contaminated sample bottles or preservatives, and any contamination from atmospheric sources. Suspected sources of contamination (e.g., atmospheric VOC contamination) should be documented. Field blanks are filled at the field location by pouring the analyte-free water through the air, just as an investigative sample would be prepared in the field. If several samples are to be collected from different areas at a facility, and air quality varies between these areas, then field blanks should be prepared at each area.

Background Samples: In cases where ground water contamination is suspected or known to have occurred, or where baseline data on aquifer quality is needed, at least one sample should be taken from the same aquifer at an upgradient or background location.

B5.2 <u>Laboratory QC Checks</u>.2 <u>Laboratory QC Checks</u>

Laboratories used for analyzing samples collected in support of the UIC program by either COGCC staff, operators, or contractors must use standard analytical procedures and any deviations from a standard method must be documented in a laboratory SOP and approved by the laboratory QA officer and laboratory manager. In addition, laboratories must have an internal QC program established to monitor and document laboratory performance during the course of the sample analysis. Included in the QC samples are blanks, spiked sample, duplicate spiked samples, laboratory control spikes, surrogates, calibration check standards and internal standards. QC samples for each specified method usually are provided in the project specific analysis plan. QC samples are analyzed in the same manner as field samples and are used to document the validity of data and to control data quality within predetermined acceptance limits. Table 3 summarizes acceptable calibration and QC procedures for several basic laboratory methods. RLs, QC acceptance criteria, and a summary of calibration and QC procedures for EPA Methods SW 8015, 8020A, 6010A, and 9056 are presented in tables in Appendix I.

B7 INSTRUMENT CALIBRATION AND FREQUENCYINSTRUMENT CALIBRATION AND FREQUENCY

Most mechanical measuring devices require periodic calibration and service to ensure accuracy and to maintain QC. Each instrument has its own operating requirements and limitations that may vary with manufacturer and model. The requirements for a field pH meter or pressure gauge will of course be different than those for a laboratory gas chromatograph. It is necessary to meet the instrument specific requirements to ensure that it works properly and that DQOs are being met. All tools, gauges, meters, field or analytical instrumentation must be calibrated and serviced according to manufacturer's specifications. In addition, pressure gauges will be calibrated with a dead weight tester or other appropriate means annually/

Operators must ensure that laboratories used for the analysis of fluid samples have established and adhered to calibration procedures as part of their overall QA/QC Plans and SOP. The calibration, QC, corrective action, and data flagging requirements are presented in Appendix I for laboratory analytical methods that might routinely be used for UIC related projects. Methods for non-routine analyses must be specified in a site-specific SAP.

In addition, as required by COGCC Rule 328.b: *The volume of water injected into a Class II injection well shall be computed and reported in terms of barrels on the basis of properly calibrated meter measurements or tank measurements of water-level differences, made and recorded to the nearest one-quarter (1/4) inch of one hundred percent (100%) capacity tables. If water is transported to an injection facility by means other than direct pipeline, measurement of water is required by a properly calibrated meter.*

B10 DATA MANAGEMENT DATA MANAGEMENT

Sampling and analysis results and field measurement data are received primarily in the form of permit applications, monthly injection reports, fluid analysis reports, COGCC inspection reports, and MIT reports. Trained staff enter these data into a computerized UIC database, a copy of which can be accessed by all UIC staff through a local area network (LAN). Hard copy data are placed in the appropriate facility, well, and/or Form 14A (Monthly Reports of Fluids Injected) file. These data are used to support program decisions and activities and to meet reporting requirements.

While correct field practices are necessary for generating data of known quality, the ability to maintain this quality for decision making can be compromised if the method for managing the data is inadequate. In an effort to minimize the opportunity for paperwork-related errors and data loss, the COGCC has developed and adopted some QC-based practices that include:

- Checklist to confirm that all permit related hard copy data is complete and current.
- All hard copy data to be entered is matched to a well-specific or facility specific computer file through a unique number, i.e., API number for well-specific data or facility number for facility specific data, to prevent data entry into the wrong file.
- Computerized system for generating quarterly "Delinquency Reports" which indicate whether an operator has submitted permit and rule required data.
- Computerized system for identifying reported injection pressures which exceed the permitted maximum values.
- Data in the violation tracking file is automatically imprinted with the date of computer entry.
- All computerized data is physically backed up on a weekly basis.

In addition, the COGCC has created a set of instructions available to operators to assist them in accurately completing the required monthly report of fluids injected (Form 14A). A copy of these instructions is included in Appendix C.

C ASSESSMENT/OVERSIGHTC ASSESSMENT/OVERSIGHT

This group of QAPP elements addresses the activities for assessing the effectiveness of the implementation of the project and associated QA/QC. The purpose of assessment is to ensure that the QAPP is implemented as prescribed.

C1 ASSESSMENT AND RESPONSE ACTIONSASSESSMENT AND RESPONSE ACTIONS

Reviews and audits are used to determine the adequacy of sampling and/or analysis, field measurements, completeness of documentation of data generating activities, to document if DQOs are being met, to identify non-conformance and to verify correction of identified deficiencies.

C1.1 Assessment.1 Assessment

Assessment activities may include surveillance, inspections, management system reviews, technical system audits, performance evaluations, data quality assessments, etc. It is the responsibility of the operator and laboratory to ensure that proper assessment activities are undertaken to assure DQOs are achieved. However, the UIC Program Manager or the EPA Project Officer may also initiate independent assessments including any of the above activities. These activities may be performed by COGCC staff or the EPA QA staff as directed by the UIC Program Manager or the EPA Project Officer, respectively.

C1.2 Response Actions.2 Response Actions

It is the responsibility of the operator and laboratory to ensure that proper corrective actions are taken in response to deficiencies identified by assessments. However, the COGCC maintains the right to review assessments and perform investigations to verify that proper corrective actions were implemented.

PAGE REVISED 10/22/97

D DATA VALIDATION AND USABILITYD DATA VALIDATION AND USABILITY

This group of QAPP elements covers the QA activities that occur after the data collection phase of the project is completed. Implementation of these elements determines whether or not the data conform to the specified criteria, thus satisfying the project objectives.

D1 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTSDATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

The COGCC's data review, validation, and verification requirements specific to the Class II UIC program primarily include a detailed review of all data submitted to the COGCC in association with Class II injection activities. Data are reviewed to assure that the data were collected in adherence with this QAPP. In addition, operators of Class II injection wells must adhere to applicable statutes, and COGCC rules, orders, permits, etc. Adherence is determined through the permit review process, file review, and other permitting, compliance, field oversight, and enforcement activities. Using this process, the COGCC is able to confirm that a process, item, data set, or other related activity satisfies COGCC requirements.

In instances where the COGCC believes data submitted are suspect, Section 34-60-106 provides the COGCC and its staff with the power to perform all acts for the purpose of protecting USDW for Class II UIC activities. This could include such things as:

- Investigating conditions relating to violations of permit conditions.
- Having access to and copying records required.
- Inspecting monitoring equipment or methods.
- Sampling fluids which the operator is required to sample.

Fluid Samples and Analysis: The operator's project manager should be responsible for deciding what criteria are used to review and verify data. These criteria should be based upon the circumstances surrounding the sampling event, the expected results from sampling, and the intended use of the analytical data.

Field Measurements: Review of field measurement data (wellhead pressure, volumes, pH, etc.) should include a review of each applicable item listed under Group B of this document. This review should attempt to determine if measurements were made according to the accepted methods and taken at an appropriate location, if proper QA/QC measures were followed, if the instrument was on an acceptable maintenance schedule, and if the instrument was properly calibrated prior to taking the measurement.

D2 VALIDATION AND VERIFICATION METHODSVALIDATION AND VERIFICATION METHODS

D2.1 Fluid Samples and Analysis.1 Fluid Samples and Analysis

Several methods to be used for validating data from fluid sampling and analysis are described in Section B5, or should be defined in a site-specific SAP. The project manager is responsible for deciding what criteria are to be used to validate data. These criteria are to be based upon the circumstances surrounding the sampling event, the expected results from sampling, and the intended use of the analysis data.

It should be kept in mind that for Class II wells, fluid sampling may include only a few samples analyzed for only a few parameters over the life of the well, unless contamination is suspected or detected; therefore the effort required for data validation and verification will be limited.

D2.2 Routine Field Measurements.2 .... Routine Field Measurements

When using COGCC-owned instrumentation, the calibration data should be recorded. A copy of the results should be kept with the instrument and one with the test results for use by data users.

For field measurements that are reported by the well operator, the operator should maintain documentation of instrument calibration. Because most operators do not maintain a records-keeping facility at a well location, documentation of instrument calibration may be maintained at the operator's office. This documentation must be available for inspection by COGCC staff during normal working hours.

D3 RECONCILIATION WITH USER REQUIREMENTSRECONCILIATION WITH USER REQUIREMENTS

When a sampling or field measurement is complete the results will be compared with the DQOs. The goal of this assessment is to demonstrate that a sufficient number of representative samples were collected or measurements made, and the resulting analytical data can be used to support the project decision making process. If it is determined that the DQOs have not been met, the appropriate data decision makers will determine whether new DQOs should be developed and/or whether further monitoring and/or sampling activities are to be conducted.

REFERENCESREFERENCES

Organic and inorganic compounds, water quality measurements: 40 CFR Part 136 "Guidelines Establishing Test Procedures for the Analysis of Pollutants," (as revised on October 26, 1984 and January 4, 1985), 136.3, Table I. This list references the accepted methods to analyze waters for organic and inorganic contaminates. It also includes some physical tests (temperature, specific gravity, etc.).

Organic compounds, water quality measurements: "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater." EPA-600/4-82-057, July 1982, available from the Center for Environmental Research Information (CERI) 26 West St. Clair Street, Cincinnati, Ohio 45268, Phone: (513)-684-7562 or FTS 684-7562. NOTE: This technical report provides procedures that are as uniform and cost effective as possible (with some minor compromises) for the analysis of some organic pollutants. It also provides references that would be helpful to the analyst.

Methods for the analysis of inorganic compounds: "Methods for Chemical Analysis if Water and Wastes", EPA-600/4-79-020, March 1979; available form the Center for Environmental Research (CERI), 26 West St. Clair Street, Cincinnati, Ohio 45268. NOTE: This reference is included in 1. above and provides acceptable analytical methods.

Other analyses not covered above should be performed in accordance with the most recent edition of " Standard Methods for the Examination of Water and Wastewaters": American Public Health Association, American Water Works and the Water Pollution Control Federation.

Class II programs, analyses which require a high degree of accuracy must be done as explained above or in accordance with "API Recommended Practice for Analysis of Oil-Field Waters" API Report No. 45.

NOTE: Techniques already approved and used for other programs (RCRA, CERCLA, NPDES, PWSS, etc.) should be deemed acceptable for the same type of analyses.

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MEMO: Acidification and Icing of Metals Samples. FROM: Alan A. Stevens, Director, Technical Support Division, Cincinnati, OH. TO: Environmental Services Division Directors, Water Management Division Directors, Certification Program Managers Regions I-X. February 8, 1995.

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Locational Data Policy Implementation Guidance - Guide to the Policy. US Environmental Protection Agency, Administration and Resources Management (PM-211D). March 1992

Tony Selle Region VIII Strategic Integration, Data Integration (SIDI) Office. Personal telephone conversation with Chuck Tinsley. April 12, 1995.

LIST OF ACRONYMS AND ABBREVIATIONSLIST OF ACRONYMS

AA	atomic absorption
ASCII	American Standard Code Information Interchange
ASTM	American Society for Testing and Materials
BFB	bromofluorobenzene
Br^-	bromide
BTEX	benzene, toluene, ethylbenzene, xylenes
°C	degrees Celsius
CCC	calibration check compound
CF	calibration factor
CFR	Code of Federal Regulation
Cl^-	chloride
CL	control limit
COC	chain of custody
COGCC	Colorado Oil and Gas Conservation Commission
DQO	data quality objective
DRO	diesel range organics
EPA	Environmental Protection Agency
F^-	fluoride
FID	flame ionization detector
FLAA	flame atomic absorption
FS	feasibility study
FSP	field sampling plan
g	gram
GC	gas chromatography
GC/MS	gas chromatography/mass spectroscopy
GFAA	graphite furnace atomic absorption
GPS	global positioning system
GRO	gasoline range organics
HCl	hydrochloric acid
HNO_3	nitric acid
H_2SO_4	sulfuric acid
ICP	inductively coupled plasma

ICPES	inductively coupled plasma emission spectroscopy
ICP-MS	inductively coupled plasma - mass spectroscopy
ICS	interference check standard
ID	identification
IS	internal standard
LCL	lower control limit
LCS	laboratory control sample
LAN	local area network
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
mm	millimeter
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NO_2^-	nitrite
NO_3^-	nitrate
NTU	nephelometric turbidity unit
ORP	oxidation-reduction potential
OVA	organic vapor analyzer
P	polyethylene
PID	photoionization detector
PO_4^{-3}	phosphate
ppb	parts per billion
ppm	parts per million
ppmv	parts per million volume
PQL	practical quantitation limit
psi	pounds per square inch
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
R	recovery
RCA	recommendations for corrective action
RI	remedial investigation
RI/FS	remedial investigation/feasibility study

RPD	relative percent difference
RSD	relative standard deviation
SAP	sampling and analysis plan
SC	specific conductance
SO_4^{-2}	sulfate
SOP	standard operating procedure
SOW	statement of work
SPCC	system performance check compound
SVOC	semivolatile organic compound
TCLP	toxicity characteristic leaching procedure
TIC	tentatively identified compound
TPH	total petroleum hydrocarbon
UCL	upper control limit
UIC	underground injection control
USDW	underground source of drinking water
VOC	volatile organic compound
v/v	volume to volume
W	water

SYMBOLS

mg/kg	micrograms per kilogram
mg/L	micrograms per liter
mg/mL	micrograms per milliliter
mL	microliter
mm	micrometer

APPENDIX A

COGCC
UIC DISPOSAL WELL APPLICATION

APPENDIX B

COGCC
400 SERIES RULES
UNIT OPERATIONS, ENHANCED RECOVERY PROJECTS, AND STORAGE OF LIQUID HYDROCARBONS

APPENDIX C

COGCC
FORM 14A
MONTHLY REPORTS OF FLUIDS INJECTED

APPENDIX D

COGCC
FIELD REPORT

APPENDIX E

UNDERGROUND INJECTION CONTROL FIELD PROCEDURES

APPENDIX F

DATA QUALIFIERS AND DATA FLAGGING CONVENTIONS

APPENDIX F
LIST OF TABLES

Appendix F
Table 1 Data Qualifiers
(after AFCEE QAPP Version 2, January 1997)

Qualifier	Description
J	The analyte was positively identified, the quantitation is an estimation.
U	The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL.
F	The analyte was positively identified but the associated numerical value is below the RL.
R	The data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.
B	The analyte was found in an associated blank, as well as in the sample.
M	A matrix effect was present.
S	To be applied to all field screening data.
T	Tentatively identified compound (using GC/MS)

APPENDIX F
Table 2. General Flagging Conventions
(after AFCEE QAPP Version 2, January 1997)

QC Requirement	Criteria	Flag	Flag Applied To
Holding Time	Time exceeded for extraction or analysis	R	All analytes in the sample
LCS	% R > UCL %R < LCL	J for the positive results J for the positive results, R for the nondetects	The specific analyte(s) in all samples in the associated analytical batch
Method Blank	Analyte(s) detected > RL	B	The specific analyte(s) in all samples in the associated analytical batch
Equipment Blank	Analyte(s) detected > RL	B	The specific analyte(s) in all samples with the sampling date
Field duplicates	Field duplicates > RLs AND RPD outside CL	J for the positive results R for the nondetects	The specific analyte(s) in all samples collected on the same sampling date
MS/MSD	MS or MSD % R > UCL OR MS or MSD % R < LCL OR MS/MSD RPD > CL	M for all results	The specific analyte(s) in all samples collected from the same site as the parent sample
Sample Preservation/ Collection	Preservation or collection requirements not met	R for all results	All analytes in the sample
Sample Storage	< 2°C or > 6°C	J for the positive results R for the nondetects	All analytes in the sample

UCL = upper control limit LCL = lower control limit CL = control limit

	Criteria	**Flag***
Quantitation	≤ MDL	U
	> MDL < RL	F
	≥ RL	as needed

* Example 1: if the MDL is 0.04, the RL is 0.9 and the result is 0.03, the concentration reported on the results form would be 0.04 (the MDL) and the qualifier flag would be U.

Example 2: if the MDL is 0.04, the RL is 0.9 and the result is 0.07, the concentration reported on the results form would be 0.07 and the qualifier flag would be F.

Example 3: if the MDL is 0.04, the RL is 0.9 and the result is 1.2, the concentration reported on the results form would be 1.2 and the qualifier would be any flag needed because of a data quality problem (e.g., R, J, B, etc.).

APPENDIX F

Table 3. Flagging Conventions Specific to Organic Methods (after AFCEE QAPP Version 2, January 1997)

QC Requirement	Criteria	Flag	Flag Applied To
Ambient Blank (VOC samples only)	Analyte(s) detected > RL	B	The specific analyte(s) in all samples with the same matrix and sampling date
Trip Blank (VOC samples only)	Analyte(s) detected > RL	B	The specific analyte(s) in all samples shipped in the same cooler.
Initial Five Point Calibration (GC methods)	RSD > CL	R for all results	The specific analyte(s) in the sample associated with the calibration
Initial Five Point Calibration (GC/MS methods)	SPCC criteria not met	R for all results	All analytes in all samples associated with the calibration
Second Source Calibration Verification (GC and GC/MS methods)	RF outside ± CL	R for all results	The specific analyte(s) in the sample associated with the calibration
Initial Daily Calibration Verification (GC methods)	RF outside ± CL	R for all results	The specific analyte(s) in the sample associated with the calibration
Initial Daily Calibration Verification (GC/MS methods)	SPCC and CCC criteria not met	R for all results	The specific analyte(s) in the sample associated with the calibration
	RF outside ± CL	R for specific results	All analytes in all samples associated with the calibration
Continuing Calibration (GC methods)	RF outside ± CL	R for all results	The specific analyte(s) in the sample associated with the calibration
Retention time	Retention time of analyte outside of established retention time window	R	The specific analyte(s) in the samples
Surrogates	any surrogate % R >UCL OR any surrogate % R <LCL OR any surrogate recovery < 10%	J for the positive results J for the positive results R for the nondetects R for all results	All analytes in the sample
Mass Spectrometer Tune	Ion abundance criteria not met	R for all results	All analytes in all samples associated with the tune
Tentatively Identified Compounds (TICs)		T	All TICs

UCL = upper control limit
LCL = lower control limit
CL = control limit

APPENDIX F
Table 4. Flagging Conventions Specific to Inorganic Methods
(after AFCEE QAPP Version 2, January 1997)

QC Requirement	Criteria	Flag	Flag Applied To
Initial multipoint calibration	Correlation coefficient ≤0.995	R	All results for specific analyte(s) for all samples associated with the calibration
Highest calibration standard	result not within 95–105% of expected value	R	All results for specific analyte(s) for all samples associated with the calibration
Calibration blank	analyte detected ≥ RL	B	All results for specific analyte(s) in all samples associated with the blank
Continuing calibration verification (Instrument Check Standard)	result not within 90–110% of expected value	R	All results for the specific analyte(s) in all samples since the last acceptable calibration
Interference check solution (ICS)	result not within 80–120% of expected value	R	All results for specific analyte(s) in all samples associated with the ICS
Dilution test	dilution not within 90–110% of the original determination	J	Apply to all sample results if the new matrix check was not run or RPD ≥10%
New matrix check	result > 10% of original result	J	All samples in digestion batch if analytical spike not performed
Recovery test	% R not within 85–115% of expected value	J	All samples in digestion batch if method of standard addition is not performed
Post digestion spike addition	% R of expected value not within 75–125%	J	All sample results (for same matrix) for specific analyte(s) for all samples associated with the post digestion spike addition
	% R < 10%	R	
Second source calibration verification	RPD outside ± CL	R	All samples
Method of standard addition	Method of standard addition not done OR Method of standard addition spike levels inappropriate OR correlation coefficient < 0.995	J to all positive results	Sample

APPENDIX G

TYPICAL SAMPLE LABEL

APPENDIX H

TYPICAL CHAIN-OF-CUSTODY FORM

APPENDIX I

CALIBRATION, QC, CORRECTIVE ACTION, AND DATA FLAGGING REQUIREMENTS FOR LABORATORY ANALYTICAL METHODS

APPENDIX I
LIST OF TABLES

APPENDIX I
Table 1. RLs for Method SW8015 (Modified)
(modified from AFCEE QAPP Version 2.0, January 1997)

		Water		Soil	
Parameter/Method	**Analyte**	**RL**	**Unit**	**RL**	**Unit**
Petroleum Hydrocarbons SW8015 (Modified)	Gasoline	0.1	mg/L	1.0	mg/kg
	Diesel, Jet Fuel	1.0	mg/L	10.0	mg/kg

APPENDIX I
Table 2. QC Acceptance Criteria for Method SW8015 (Modified)
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8015 (Modified) GRO	TPH–Gasoline	67–136	≤ 30	57–146	≤ 50
	Surrogate:				
	Chlorobenzene	74–138		64–148	
SW8015 (Modified) DRO	TPH–Diesel	61–143	≤ 30	51–153	≤ 50
	TPH–Jet Fuel	61–143	≤ 30	51–153	≤ 50
	Surrogates (choose 2):				
	Octacosane	26–152		25–162	
	Ortho-Terphenyl	57–132		47–142	
	Fluorobenzene	75-125		65-135	
	Tricontane	40-140		30-150	

APPENDIX I

Table 3. Summary of Calibration and QC Criteria for Method SW8015 (Modified)

Page 1 of 3

(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria[a]
SW8015 (mod)	Volatile and Extractable Total Petroleum Hydrocarbons	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	%RSD < 20%	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Initial calibration verification	Daily, before sample analysis	All concentration levels of GRO within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All concentration levels within ±15% of initial calibration	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst

APPENDIX I

Table 3. Summary of Calibration and QC Criteria for Method SW8015 (Modified)

Page 2 of 3
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria[a]
SW8015 (mod)	Volatile and Extractable Total Petroleum Hydrocarbons	Method blank	One per analytical batch	No TPH detected ≥ RL	Correct problem then repeat and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 2	Correct problem then repeat and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 2	Correct problem then reextract and analyze sample	

APPENDIX I

Table 3. Summary of Calibration and QC Criteria for Method SW8015 (Modified)

Page 3 of 3

(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria[a]
SW8015 (mod)	Volatile and Extractable Total Petroleum Hydrocarbons	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria, Table 2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be < the RLs in Table 1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

APPENDIX I
Table 4 RLs for Method SW8020A
(modified from AFCEE QAPP Version 2.0, January 1997)

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
Aromatic Volatile Organics SW8020A	Benzene	2.0	µg/L	0.002	mg/kg
	Chlorobenzene	2.0	µg/L	0.002	mg/kg
	Ethylbenzene	2.0	µg/L	0.002	mg/kg
	Toluene	2.0	µg/L	0.002	mg/kg
	Xylenes, total	2.0	µg/L	0.002	mg/kg

APPENDIX I
Table 5 QC Acceptance Criteria for Method SW8020A
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8020A	Benzene	75–125	≤ 20	66–135	≤ 30
	Chlorobenzene	75–129	≤ 20	66–139	≤ 30
	Ethylbenzene	71–129	≤ 20	61–139	≤ 30
	Toluene	70–125	≤ 20	60–135	≤ 30
	Xylenes, total	71–133	≤ 20	61–143	≤ 30
	Surrogates (choose at least two):				
	Bromochlorobenzene	46–136		36–146	
	Bromofluorobenzene	48–138		38–148	
	Difluorobenzene	48–138		38–148	
	Fluorobenzene	44–165		34–175	
	1,1,1-Trifluorotoluene	44–165		34–175	

APPENDIX I

Table 6 Summary of Calibration and QC Procedures for Method SW8020A

Page 1 of 3

(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria[a]
SW8020A	Aromatic volatile organics	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	%RSD < 20% for CFs or RFs	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Second-source calibration verification	Once per five-point initial calibration	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Initial calibration verification	Daily, before sample analysis	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within ±15% of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification

APPENDIX I
Table 6 Summary of Calibration and QC Procedures for Method SW8020A
Page 2 of 3
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria[a]
SW8020A	Aromatic volatile organics	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 5	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then repeat and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 5	Correct problem then repeat and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis	Apply R to the result for the specific analyte(s) in the sample
		MDL study	Once per 12 month period	Detection limits established shall be < the RLs in Table 4	none	Apply R to all results for the specific analyte(s) in all samples analyzed

APPENDIX I
Table 6 Summary of Calibration and QC Procedures for Method SW8020A
Page 3 of 3
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria[a]
SW8020A	Aromatic volatile organics	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 5	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for any surrogate, apply J to all positive results if the %R < LCL for any surrogate, apply J to all positive results, apply R to all non-detects If any surrogate recovery is < 10%, apply R to all results
		MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria, Table 5	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

APPENDIX I
Table 7. RLs for Method SW6010A
(modified from AFCEE QAPP Version 2.0, January 1997)

		Water		Soil	
Parameter/Method	Analyte	RL	Unit	RL	Unit
ICP Screen for Metals SW6010A	Aluminum	0.2	mg/L	22.0	mg/kg
	Antimony	0.05	mg/L	10.0	mg/kg
	Arsenic	0.03	mg/L	40.0	mg/kg
	Barium	0.005	mg/L	1.0	mg/kg
	Beryllium	0.005	mg/L	1.0	mg/kg
	Cadmium	0.007	mg/L	0.50	mg/kg
	Calcium	1.1	mg/L	100	mg/kg
	Chromium	0.01	mg/L	20	mg/kg
	Cobalt	0.006	mg/L	10.0	mg/kg
	Copper	0.01	mg/L	2.0	mg/kg
	Iron	0.20	mg/L	3.0	mg/kg
	Lead	0.025	mg/L	10.0	mg/kg
	Magnesium	0.10	mg/L	100	mg/kg
	Manganese	0.003	mg/L	2.0	mg/kg
	Molybdenum	0.015	mg/L	3.0	mg/kg
	Nickel	0.01	mg/L	2.0	mg/kg
	Potassium	0.50	mg/L	600	mg/kg
	Selenium	0.03	mg/L	3.0	mg/kg
	Silver	0.01	mg/L	1.0	mg/kg
	Sodium	1.0	mg/L	10.0	mg/kg
	Thallium	0.08	mg/L	6.0	mg/kg
	Vanadium	0.01	mg/L	1.0	mg/kg
	Zinc	0.01	mg/L	1.0	mg/kg

APPENDIX I

Table 8. QC Acceptance Criteria for Method SW6010A (modified from AFCEE QAPP Version 2.0, January 1997)

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW6010A	Aluminum	80–120	≤ 15	80–120	≤ 25
	Antimony	80–120	≤ 15	80–120	≤ 25
	Arsenic	80–120	≤ 15	80–120	≤ 25
	Barium	80–120	≤ 15	80–120	≤ 25
	Beryllium	80–120	≤ 15	80–120	≤ 25
	Cadmium	80–120	≤ 15	80–120	≤ 25
	Calcium	80–120	≤ 15	80–120	≤ 25
	Chromium	80–120	≤ 15	80–120	≤ 25
	Cobalt	80–120	≤ 15	80–120	≤ 25
	Copper	80–120	≤ 15	80–120	≤ 25
	Iron	80–120	≤ 15	80–120	≤ 25
	Lead	80–120	≤ 15	80–120	≤ 25
	Magnesium	80–120	≤ 15	80–120	≤ 25
	Manganese	80–120	≤ 15	80–120	≤ 25
	Molybdenum	80–120	≤ 15	80–120	≤ 25
	Nickel	80–120	≤ 15	80–120	≤ 25
	Potassium	80–120	≤ 15	80–120	≤ 25
	Selenium	80–120	≤ 15	80–120	≤ 25
	Silver	80–120	≤ 15	80–120	≤ 25
	Sodium	80–120	≤ 15	80–120	≤ 25
	Thallium	80–120	≤ 15	80–120	≤ 25
	Vanadium	80–120	≤ 15	80–120	≤ 25
	Zinc	80–120	≤ 15	80–120	≤ 25

APPENDIX I
Table 9 Summary of Calibration and QC Procedures for Method SW6010A
Trace Elements (Metals/Cations)
Page 1 of 3
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria[a]
SW6010A	ICP Metals	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Highest calibration standard	Before beginning a sample run	All analytes within ±5% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration blank	After every 10 samples and at end of the analysis sequence	No analytes detected ≥ RL	Correct problem then analyze calibration blank and previous 10 samples	Apply B to all results for specific analyte(s) in all samples associated with the blank
		Continuing calibration verification (Instrument Check Standard)	After every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value	Repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 8	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst

APPENDIX I
Table 9 Summary of Calibration and QC Procedures for Method SW6010A
Trace Elements (Metals/Cations)
Page 2 of 3
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria[a]
SW6010A	ICP Metals	Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then repeat and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		Interference check solution (ICS)	At the beginning and end of an analytical run or twice during an 8 hour period, whichever is more frequent	Within ±20% of expected value	Terminate analysis; correct problem; reanalyze ICS; reanalyze all affected samples	Apply R to all results for specific analyte(s) in all samples associated with the ICS
		LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 8	Correct problem then repeat and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Dilution test	Each new sample matrix	1:4 dilution must agree within ±10% of the original determination	Perform post digestion spike addition	Apply J to all sample results if either of following exist: (1) new matrix check not run (2) RPD ≥10%

APPENDIX I
Table 9 Summary of Calibration and QC Procedures for Method SW6010A
Trace Elements (Metals/Cations)
Page 3 of 3
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW6010A	ICP Metals	Post digestion spike addition	When dilution test fails	Recovery within 75-125% of expected results	Correct problem then reanalyze post digestion spike addition	Apply J to all sample results (for same matrix) for specific analyte(s) for all samples associated with the post digestion spike addition If post digestion spike addition recovery is < 10%, apply R to all sample results (for same matrix) for specific analyte(s) for all samples associated with the post digestion spike addition
		MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria, Table 8	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be < the RLs in Table 71	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

APPENDIX I
Table 10. RLs for Method SW9056
(modified from AFCEE QAPP Version 2.0, January 1997)

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
Common Anions SW9056	Bromide	0.5	mg/L	0.5	mg/kg
	Chloride	1.0	mg/L	1.0	mg/kg
	Fluoride	1.0	mg/L	1.0	mg/kg
	Nitrate	1.0	mg/L	1.0	mg/kg
	Nitrite	1.0	mg/L	1.0	mg/kg
	Phosphate	1.0	mg/L	1.0	mg/kg
	Sulfate	1.0	mg/L	1.0	mg/kg

APPENDIX I
Table 11. QC Acceptance Criteria for Method SW9056
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW9056	Bromide	86–112	≤ 20	86–112	≤ 30
	Chloride	91–111	≤ 20	91–111	≤ 30
	Fluoride	86–114	≤ 20	86–114	≤ 30
	Nitrate	90–110	≤ 20	90–110	≤ 30
	Nitrite	88–116	≤ 20	88–116	≤ 30
	Phosphate	87–110	≤ 20	87–110	≤ 30
	Sulfate	88–115	≤ 20	88–115	≤ 30

APPENDIX I
Table 12. Summary of Calibration and QC Procedures for Method SW9056
Page 1 of 3

(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria[a]
SW9056	Common anions	Multipoint calibration for all analytes (minimum 3 standards and one calibration blank)	Initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Second-source calibration verification	Once per multipoint calibration	All analytes within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Initial calibration verification	Daily, before sample analysis or when elutent is changed	All analytes within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	Instrument response within ±5% of expected response	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification
			After every analytical batch	All analytes within ±10% of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification

APPENDIX I
Table 12. Summary of Calibration and QC Procedures for Method SW9056
Page 2 of 3
(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria[a]
SW9056	Common anions	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 11	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then repeat and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 11	Correct problem then repeat and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Duplicate	One per every 10 samples	Analytes within ±10% of expected value		

APPENDIX I
Table 12. Summary of Calibration and QC Procedures for Method SW9056
Page 3 of 3

(modified from AFCEE QAPP Version 2.0, January 1997)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria[a]
SW9056	Common anions	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria, Table 11	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be < the RLs in Table 10	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.