Appendix B

Eugene/Springfield Environmental Services Laboratory Quality Assurance Plan

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CONTROLLED DOCUMENT

CITY OF EUGENE – WASTEWATER DIVISION

Plan

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None at this time

Abbreviations & Acronyms

AA	Atomic Absorption spectrometer
BMF	Biosolids Management Facility
CCV	Continuing Calibration Verification standard
CFR	Code of Federal Regulations
COC	Chain-of-Custody
DEQ	Oregon Department of Environmental Quality
E/S WPCF	Eugene/Springfield Water Pollution Control Facility
EAS	Environmental Analytical Services
ICP	Inductively Coupled Plasma spectrometer
ICV	Initial Calibration Verification standard
ID	Identification
IDL	Instrument Detection Limit
IPR	Initial Precision Recovery
ISC	Industrial Source Control
LCR	Linear Calibration Range
LCS	Laboratory Control Sample
LDR	Linear Dynamic Range
LIMS	Laboratory Information Management System
LPSS	Laboratory/Pretreatment/Stormwater/Sampling Team
MDL	Method Detection Limit
mgd	million gallons per day
MRL	Method Reporting Limit
MWMC	Metropolitan Wastewater Management Commission
QA	Quality Assurance
QAP	Quality Assurance Plan
QC	Quality Control
RPD	Relative Percent Difference
SIWS	Seasonal Industrial Waste Site
SAP	Sampling and Analysis Plan
USEPA or EPA	United States Environmental Protection Agency

1.0 INTRODUCTION and WASTEWATER DIVISION QUALITY ASSURANCE STATEMENT

Wastewater Division is actively engaged in many processes and environmental sampling programs. Among the media sampled and analyzed are groundwater, surface water, wastewater, soil, sludge, biosolids, industrial waste, and stormwater. To ensure samples are representative of the media from which they are sampled, and analytical results are of sound, defensible, and of documented quality, the Eugene/Springfield Water Pollution Control Facility (WPCF) has implemented this Environmental Services Quality Assurance Plan (QAP).

Quality assurance and quality control procedures are presented here with emphasis on activities in facility laboratories. The procedures cover the full scope of sample collection, preparation and analysis including sample receipt, handling, and storage; preparation and maintenance of standards, reagents, gases, and water; calibration and maintenance of analytical equipment; performance and evaluation of analytical methodologies (in conformance with standards defined by the appropriate regulatory agency), and the compilation and generation of reportable data. Particular emphasis is given to documentation practices from sample collection through laboratory analysis and reporting with the objective of employing uniform standards for instrument maintenance, document control, analytical methodologies, data generation, quality assurance, and quality control.

WPCF staff is dedicated to providing data of the highest quality and recognizes that success in achieving this goal requires a commitment to and ownership of the Plan by everyone in the organization.

2.0 PROGRAM DESCRIPTIONS

The following sections present program descriptions for the work sections within the WPCF, as well as Mission Statements reflecting commitment to quality assurance:

Regional Environmental Analytical Services Laboratory

Program Description: The Environmental Analytical Services (EAS) Laboratory provides analytical services in support of Wastewater Division program operations including wastewater treatment, residuals management, industrial source control, storm water monitoring, ambient monitoring, and special projects. Laboratory services include sample handling and analysis of wastewater, sludge, biosolids, soil, industrial wastes, ambient water, stormwater, and groundwater. Analytical results generated by the laboratory are used to make process control decisions, document compliance with regulatory requirements, demonstrate environmental protection, and ensure worker health and safety.

Mission Statement: "To operate the environmental laboratory in an ethical manner, which ensures production of accurate and precise analytical results, using regulatory approved methodologies, in a timely, environmentally conscious, and cost-effective manner and a useable format to meet the defined needs of our customers."

Industrial Source Control

Program Description: The Pretreatment Program is a regional activity implemented jointly by the cities of Eugene and Springfield. The Industrial Source Control (ISC) section of Wastewater Division is charged with administering the Pretreatment Program for the regulation and oversight of wastewaters discharged to the sanitary collection system by fixed-site industries in Eugene and by mobile waste haulers in the Eugene-Springfield areas. ISC is responsible for ensuring these wastes do not damage the collection system; interfere with wastewater treatment processes; result in the pass-through of harmful pollutants to treated effluent, water reuse, or biosolids; or threaten worker health and safety.

This responsibility is fulfilled through the use of a permit system for industrial dischargers. This permit system, common to both Eugene and Springfield, implements necessary limitations on waste characteristics and establishes inspection, monitoring, and reporting requirements for documenting waste quality and quality

controls. ISC staff is also responsible for locating new industrial dischargers in Eugene and evaluating the impact of new non-residential discharges on the regional wastewater treatment facility.

The ISC section also has responsibilities related to spill tracing in the collection system as well as being backup for sample collection activities as they pertain to the industrial wastewater, stormwater and ambient water quality monitoring programs.

Mission Statement: "To administer programs governing the activities of industrial wastewater sources to the sanitary sewer system, within the guidelines established by federal, state, and local regulations and to effectively fulfill responsibilities related to spill response and water quality monitoring for the ambient and stormwater program."

Biosolids Management (Residuals staff operate the Biosolids Management Facility (BMF) and the Beneficial Reuse Site (BRS).

Program Description (Biosolids Management Facility): Biological solids (biosolids) produced from the activated sludge treatment of wastewater are managed by the Residuals Management section of Wastewater Division. This section operates the Biosolids Management Facility, (BMF); located on Awbrey Lane in Eugene. Approximately 195,500 tons of wet biosolids are produced annually by the WPCF. These biosolids are treated using anaerobic digestion, stored in facultative lagoons, which provide some additional treatment benefits, dewatered and then air-dried to reduce the water content and facilitate transport. The dried material is ultimately recycled to agricultural land as a beneficial fertilizer and soil conditioner.

In addition to sample collection and testing activities to meet operational controls, BMF staff performs limited sampling and analysis activities that meet permit requirements and are subject to the protocol specified in the QAP.

Mission Statement (Biosolids Management Facility): "To effectively and efficiently operate and maintain the Biosolids Management Facility. To harvest and recycle biosolids, to the benefit of the environment, meeting all applicable state and federal regulations governing land application programs."

Program Description (Biocycle Farm): The Biocycle Farm is a 595-acre farm designed and operated to grow hybrid poplar trees utilizing nutrients provided by liquid biosolids and moisture from recycled water to encourage rapid tree growth. The trees will eventually be harvested and marketed on a 10-12 year cycle.

Mission Statement (Biocycle Farm): "To effectively and efficiently operate and maintain the Biocycle Farm. To irrigate Recycled Water and liquid biosolids to the benefit of the environment, meeting all applicable state and federal regulations governing land application and agricultural programs, in the most cost-efficient and environmentally beneficial manner."

Program Description (Beneficial Reuse Site): The Beneficial Reuse Site (BRS) was originally designed and operated to dispose of seasonal industrial wastewater from a vegetable cannery processor. The vegetable cannery permanently closed operations in 2001, and the BRS is no longer receiving seasonal influent flow. Lagoon stored wastewater will continue to be irrigated on the site until lagoon wastewater and solids are completely removed or use and purpose of the site is redefined. Biosolids are land applied to the irrigated area providing needed nutrients and soil building properties. A grass hay crop is harvested to remove the nutrients.

Mission Statement (Beneficial Reuse Site): "To effectively and efficiently operate and maintain the Beneficial Reuse Site. To irrigate water and land apply biosolids to the benefit of the environment, meeting all applicable state and federal regulations governing land application and agricultural programs in the most cost-efficient and environmentally beneficial manner."

Regional Wastewater Treatment Facility Operations

Program Description: Wastewater Division operates the WPCF to treat domestic and industrial wastewater and achieve a quality that protects and sustains the beneficial uses of the Willamette River. The WPCF was

designed to treat 49 million gallons per day (mgd) of dry weather flow, with a peak hydraulic capacity of 105 mgd for full secondary treatment.

The Operations section optimizes integrated wastewater treatment processes to ensure effluent quality requirements are met in an effective manner. In addition, Operations provides 24-hour alarm monitoring of all plant processes; regional and local pump stations; and biosolids and seasonal waste facilities.

In addition to sample collection and testing activities to meet operational controls, BMF performs limited sampling and analysis activities to meet permit requirements and is also subject to the protocol specified in the QAP.

Mission Statement: "Operate the regional wastewater-treatment facility equipment and processes to produce an effluent quality that protects the environment and meets all limits established by state and federal regulations. Provide 24-hour alarm monitoring for all wastewater facilities in the regional system."

3.0 STATEMENT of PROFESSIONAL CONDUCT and ETHICAL PRACTICE

The integrity and quality of the data generated by the Environmental Services Laboratory is taken seriously. Any manipulation or falsification of analytical data is unacceptable; therefore, employees at Wastewater Division will be held to the following statements of conduct:

Under no circumstance does Wastewater Division condone the willful act of fraudulent manipulation of analytical data. Such acts are to be reported immediately to staff's Supervisor or the Division Director.

Wastewater Division will not tolerate falsification of data in any form. While it is understood that at times data is subject to professional judgment and interpretation, any willful falsification, if observed or discovered, will be documented and appropriate actions taken toward those responsible.

Lab staff engaged in data collection, generation, analysis, or reporting are required to go through in-house ethics training to reinforce the Division's expectations in this area.

4.0 ORGANIZATIONAL STRUCTURE and RESPONSIBILITIES

The organizational structure of Wastewater Division follows a traditional hierarchy system of management with overall authority and responsibility for management of the organization held by the Division Director. Individuals within the organization that direct and supervise staff, who are either directly or indirectly responsible for collection and/or analysis of samples required by permits issued to the facility, include the Plant Operations Supervisor, the Residuals Supervisor, and the Laboratory Supervisor. The Laboratory Supervisor reports directly to the Division Director and the Plant Operations and Residuals Supervisors report to the Plant Manager. Staff within each work section report to their respective supervisor. The QA/QC Officer reports directly to the Division Director. Figure 4.1 Wastewater Division Organizational Chart presents the Organizational Chart for Wastewater Division.

Implementation of the QAP is achieved through delegation of defined responsibilities to individuals in the organization. The individual responsibilities related to the Quality Assurance Plan are described below. Sample collection duties are performed by trained analysts and technicians within the organization; these activities are conducted under site-specific Sampling and Analysis Plans (SAPs) describing the sampling program requirements. Sample collection and handling protocol are outlined in Standard Operating Procedures (SOPs) appended to the SAP. The SAPs are incorporated through reference to the Quality Assurance Plan.

In general, analysts and technicians, as designated by their supervisor, are responsible for ensuring that sample collection, handling, analysis, and reporting protocol are followed in accordance with documented methods. Technicians in these work sections are responsible for following all quality assurance guidelines and requirements specified in applicable SAP/SOPs and the QAP, participation in all internal and external audits, and completing all

associated quality assurance administrative duties related to the data they generate (sample QA/QC, chain-of-custody, etc.).

Laboratory Supervisor

The responsibilities of the Laboratory Supervisor are to manage, coordinate, and lead the industrial source control, stormwater, and analytical laboratory activities of Wastewater Division; coordinate these programmatic activities with other City Divisions and Departments; and provide technical assistance to Wastewater Division Director. The Laboratory Supervisor provides technical, operational, and administrative leadership through planning, allocation, and management of resources (personnel and equipment). In addition, the Laboratory Supervisor is responsible for achieving the quality assurance and quality control objectives defined in this document, ensuring overall laboratory operation efficiency, as well as cost effectiveness of laboratory activities.

Additional Laboratory Supervisor responsibilities include:

- Ensuring the quality of analytical data generated: laboratory results must meet the reliability and accuracy standards established by the U.S. Environmental Protection Agency (EPA), the State of Oregon Department of Environmental Quality (DEQ), and the State of Oregon Water Resources Board.
- Ensuring analysts adhere to and follow the QAP: development and management of sample collection, handling, analysis, and reporting activities will follow quality assurance protocol to satisfy the standards for precision and accuracy of the EPA and DEQ.
- Ensuring analysts are appropriately trained in sample collection, handling, analysis, reporting protocol, safety, and quality assurance protocol as applicable to their job duties.
- Ensuring analysts have received appropriate training on professional conduct and ethical standards expectations as related to their job duties.
- Ensuring quality assurance problems or issues are reported in a timely manner to the QA/QC Officer,
- Reviewing the QAP on a scheduled basis, including contributing revisions and making suggestions, as necessary, for improvement to the Division Director for consideration by the Management Team.

Sr. Laboratory Technical Analysts

The responsibilities of the Sr. Laboratory Technical Analysts are to provide technical guidance and oversight for other laboratory analysts. This individual also administers the Laboratory Information Management System (LIMS), and has administrative responsibilities in relation to the QAP.

Sr. Laboratory Technical Analysts have other responsibilities related to the QAP including new procedure implementation, data evaluation in relation to annual detection limit studies, oversight of quality control charts, review and analysis of quality assurance data and test procedures to determine whether any data are out-of-compliance with the QAP, and routine review of control charts.

Senior Laboratory Technical Analysts perform their duties under the direction of the Laboratory Supervisor.

Laboratory Technical Analysts

Laboratory Technical Analysts are responsible for performing laboratory analyses on samples submitted for purposes of process control and regulatory compliance.

Laboratory Technical Analysts are responsible for following all quality assurance guidelines and requirements specified in SAP/SOPs and the QAP. In addition, analysts are responsible for participation

in all internal and external audits, reporting any quality assurance problems to the Sr. Laboratory Technical Analyst or the LPSS Supervisor, and completing all associated quality assurance administrative duties related to the data they generate (data entry, reports, control charts, etc.).

Laboratory Technical Analysts perform their duties under the direction of the LPSS Supervisor and under technical guidance of the Senior Laboratory Technical Analysts.

Plant Operations and Residuals Supervisors

Within the scope of the QAP the Plant Operations and Residuals Supervisors are responsible for management and coordination of staff involved in the collection and analysis of samples to meet program requirements. Wastewater Division supervisors provide technical, operational, and administrative leadership through planning, allocation, and management of resources (personnel and equipment) in a cost effective and efficient manner and provide direction and guidance to staff in achieving the quality assurance and quality control objectives defined in this document.

Additional Plant Operations and Residuals Supervisors responsibilities include:

- Coordinating assistance and support staff to the Laboratory Supervisor during sample collection activities.
- Ensuring the quality of analytical data generated: laboratory results must meet the reliability and accuracy standards established by the U.S. Environmental Protection Agency (EPA), the State of Oregon Department of Environmental Quality (DEQ), and the State of Oregon Water Resources Board.
- Ensuring technicians adhere to and follow the QAP: development and management of sample collection, handling, analysis, and reporting activities will follow quality assurance protocol to satisfy the standards for precision and accuracy of the EPA and DEQ.
- Ensuring technicians are appropriately trained in sample collection, handling, analysis, reporting protocol, safety, and quality assurance protocol as applicable to their job duties.
- Ensuring technicians have received appropriate training on professional conduct and ethical standards expectations as related to their job duties.
- Ensuring quality assurance problems or issues are reported in a timely manner to the QA/QC Officer,
- Reviewing the QAP on a scheduled basis and contributing revisions as necessary and suggestions for improvement to the Division Director for consideration by the Management Team.

Wastewater Technicians

Wastewater Technicians performing sampling and analysis activities are responsible for following all quality assurance guidelines and requirements specified in applicable SAP/SOPs and the QAP, participation in all internal and external audits, reporting any quality assurance problems to their Supervisor, and completing all associated quality assurance administrative duties related to the data they generate (chain-of-custody, etc.).

Wastewater Technicians perform their duties under the direction of their respective Supervisor.

QA/QC Officer

Conformance to the QAP procedures is monitored by the QA/QC Officer, who also oversees and coordinates all QA/QC programs for Wastewater Division. The function of the QA/QC Officer is to provide an independent assessment of the QAP to ensure that plan elements are adequate, consistent, and implemented as intended. In addition, the QA/QC Officer ensures that all data collection activities within the Division follow uniform

standards of quality assurance/quality control with respect to sampling and analysis, documentation, and record keeping.

5.0 SAMPLING, SAMPLE PRESERVATION & HANDLING PROCEDURES

The degree to which analytical data represent the media sampled is largely a function of the procedures used to collect, preserve and store samples as well as the analytical procedures used in the laboratory. Wastewater Division staff follows the sampling protocol included in the SAPs referencing this QAP. Sampling procedures follow sampling guidelines described in 40 CFR 136 pr 40 CFR 503 as applicable.

Sample Tracking

Samples received by the laboratory are entered into the Laboratory Information Management System (LIMS) developed by AAS LabWorks. Data entered into the LIMS with a batch of samples includes:

- Client Project Site Codes
- Sample Location
- Project Name
- DVSW or Cost Code
- Matrix code
- Sample Collection End date/time
- Sample Duration
- Sample Received date/time
- Received from:
- Received by:
- Tests required
- Preservation of Sample aliquots

The LIMS system assigns each sample an individual sample number (e.g. BB0001).
Labels (see Figure 5.1) are generated for each sample and aliquot entered into the system and include:

- Sample Number or ID
- Client project site Location Code
- Bottle type
- Test Codes ordered
- Preservative and holding time requirements (see Table 5-1).

LIMS includes extra management features that enhance the QAP, including an audit trail to document changes to results data in the system to preserve data integrity, results validation to ensure data integrity before report generation, and a QA/QC batching module for generation of QC reports related to analytical results.

6.0 CHAIN-OF-CUSTODY (SAMPLE CUSTODY)

Samples delivered to the EAS Laboratory are received by laboratory staff who verify that samples are clearly marked, proper containers are used, sample quantity is adequate to perform requested tests, and chain-of-custody forms are complete and correctly filled out. All samples must be accompanied by a chain-of-custody (COC) form. If the laboratory staff receiving the sample(s) detects obvious or potential inconsistencies with sampling or handling requirements, the receiver will notify the Senior Laboratory Technical Analyst or the Laboratory Supervisor who will determine whether to contact the client for additional sample or a new sample.

Water Pollution Control Facility Samples

Plant (WPCF) samples are collected by designated staff, either from the Sampling Team, Laboratory, Operations, or Residuals work groups, and delivered directly to the laboratory. The sample collector is identified in a logbook stored at the sampler location. Though the samplers are not locked, the plant site is

secured. Plant samples are accompanied by COC forms and are centrally retained and controlled by the EAS laboratory.

Industrial Waste Samples

Industrial waste samples are collected by Sampling Team or designated Industrial Source Control staff, and must be accompanied by a chain-of-custody form. Chain-of-custody forms are centrally retained and controlled by the EAS laboratory.

Ground Water Samples, Soil, Sludge, Stormwater, and Ambient samples

These samples are collected by Sampling Team staff and, on occasion, in coordination with designated staff from other Division work sections. All samples must be accompanied by a chain-of-custody form. The COC is centrally retained and controlled by the EAS laboratory.

7.0 QUALITY CONTROL OBJECTIVES (PRECISION, ACCURACY, and MRLs)

This section presents elements developed by the Environmental Services Laboratory to ensure the accuracy and precision of analytical results. Quality Control (QC) objectives for accuracy and precision are derived from the applicable published method or statistical techniques. The QC objectives define tolerance limits for "acceptable" data generated in the laboratory. Quality Control objectives are defined below and the tolerance limits are shown in Table 7-1.

Definition of Accuracy

Accuracy means the nearness of a result, or the mean of a set of results, to the true value. Accuracy is assessed through use of laboratory control samples and percent recoveries of spikes.

Definition of Precision

Precision means the measurement of agreement of a set of replicate results among themselves without assumption of any prior information as to the true result. Precision is assessed by means of duplicate or replicate sample analysis.

Procedure for Determining Precision and Accuracy

The precision of an analytical process is monitored by use of duplicate samples, matrix spike duplicates, or duplicate determinations of a laboratory control sample.

Relative percent differences (RPDs) of the duplicates must be within the ranges specified in Table 7-1. These tolerance limits apply only to sample values greater than five times the MDL. Sample values less than five times the MDL will result in a high RPD because the value is near the MDL.

The LIMS system allows for construction of QC charts. Analysts re-run an analysis when data quality objectives are not met, thus only data that meets objectives are entered in the system. Control Charts Developed from Duplicates.

Control charts are generally constructed of duplicate determinations of a laboratory control sample over a specified period. The average range of duplicate determinations is first established by accumulating data on 60 pairs of data and establishing control limits as follows:

$$\text{Upper Control Limit} = 3.27 \times RangeAverage$$

$$\text{Upper Warning Limit} = 2.51 \times RangeAverage$$

Control charts can also be constructed from sample duplicates or sample spike duplicates, if the data are approximately grouped by concentration range.

The accuracy of an analytical process is determined by the analysis of laboratory control samples, showing the degree of difference between the known and found values, and the use of spikes, showing the spike recovery.

Determination of precision criterion for microbiological tests is based on the standard deviation of a range of values. The equation to determine the standard deviation of a range is taken from Taylor (Statistical Techniques for Data Analysis, 1990; p. 48), and is as follows:

$$\overline{R} = \left(R_1 + R_2 + \ldots + R_k\right) \big/ k$$

$$\sigma = \overline{R} \big/ d_2^* \ .$$

The constant d_2^* must be obtained from statistical tables for Replicate QC data, (Taylor, 1990; p. 163). Since the number of sets of replicates is generally greater than 20, the constant is 1.13. Hence, the upper control and warning limits is simply 3σ and 2σ respectively.

When using data from laboratory control samples or spikes without a control chart, the result must meet the tolerance limits specified in Table 7-1.

7.1 Control Charts Developed from Laboratory Control Samples

Control charts constructed from laboratory control samples require the results from 60 analyses of the same sample. When using spike data, recoveries must be at least 20%. In both cases, the upper and lower warning limits are set at ± 2 σ (standard deviation) from the mean, while the upper and lower control limits are set at ± 3 σ.

7.2 Method Detection Limits and Method Reporting Limits

The Method Reporting Limits (MRLs)) and Method Detection Limits (MDL's) used by the laboratory are either method specified or determined as outlined in 40 CFR 136, Appendix B.

8.0 QUALITY CONTROL PROCEDURES

Results of analytical quality control samples are used to estimate the precision and accuracy of data from sample preparation through analysis. The specific types, frequencies, and processes for quality control sample analyses are described in the sections that follow and are performed according to individual method requirements. For some test procedures, the quality control sample analyses are not appropriate and are not required. Also note that laboratory control samples and/or matrix blanks are not available for some test procedures and sample matrices. Synonymous terms are provided in parentheses.

Quality Control Frequency

Quality control samples are analyzed for each analytical batch, as specified in individual analytical methods, or once every twenty samples, whichever frequency is greater. The laboratory control standard is used as the verification standard. Quality control samples for each batch generally include:

- Method Blank (Laboratory Reagent Blank)
- Laboratory Control Sample (Quality Control Sample)
- Matrix Spike (if Duplicate Matrix Spike is not done)
- Laboratory Duplicate and/or Duplicate Matrix Spike
- Initial Calibration Verification Standard
- Continuing Calibration Verification Standard

Other initial or periodic QC such as IPR, IDL, LDR, LCR, spectral interference checks, or equivalency studies may be required. Analysts will verify that all initial and periodic QC is performed according to individual method requirements.

The definitions for each type of quality control sample used in the laboratory are provided below.

Method Blank (Laboratory Reagent Blank)

The method blank is analyte-free water (a blank matrix for solid samples is not available), subjected to the entire analytical process. Analysis of a method blank verifies that interferences from contaminants in solvents, reagents, glassware, and other sample-processing devices are quantified. If contamination is found in the method blank, the analyst attempts to identify the source and samples are reanalyzed. Method blank results should be below the MRL for the analyte(s) tested.

Laboratory Control Sample (Quality Control Sample)

A laboratory control sample (LCS) is a sample of known value that serves as an independent check on equipment performance, technique, and standards. Results provide an estimate of method bias. The LCS consists of an aliquot of analyte-free water or analyte-free solid to which a known amount of the method analyte(s) is added. A standard reference material of known matrix type, containing certified amounts of target analyte(s), is used for the LCS. The LCS is analyzed according to method requirements and consists of a commercially prepared standard solution / solid, or an aliquot of a commercially prepared standard solution.

Standard reference materials for the LCS are purchased from sources independent of calibration standards. The percent recovery of the target analytes in the LCS assists in determining whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements at the MRL. Acceptable percent recovery limits for each analyte are shown in Table 7-1; and or specified by the manufacturer.

Matrix Spikes

A matrix spike consists of a sample aliquot to which a known amount of the target analyte has been added. . LFB shall be spiked at the same concentration as the matrix spike. The spiked sample is then prepared and analyzed in exactly the same manner as routine samples. Stock solutions are purchased for spiking the samples. The spike recovery measures the effects of interferences caused by the sample matrix and reflects the accuracy of the method for a given matrix.

Recovery results verify the presence or absence of matrix effects and are particularly important when analyzing complex matrices, such as soil and sludge. Samples to be spiked are selected by the analyst.

Laboratory Fortified Blank (LFB)

The laboratory Fortified Blank is prepared by fortifying an aliquot of the Laboratory Reagent Blank with a known amount of the target analyte. The LFB is then prepared and analyzed in exactly the same manner as routine samples.

Spike recoveries are calculated as follows:

$$\%\,\text{Recovery} = \frac{(S - A)}{T} \times 100$$

where:

S = The observed concentration of analyte in the spiked sample;
A = The analyte concentration in the original sample; and
T = The theoretical concentration of analyte added to the spiked sample.

Laboratory Duplicates (Analytical Duplicates) and Duplicate Matrix Spikes

Laboratory duplicates are sample aliquot replicates subjected to the same preparation and analytical procedures as the original sample. If prior knowledge about the sample suggests the analyte concentration is within the measurable range of the method, a duplicate analysis and a matrix-spiked sample are run. If it is known that the original sample will be low, a matrix-spiked sample and duplicate matrix-spiked sample are analyzed.

The relative percent difference (RPD) between duplicate analyses, or between the matrix-spiked sample and duplicate matrix-spiked sample, is a measure of batch precision for the given method. The RPD for the analyses is calculated as follows:

$$\text{Relative Percent Difference (RPD)} = \frac{\left|[C_1]-[C_2]\right|}{\left([C_1]+[C_2]\right)/2} \times 100$$

where:

C_1 and C_2 = The observed concentrations of analyte in the sample and its duplicate, or in the matrix spike and its duplicate matrix spike; and

Determination of precision criterion for microbiological tests is based on the standard deviation of a range of values. The equation to determine the standard deviation of a range is taken from Taylor (Statistical Techniques for Data Analysis, 1990; p. 48), and is as follows:

$$\overline{R} = \left(R_1 + R_2 + \ldots + R_k\right)\Big/k$$

$$\sigma = \overline{R}/d_2^* \,.$$

The constant d_2^* must be obtained from statistical tables for Replicate QC data, (Taylor, 1990; p. 163). Since the number of sets of replicates is generally greater than 20, the constant is 1.13. Hence, the upper control and warning limits is simply 3σ and 2σ respectively.

Initial Calibration Verification Standard

Initial calibration standards (ICVs) are analyzed after the calibration standards, but before sample analysis, in order to verify calibration of the analytical procedure. Preparation of the ICV must be from a source other than the calibration standards. The laboratory uses Laboratory Control Samples (LCSs) as ICVs.

Continuing Calibration Verification Standard

Continuing calibration standards (CCVs) are midrange analytical standards that are reanalyzed with test samples to verify calibration of the analytical system.

Analytical Batch

The analytical batch is defined as samples that are analyzed together with the same method sequence and the same lots of reagents and with manipulations common to each sample within the same time or in continuous sequential times. Samples in each batch should be of similar composition.

Calibration Blank

Calibration blanks are prepared along with calibration standards in order to create a calibration curve. Calibration blanks are free of the analyte of interest, and provide the zero point of the calibration curve.

Continuing Calibration Blank

Continuing calibration blanks are solutions of either analyte free water or solvent that are analyzed in order to verify the zero point of the analytical procedure.

Calibration Standard

Calibration standards are solutions of known concentration prepared from primary standard solutions, which are in turn prepared from stock standard materials. Calibration standards are used to calibrate the instrument response with respect to analyte concentration.

Calibration Procedures and Frequency are specified in Table 8-1.

9.0 DATA REDUCTION, VALIDATION, REPORTING, and STORAGE

All analytical data generated by the laboratories is recorded, reported, reviewed, and stored according to Division policy. The general procedures involved in this process of data reduction, validation, reporting, and storage, are explained in this section.

Data Reduction – Projects

Data reduction is the process of transforming raw data into results that are reported in standard units. The goal is to minimize the steps needed to transform raw data into reportable results and hence minimize the potential for data transcription and calculation error. Every instrument and/or method has a slightly different data reduction process depending on the way in which data are generated and the required data transformations. Laboratory SOPs include equations used to calculate results, the method of calculation, and bench sheets used to record pertinent data for each analytical method.

A project file is created for each set of project samples received. All raw data, including paper data sheets, charts, printouts, graphs, etc., are stored in the project file. Calculations are done by the analyst performing the laboratory testing. After the analysis is complete the results are entered into LIMS, and a two-tiered validation process is applied – analysis validation and sample validation.

The analyst validates the analytical results by comparing these to raw data. Once all analyses for a project are complete, the Senior Laboratory Analyst will review the data, validate the sample results in the LIMS, and generate a printed report. This report, together with the project file, is circulated among the analysts who performed the testing and who again review their data in the report.

After validation, the report and file are forwarded to the Senior Laboratory Analyst for review of calculations, significant figures, etc., and forwarded to the Laboratory Supervisor for final review and signature. Upon final approval, the report is submitted to the client. All original documentation is filed, including all laboratory generated raw data, notebooks, and instrument output.

Water Pollution Control Facility Samples

Laboratory data for WPCF samples are recorded in separate analytical procedure notebooks/data sheets. For example, a notebook with preprinted, numbered pages is used for BOD analyses. Following the analysis, the data is entered into LIMS and transferred to a computer spreadsheet for the monthly DMR report.

These notebooks/data sheets and or LIMS data are reviewed on an ongoing basis by the Senior Laboratory Technical Analyst and as necessary by the Lab Supervisor. Results for pH and chlorine residual are recorded on individual monthly data sheets and/or plant COC. When data sheets are full, they are transferred to a three-ring notebook titled “Plant Data.” Analytical results are validated by the analysts in the LIMS, and completed sample results are validated by the Senior Laboratory Analyst or the Laboratory Supervisor in LIMS.

Industrial Samples

Laboratory data for industrial samples are entered into LIMS following analysis. The analyst validates the analytical results in LIMS by comparing it to the raw data. When all analyses have been completed for a sample, the Senior Laboratory Analyst reviews the data, validates sample results in LIMS, and generates a printed report. This report is reviewed by the Senior Laboratory Analyst who re-validates the report data by comparing it to the raw data. After signature by the Laboratory Supervisor, Pretreatment staff reviews the report and submits it to the industry. All original documentation is filed as described for **Projects** (above).

Residuals Samples

Laboratory data for residuals samples are recorded in notebooks dedicated to each sampling program, specifically the Biosolids Management Facility, Beneficial Reuse Site and Biocycle Farm. Raw data worksheets are also filed in the notebooks. Following sample analysis, the data is entered into LIMS, and analytical results are validated by the analysts. The Senior Laboratory Analyst or the Laboratory Supervisor performs the next level of validation in LIMS. Notebooks are reviewed, as needed, by the Senior Laboratory Technical Analyst and as needed by the Laboratory Supervisor.

Data Validation

The analyst who generates the analytical data has the primary responsibility for its correctness and completeness. It is also the responsibility of the analyst to verify that the instrument was calibrated and performing correctly, and to analyze the appropriate type and quantity of quality control samples with their daily work.

The integrity of the data generated by the analyst is assessed using a variety of control samples described in Section 8.0, including reagent blanks, matrix spikes, duplicates, laboratory control standards, etc. The process of data validation consists of systematic review of analytical results for control samples, verification of accurate transcription of results from the laboratory notebooks to LIMS, and crosschecks through multiple reviews.

In general, comparison is made between the expected value and the analysis value and assessing whether the comparison is within the tolerance limits specified for the procedure. The tolerance limits may be defined by the analytical method, through construction of control charts, or application of standardized statistical methods.

In the event discrepancies are found during the data validation process, LIMS provides strict control over the means by which data are changed. An interactive module prompts the user for specific input to modify or delete current information. Previous and subsequent inputs are stored as the permanent audit trail for the record.

Data Reporting

A data report is generated following the systematic review and validation processes described in the previous sections. All data are calculated and reported in units consistent with project specifications.
Final reports prepared to satisfy regulatory requirements are first distributed to appropriate program supervisors and staff for review and approval before submittal to the regulatory agency. An additional report copy is maintained in the project file with raw laboratory data. All original reports, with the exception of industrial reports, are filed and maintained. Industrial and stormwater reports are retained by the Senior Analyst for pickup by Industrial Source Control staff from Eugene and Springfield. All reports generated are kept for five years as specified in the laboratory data retention schedule (See: Records Retention Schedule). Generally, no reports are generated for extra process-type samples.

Data Storage

Laboratory data is maintained in such a manner that the records are retrievable by the Senior Laboratory Technical Analyst and LPSS Supervisor. Laboratory notebooks used to document pertinent information are stored in the laboratory. Information contained in the notebooks includes: sample-processing steps such as

extractions and digestion records, instrument maintenance and routine checks, and standard and reagent preparations. Data is retained following the protocol specified in the Records Procedure.

Data in the LIMS system reside in the local E/S WPCF server and is backed-up using the schedule specified in Application Support Notes, which are maintained by MIS staff. Contact MIS staff for specifics regarding these notes.

10.0 AUDITS

The success of the QA program is driven by its ability to monitor the effectiveness of the quality systems that are in practice. The means for monitoring effectiveness of quality systems is the auditing process. Both internal and external quality control programs are established to evaluate the effectiveness of the QA program. These consist of performance evaluations and system audits.

Internal and External Performance Evaluations

The QA Officer conducts internal performance evaluations on a quarterly to annual basis. This consists of a group of samples that are tested for the typical parameters run by the laboratory. Internal performance evaluations are run blind; the technician knows the sample is for performance evaluation purposes but the known values are only known to the QA Officer. Performance results are reported to the respective work section supervisor and the Division Manager.

The EAS Laboratory participates in two external performance evaluation programs consisting of three studies annually, including

- Annual U.S. Environmental Protection Agency DMR-QA Laboratory Performance Evaluation Studies; and
- State of Oregon Department of Environmental Quality Bi-annual Inspection, including Inter-Laboratory Split Comparison.

Results of the performance evaluation studies external inspections are reviewed by the LPSS Supervisor, the QA/QC Officer, and laboratory staff. Any problems identified are investigated and corrective action is taken regarding all deficiencies. The LPSS Supervisor is responsible for informing the Division Director of these performance activities.

System Audits

System audits are conducted internally by the QA/QC Officer on an annual basis. These audits provide a thorough overview of implementation of the QAP by the laboratories. Audits will be performed using the following protocol:

An audit plan will be prepared, reviewed, and updated for every annual audit, taking into consideration the information gained during the previous audits. The audit plan will be the basis for the audit and will define the audit schedule, applicable documentation, and scope of laboratory activities to be audited. Based on the audit plan, a detailed audit checklist will be prepared for use in future audits. The scope of the audit may include, but is not necessarily limited to, the following:

- Review of written QA/QC policies and procedures.
- Random evaluations of the QA/QC program with attention to the following:
  - Written and Electronic Records
    - Chain of Custody
    - Data Entry
    - Raw Data
    - Calculations
    - Calibration

Charts and Control Charts

- Sampling
  - Sampling Protocol Adherence
  - Documentation (field data sheets, chain-of-custody)
  - Quality Assurance Field Samples (duplicates, blanks)
  - Field Meters (calibration, operation, maintenance)
  - Safety
- Laboratory Analyses
  - SOP Adherence
  - Method adherence
  - Quality Assurance Plan Adherence
  - Laboratory Instrumentation (calibration, operation, maintenance)
  - Corrective Action Protocol Adherence
  - Storage (holding times, preservative)
  - Appropriate Dilutions and Calibration Ranges
- Safety

At the close of the audit, a post-audit meeting will be held with the laboratory supervisor and staff to discuss the audit findings. Upon completion, the auditor will submit an audit summary report to the laboratory supervisor (with a copy routed to the Division Director) containing the following:

- Date and location of audit
- Laboratory operations audited
- Findings requiring corrective action
- For each finding, a due date for corrective action will be specified, as well as the means for verifying correction. A finding closure statement will be filed with the audit record upon completion of all requirements. All findings must be closed.
- Observations or recommendations for improvement

The audit summary report will be issued as soon as possible after completing the audit.

A bi-annual inspection of the EAS Laboratory is also conducted by the DEQ.

11.0 PREVENTIVE MAINTENANCE

Preventive maintenance procedures include work performed through instrument service contracts and in-house preventive maintenance procedures. In-house preventive maintenance procedures and schedules are used by staff to schedule maintenance tasks in their respective work areas.

Routine minor equipment maintenance tasks outlined in manufacturer instruction manuals are performed regularly by laboratory staff or under contract services. All maintenance tasks are documented in appropriate forms and retained for verification purposes.

Laboratory staff use preventive maintenance forms to document on-going instrument maintenance activities. Blank forms are obtained and printed from an electronic repository. Analysts responsible for instruments in their work area document maintenance activities on these forms, which list monthly scheduled activities for the year. At the end of the year, staff submits the forms to the Senior Analyst who files the records. These records are retained for five years in accordance with the laboratory record retention requirements (See: Records Retention Schedule).

12.0 CORRECTIVE ACTION

Data qualifiers from Table 12.1 are used to explain out of control data. An analyst reports the use of data qualifiers to the Senior Laboratory Analyst or Laboratory Supervisor.

Corrective actions may be initiated because of a problem identified through a system audit, performance audit, or data end user's request. The process is generally initiated by the QA Officer and documented on a Quality Assurance Irregularity Report form (see Shared Documents) by the analyst responsible for the data, the Senior Laboratory Analyst, or the Laboratory Supervisor. The Laboratory Supervisor authorizes the implementation of corrective actions recommended in the Irregularity Report. The lead analyst is responsible for evaluating the effectiveness of the corrective actions. If a corrective action is ineffective, it is the analyst's responsibility to notify the laboratory supervisor. The steps taken in the corrective action process are:

- Identify and define the problem;
- Assign responsibility for investigating the problem;
- Determine the cause of the problem;
- Determine the actions needed to eliminate the problem;
- Implement corrective action; and
- Establish effectiveness of the corrective action.

When Data Quality Objectives defined in Section 8.0 are not met, corrective action is initiated by the appropriate person(s) in the Division. These corrective actions may include, but are not limited to:

- Review of the raw data and calculations;
- Re-calibration of instrumentation;
- Re-analysis of calibration standards;
- Re-analysis of samples;
- Instrumentation troubleshooting tasks;
- Method of standard additions, dilutions, post spikes;
- Re-sampling;
- Review of analytical procedures; or
- Qualifying statements on reports as pertain to the problem.

When using a control chart, the result must be within the control limits. A result outside the limits is termed "out of control" and the analysis repeated. If the analysis cannot be repeated, the laboratory report for all samples in the analytical batch will indicate that an analysis was "out of control".

In the absence of control charts, spike recoveries must be within the range defined by the data quality objective for the analysis to be accepted. If recovery is outside this range, the analysis must be repeated. If the recovery is again outside this range, this will be noted on the laboratory report for any samples in the analytical batch, or another analytical technique will be used (e.g. standard additions).

In the absence of control charts, check sample analytical results must be within the range defined by the data quality objective of the true value, or the analysis repeated, or noted on the effected laboratory reports.

Flow charts outlining procedures to follow in relation to quality data are presented in Figures 12.1 through 12.7. These flow charts are distributed throughout the laboratory as guidelines of appropriate corrective action steps to be used at different steps of the analysis. All corrective action steps must be documented.

Figure 12.2 – Evaluation of Method Calibration
Figure 12.3 – Evaluation of Method Blank and Instrument Blank
Figure 12.4 – Evaluation of Continuing Calibration
Figure 12.5 – Evaluation of Duplicate Sample and/or Duplicate Matrix Spike Results
Figure 12.6 – Evaluation of Laboratory Control Sample (LCS) Results
Figure 12.7 – Evaluation of Matrix Spike Recoveries
Figure 12.8 – Evaluation of Sample Results for Inorganic Analyses

References in the flow charts to Qualifier Codes that are used in LIMS are detailed in Table 12-1.

13.0 QUALITY ASSURANCE REPORTS

The Laboratory Information Management System (LIMS) allows for the generation of quality assurance reports that include blank, relative percent difference, recoveries, and qualifier information. These reports are printed for all projects where reports are generated.

All laboratory Analysts and Technicians review the Quality Assurance Plan on an annual basis and understand their responsibilities and the data quality objectives they must meet in order to report their data. Either the Senior Laboratory Analyst or the Laboratory Supervisor reviews analytical data to ensure it is acceptable.

The QA/QC Officer conducts audits and provides overview and support for the Quality Assurance Plan components.

14.0 ANALYTICAL METHODS

Analytical methods performed by the Environmental Analytical Services, Operations, and Residuals Laboratories are summarized in Table 14-1.

15.0 CHEMICALS and REAGENTS

After receipt in the laboratory, chemicals will be entered into the laboratory inventory system including the date received and the assigned container number written on the chemical container label. When a chemical container is opened, the date opened will be hand written on the container label.

All prepared standards solutions are documented in the standards and solutions notebooks located on the server. There is one electronic notebook for each of the four work-group areas in the laboratory.

16.0 CHEMICAL HYGIENE PLAN

Work practices and procedures pertaining to health and safety implemented in the laboratories are documented in the Chemical Hygiene Plan. Laboratory facilities operated by the E/S WPCF conforms to the Occupational Safety and Health Administration (OSHA) standards specified in 29 CFR 1910 Subpart Z: Occupational Exposure to Hazardous Chemicals, and the General Occupational Safety and Health Rules specified in OAR 437, Division 2.

Table 5.1 Sample Preservation and Holding Times [(a)]					
Determination	**Units**	**Matrix**	**Container**	**Preservation**	**Maximum Holding Time**
Alkalinity, as $CaCO_3$	mg/L	Sludge, Supernatant	Plastic	Cool, $\leq 6^{\circ}C$	14 days
Aluminum, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Alkalinity, as $CaCO_3$	mg/L	Aqueous	Plastic or Glass	Cool, $\leq 6^{\circ}C$	14 days
Aluminum, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Aluminum, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Aluminum, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Ammonia, as N	mg/L	Aqueous	Plastic or Glass	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Ammonia, as N	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Ammonia, as N	% dry weight	Sludge	Plastic	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Arsenic, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Arsenic, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Arsenic, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months
Arsenic, Total	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Arsenic, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Arsenic, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Biochemical Oxygen Demand	mg/L	Aqueous	Plastic	Cool, $\leq 6^{\circ}C$	48 hours
Cadmium, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Cadmium, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Cadmium, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months
Cadmium, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-um membrane filter	6 months
Cadmium, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Cadmium, Total	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Cadmium, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months

Table 5.1 Continued Sample Preservation and Holding Times					
Determination	**Units**	**Matrix**	**Container**	**Preservation**	**Maximum Holding Time**
Calcium, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Calcium, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Calcium, Extractable	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Carbonaceous Biochemical Oxygen Demand	mg/L	Aqueous	Plastic	Cool, $\leq 6^{\circ}C$	48 hours
Cation Exchange Capacity	meq/100g	Soil	Plastic	Dry, grind, screened	2 months
Chemical Oxygen Demand	mg/L	Aqueous	Plastic	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Chloride	mg/L	Aqueous	Plastic	None Required	28 days
Chloride, Automated	mg/L	Aqueous	Plastic	None Required	28 days
Chlorine Residual	mg/L	Aqueous	Plastic	None Required	Analyze immediately
Chromium, Hexavalent	mg/L	Aqueous	Plastic	Cool to $\leq 6^{\circ}C$	24 hours
Chromium, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Chromium, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Chromium, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Chromium, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Chromium, Total	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Chromium, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months
Copper, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Copper, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Copper, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Copper, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Copper, Total	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Copper, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months

Table 5-1 Continued Sample Preservation and Holding Times					
Determination	**Units**	**Matrix**	**Container**	**Preservation**	**Maximum Holding Time**
Cyanide, Amenable to Chlorination	mg/L	Aqueous	Plastic, Glass	Cool, $\leq 6^{\circ}C$ NaOH to pH >12 0.6g ascorbic acid[B]	14 days
Cyanide, Total	µg/L	Aqueous	Plastic, Glass	Cool, $\leq 6^{\circ}C$ NaOH to pH >12 0.6g ascorbic acid[B]	14 days
Cyanide, Total	mg/L	Aqueous	Plastic, Glass	Cool, $\leq 6^{\circ}C$ NaOH to pH >12 0.6g ascorbic acid[B]	14 days
Cyanide, Total	ppm, dry weight	Sludge	Plastic, Glass	Cool, $\leq 6^{\circ}C$ NaOH to pH >12 0.6g ascorbic acid[B]	14 days
Fluoride, Total	mg/L	Aqueous	Plastic	Cool, $\leq 6^{\circ}C$	28 days
Hardness, as $CaCO_3$	mg eq/L	Aqueous	NA	NA	Calculation
IA/PA Ratio	Ratio	Sludge, Supernatant	Plastic	Cool, $\leq 6^{\circ}C$	14 days
pH	pH Units	Aqueous	Plastic	None Required	Analyze immediately
pH	pH Units	Soil	Plastic	Dry, grind, screened	2 months
SMP, Lime Requirement	pH Units	Soil	Plastic	Dry, grind, screened	2 months
pH, pH Units	pH Units	Sludge	Plastic	None Required	Analyze immediately
Iron, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Iron, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Iron, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Iron, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Total Kjeldahl Nitrogen	mg/L	Aqueous	Plastic	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Total Kjeldahl Nitrogen	% dry weight	Soil	Plastic	Dry, grind, screened	2 months
Total Kjeldahl Nitrogen	% dry weight	Sludge	Plastic	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Lead, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Lead, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months

Table 5-1 Continued Sample Preservation and Holding Times					
Determination	**Units**	**Matrix**	**Container**	**Preservation**	**Maximum Holding Time**
Lead, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Lead, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Lead, Total	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Lead, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months
Magnesium, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Magnesium, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Magnesium, Extractable	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Mercury, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	28 days
Mercury, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	28 days
Mercury, Total	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Mercury, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	28 days
Molybdenum, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Molybdenum, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Molybdenum, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months
Molybdenum, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Molybdenum, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Molybdenum, Total	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Molybdenum, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months
Nickel, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Nickel, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Nickel, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Nickel, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Nickel, Total	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Nickel, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months

Table 5-1 Continued Sample Preservation and Holding Times					
Determination	**Units**	**Matrix**	**Container**	**Preservation**	**Maximum Holding Time**
Nitrate + Nitrite, as N	mg/L	Aqueous	Plastic	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Nitrate + Nitrite, as N	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Nitrate + Nitrite, as N	% dry weight	Sludge	Plastic	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Silica Gel Treated Hexane Extractable Material	mg/L	Aqueous	Glass	Cool, $\leq 6^{\circ}C$ HCl to pH <2	28 days
Hexane Extractable Material	mg/L	Aqueous	Glass	Cool, $\leq 6^{\circ}C$ HCl to pH <2	28 days
Total Organic Carbon	mg/L	Aqueous	Plastic	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Phosphorus, Ortho	mg/L	Aqueous	Plastic	Filter immediately Cool, $\leq 6^{\circ}C$	48 hours
Phenols	µg/L	Aqueous	Glass	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Phenols	mg/L	Aqueous	Glass	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Phenolics, Total	ppm, dry weight	Sludge	Glass	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Phosphorus, Total	mg/L	Aqueous	Plastic	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Phosphorus, Extractable	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Phosphorus, Total	% dry weight	Sludge	Plastic	Cool, $\leq 6^{\circ}C$ H_2SO_4 to pH <2	28 days
Potassium, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Potassium, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Potassium, Extractable	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Potassium, Total	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Potassium, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months
Residue, Total Solids	mg/L	Aqueous	Plastic	Cool, $\leq 6^{\circ}C$	7 days
Residue, Total Solids	%	Sludge	Plastic	Cool, $\leq 6^{\circ}C$	7 days

Table 5-1 Continued Sample Preservation and Holding Times					
Determination	**Units**	**Matrix**	**Container**	**Preservation**	**Maximum Holding Time**
Residue, Total Dissolved Solids	mg/L	Aqueous	Plastic	Cool, $\leq$ 6°C	7 days
Residue, Total Suspended Solids	mg/L	Aqueous	Plastic	Cool, $\leq$6°C	7 days
Residue, Volatile Solids	mg/L	Aqueous	Plastic	Cool to $\leq$6 °C	7 days
Residue, Volatile Solids	%	Sludge	Plastic	Cool to $\leq$6 °C	7 days
Selenium, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Selenium, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Selenium, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months
Selenium, Total	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Silver, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Silver, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Silver, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Silver, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Silver, Total	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Silver, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months
Sodium, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Sodium, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Sodium, Extractable	ppm, dry weight	Soil	Plastic	Dry, grind, screened	2 months
Sodium, Exchangeable	meq/100g	Soil	Plastic	Dry, grind, screened	2 months
Specific Conductivity	µmhos/cm @ 25 °C	Aqueous	Plastic	Cool to $\leq$6 °C	28 days
Total Soluble Salts, Conductivity	µmhos/cm @ 25 °C	Soil	Plastic	Dry, grind, screened	2 months
Sulfate, Low Level	mg/L	Aqueous	Plastic	Cool to $\leq$6 °C	28 days
Sulfide	mg/L	Aqueous	Plastic	Cool to $\leq$6 °C add zinc acetate plus NaOH to pH >9.	7 days

Table 5-1 Continued Sample Preservation and Holding Times					
Determination	**Units**	**Matrix**	**Container**	**Preservation**	**Maximum Holding Time**
Volatile Acids	mg/L	Sludge	Plastic	Cool, $\leq 6^{\circ}C$	14 days
Zinc, Dissolved	µg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Zinc, Total	µg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Zinc, Dissolved	mg/L	Aqueous	Plastic	HNO_3 to pH <2 after filtration through a 0.45-µm membrane filter	6 months
Zinc, Total	mg/L	Aqueous	Plastic	HNO_3 to pH <2	6 months
Zinc, Total	ppm, dry weight	Sludge	Plastic	HNO_3 to pH <2	6 months
Escherichia coli	Colonies/100mL	Aqueous	Plastic	Cool, <10 °C [(b)] 0.008% $Na_2S_2O_3$	6 hours
Fecal Coliform	Colonies/100mL	Aqueous	Plastic	Cool, <10 °C [(b)] 0.008% $Na_2S_2O_3$	6 hours
Total Coliform	Colonies/100mL	Aqueous	Plastic	Cool, <10°C [(b)] 0.008% $Na_2S_2O_3$	6 hours
Enterococci	Colonies/100mL	Aqueous	Plastic	Cool, <10°C [(b)] 0.008% $Na_2S_2O_3$	6 hours

[(a)] Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846.
[(b)] For chlorinated water samples only.

Table 7.1
Data Quality Objectives
Chemical and Microbiological Methods

General Chemistry / Water Chemistry

Method	Analyte	Units	Matrix	Method Reporting Limit Target	Precision (RPD)	Accuracy (% Recovery)
SM 2320B	Alkalinity, as $CaCO_3$	mg/L	Aqueous	10	15%	85 - 115%
SM 2320B	Alkalinity, as $CaCO_3$	mg/L	Sludge	NA	20%	75 - 125%
SM 4500-NH3 D-97	Ammonia, as N	mg/L	Aqueous	0.1	15%	85 - 115%
Methods of Soil Analysis 33-3.1	Ammonia, as N	ppm, dry weight	Soil	0.4	20%	75 - 125%
Std. Methods 20th Ed. 4500-NH_3B followed by 4500-NH_3 C	Ammonia, as N	% dry weight	Sludge	NA	20%	75 - 125%
EPA 200.8	Antimony, Dissolved	µg/L	Aqueous	0.0559	15%	70 - 130%
EPA 200.8	Antimony, Total	µg/L	Aqueous	0.0556	15%	70 - 130%
EPA 200.8	Arsenic, Dissolved	µg/L	Aqueous	0.0493	15%	70 - 130%
EPA 200.8	Arsenic, Total	µg/L	Aqueous	0.0408	15%	70 - 130%
SW-846 6010C / SW-846 3050B	Arsenic, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 - 125%
SW-846 6010C / SW-846 3050B	Arsenic, Total	ppm, dry weight	Soil	0.3	20%	75 - 125%
EPA 200.7	Arsenic, Dissolved	mg/L	Aqueous	0.02	15%	85 - 115%
EPA 200.7 / EPA 200.7 Part 11.2	Arsenic, Total	mg/L	Aqueous	0.02	15%	85 - 115%
EPA 200.8	Beryllium, Dissolved	µg/L	Aqueous	0.0986	15%	70 - 130%
EPA 200.8	Beryllium, Total	µg/L	Aqueous	0.112	15%	70 - 130%
Std. Methods 20th Ed. 5210B	Biochemical Oxygen Demand	mg/L	Aqueous	2	15%	85 - 115%
EPA 200.8	Cadmium, Dissolved	µg/L	Aqueous	0.0254	15%	70 - 130%
EPA 200.8	Cadmium, Total	µg/L	Aqueous	0.0553	15%	70 - 130%

Table 7.1 Continued
Data Quality Objectives
Chemical and Microbiological Methods

General Chemistry / Water Chemistry

Method	Analyte	Units	Matrix	Method Reporting Limit Target	Precision (RPD)	Accuracy (% Recovery)
EPA 200.7	Cadmium, Dissolved	mg/L	Aqueous	0.01	15%	85 - 115%
EPA 200.7 / EPA 200.7 Part 11.2	Cadmium, Total	mg/L	Aqueous	0.01	15%	85 - 115%
SW-846 6010C / SW-846 3050B	Cadmium, Total	ppm, dry weight	Soil	0.5	20%	75 - 125%
SW-846 6010C / SW-846 3050B	Cadmium, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 - 125%
EPA 200.7	Calcium, Dissolved	mg/L	Aqueous	1	15%	85 - 115%
EPA 200.7 / EPA 200.7 Part 11.2	Calcium, Total	mg/L	Aqueous	1	15%	85 - 115%
SW-846 6010C	Calcium, Extractable	ppm, dry weight	Soil	20	20%	75 - 125%
Std. Methods 20th Ed. 5210B	Carbonaceous Biochemical Oxygen Demand	mg/L	Aqueous	2	15%	85 - 115%
Oregon State University	Cation Exchange Capacity	meq/100g	Soil	NA	20%	75 - 125%
Hach 8000	Chemical Oxygen Demand	mg/L	Aqueous	10	15%	85 - 115%
EPA 300.0	Chloride, Automated	mg/L	Aqueous	1.0	15%	85 - 115%
SM 4500-Cl-D-00	Chlorine, Residual	mg/L	Aqueous	0.02	15%	85 - 115%
EPA 218.6	Chromium, Hexavalent	mg/L	Aqueous	2	15%	85 - 115%
EPA 200.8	Chromium, Dissolved	µg/L	Aqueous	0.0691	15%	70 - 130%
EPA 200.8	Chromium, Total	µg/L	Aqueous	0.177	15%	70 - 130%
EPA 200.7	Chromium, Dissolved	mg/L	Aqueous	0.01	15%	85 - 115%
EPA 200.7 / EPA 200.7 Part 11.2	Chromium, Total	mg/L	Aqueous	0.01	15%	85 - 115%
SW-846 6010C / SW-846 3050B	Chromium, Total	ppm, dry weight	Soil	1	20%	75 - 125%

Table 7.1 Continued
Data Quality Objectives
Chemical and Microbiological Methods

General Chemistry / Water Chemistry

Method	Analyte	Units	Matrix	Method Reporting Limit Target	Precision (RPD)	Accuracy (% Recovery)
SW-846 6010C / SW-846 3050B	Chromium, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 - 125%
EPA 200.8	Copper, Dissolved	µg/L	Aqueous	0.0421	15%	70 - 130%
EPA 200.8	Copper, Total	µg/L	Aqueous	0.0449	15%	70 - 130%
EPA 200.7	Copper, Dissolved	mg/L	Aqueous	0.05	15%	85 - 115%
EPA 200.7 / EPA 200.7 Part 11.2	Copper, Total	mg/L	Aqueous	0.05	15%	85 - 115%
SW-846 6010C / SW-846 3050B	Copper, Total	ppm, dry weight	Soil	3	20%	75 - 125%
SW-846 6010C / SW-846 3050B	Copper, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 - 125%
EPA 335.1	Cyanide, Amenable to Chlorination	mg/L	Aqueous	0.5	15%	85 - 115%
Std. Methods 20th Ed. 4500-CN C followed by 4500-CN E	Cyanide, Total	µg/L	Aqueous	5	15%	85 - 115%
Std. Methods 20th Ed. 4500-CN C followed by 4500-CN D	Cyanide, Total	mg/L	Aqueous	1.0	15%	85 - 115%
SW-846 9010C	Cyanide, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 - 125%
SM 4500-F-C-97	Fluoride, Total	mg/L	Aqueous	0.2	15%	85 - 115%
Std. Methods 20th Ed. SM 2340 B	Hardness, as $CaCO_3$	mg eq/L	Aqueous	NA	15%	85 - 115%
EPA 1664	Hexane Extractable Material	mg/L	Aqueous	5	18%	78 - 114%
SM 4500-H^+ B-00	Hydrogen Ion (pH)	pH Units	Aqueous	NA	15%	NA
SW-846 9045D	Hydrogen Ion (pH)	pH Units	Soil	NA	20%	NA
SW-846 9045D	Hydrogen Ion (pH)	pH Units	Sludge	NA	20%	NA

Table 7.1 Continued
Data Quality Objectives
Chemical and Microbiological Methods

General Chemistry / Water Chemistry

Method	Analyte	Units	Matrix	Method Reporting Limit Target	Precision (RPD)	Accuracy (% Recovery)
EPA 310.1 Modified pH endpoint 4.3 and 5.75	IA/PA Ratio	Ratio	Sludge	NA	20%	NA
Std. Methods 20th Ed. 4500N_{org} B Followed by 4500NH_3 C	Kjeldahl Nitrogen - Total	mg/L	Aqueous	0.2	15%	85 - 115%
Oregon State University	Kjeldahl Nitrogen - Total	% dry weight	Soil	NA	20%	75 - 125%
Std. Methods 20th Ed. 4500N_{org} B Followed by 4500NH_3 C	Kjeldahl Nitrogen - Total	% dry weight	Sludge	NA	20%	75 - 125%
EPA 200.8	Lead, Dissolved	µg/L	Aqueous	0.0606	15%	70 - 130%
EPA 200.8	Lead, Total	µg/L	Aqueous	0.0348	15%	70 - 130%
EPA 200.7	Lead, Dissolved	mg/L	Aqueous	0.02	15%	85 - 115%
EPA 200.7 / EPA 200.7 Part 11.2	Lead, Total	mg/L	Aqueous	0.02	15%	85 - 115%
SW-846 6010C / SW-846 3050B	Lead, Total	ppm, dry weight	Soil	5	20%	75 - 125%
SW-846 6010C / SW-846 3050B	Lead, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 - 125%
EPA 200.7	Magnesium, Dissolved	mg/L	Aqueous	0.5	15%	85 - 115%
EPA 200.7 / EPA 200.7 Part 11.2	Magnesium, Total	mg/L	Aqueous	0.5	15%	85 - 115%
SW-846 6010C	Magnesium, Extractable	ppm, dry weight	Soil	10	20%	75 – 125%
EPA 245.1, Rev. 3.0	Mercury, Dissolved	µg/L	Aqueous	0.2	15%	85 – 115%
EPA 245.1 Rev. 3.0	Mercury, Total	µg/L	Aqueous	0.2	15%	85 – 115%
EPA 1631	Mercury, Dissolved	ng/L	Aqueous	0.5	24%	71 – 125%
EPA 1631	Mercury, Total	ng/L	Aqueous	0.5	24%	71 – 125%
SW-846 7471B	Mercury, Total	ppm, dry weight	Soil	2	20%	75 – 125%

Table 7.1 Continued
Data Quality Objectives
Chemical and Microbiological Methods

General Chemistry / Water Chemistry

Method	Analyte	Units	Matrix	Method Reporting Limit Target	Precision (RPD)	Accuracy (% Recovery)
SW-846 7471B	Mercury, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 – 125%
EPA 200.8	Molybdenum, Dissolved	µg/L	Aqueous	0.113	15%	70 – 130%
EPA 200.8	Molybdenum, Total	µg/L	Aqueous	0.128	15%	70 – 130%
EPA 200.7	Molybdenum, Dissolved	mg/L	Aqueous	0.01	15%	85 – 115%
EPA 200.7 / EPA 200.7 Part 11.2	Molybdenum, Total	mg/L	Aqueous	0.01	15%	85 – 115%
SW-846 6010C/ SW-846 3050B	Molybdenum, Total	ppm, dry weight	Soil	5	20%	75 – 125%
SW-846 6010C / SW-846 3050B	Molybdenum, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 – 125%
EPA 200.8	Nickel, Dissolved	µg/L	Aqueous	0.0348	15%	70 – 130%
EPA 200.8	Nickel, Total	µg/L	Aqueous	0.0722	15%	70 – 130%
EPA 200.7	Nickel, Dissolved	mg/L	Aqueous	0.01	15%	85 – 115%
EPA 200.7 / EPA 200.7 Part 11.2	Nickel, Total	mg/L	Aqueous	0.01	15%	85 – 115%
SW-846 6010C / SW-846 3050B	Nickel, Total	ppm, dry weight	Soil	3	20%	75 – 125%
SW-846 6010C / SW-846 3050B	Nickel, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 - 125%
EPA 353.2 Rev. 2.0	Nitrate+Nitrite, as N	mg/L	Aqueous	0.05	15%	85 - 115%
Methods of Soil Analysis 33-3.1	Nitrate+Nitrite, as N	ppm, dry weight	Soil	0.5	20%	75 - 125%
EPA 353.2 Rev. 2.0	Nitrate+Nitrite, as N	% dry weight	Sludge	NA	20%	75 - 125%
EPA 420.1	Phenols	µg/L	Aqueous	50	15%	85 - 115%
EPA 420.1	Phenols	mg/L	Aqueous	0.2	15%	85 - 115%

Table 7.1 Continued
Data Quality Objectives
Chemical and Microbiological Methods

General Chemistry / Water Chemistry

Method	Analyte	Units	Matrix	Method Reporting Limit Target	Precision (RPD)	Accuracy (% Recovery)
EPA 365.3	Phosphorus, Ortho	mg/L	Aqueous	0.01	15%	85-115%
EPA 365.3	Phosphorus, Total	mg/L	Aqueous	0.01	15%	85 - 115%
Oregon State University	Phosphorus, Extractable	ppm, dry weight	Soil	0.1	20%	75 - 125%
EPA 365.3	Phosphorus, Total	% dry weight	Sludge	NA	20%	75 - 125%
EPA 200.7	Potassium, Dissolved	mg/L	Aqueous	1	15%	85 - 115%
EPA 200.7 / EPA 200.7 Part 11.2	Potassium, Total	mg/L	Aqueous	1	15%	85 - 115%
SW-846 6010C	Potassium, Extractable	ppm, dry weight	Soil	20	20%	75 - 125%
SW-846 6010C / SW-846 3050B	Potassium, Total	ppm, dry weight	Soil	50	20%	75 - 125%
SW-846 6010C / SW-846 3050B	Potassium, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 - 125%
Std. Methods 20th Ed. 2540B	Residue, Total Solids	mg/L	Aqueous	10	15%	85 - 115%
Std. Methods 20th Ed. 2540B	Residue, Total Solids	%	Sludge	NA	20%	NA
Std. Methods 20th Ed. 2540C	Residue, Total Dissolved Solids	mg/L	Aqueous	10	15%	85 - 115%
Std. Methods 20th Ed. 2540D	Residue, Total Suspended Solids	mg/L	Aqueous	1	15%	85 - 115%
EPA 160.4	Residue, Volatile Solids	mg/L	Aqueous	NA	15%	85 - 115%
EPA 160.4	Residue, Volatile Solids	%	Sludge	NA	20%	NA
EPA 200.7	Selenium, Dissolved	mg/L	Aqueous	0.03	15%	85 – 115%
EPA 200.7	Selenium, Total	mg/L	Aqueous	0.03	15%	85 – 115%
EPA 200.8	Selenium, Dissolved	µg/L	Aqueous	0.379	15%	70 - 130%

Table 7.1 Continued
Data Quality Objectives
Chemical and Microbiological Methods

General Chemistry / Water Chemistry

Method	Analyte	Units	Matrix	Method Reporting Limit Target	Precision (RPD)	Accuracy (% Recovery)
EPA 200.8	Selenium, Total	µg/L	Aqueous	0.171	15%	70 - 130%
SW-846 6010C / SW-846 3050B	Selenium, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 - 125%
SW-846 6010C / SW-846 3050B	Selenium, Total	ppm, dry weight	Soil	0.3	20%	75 - 125%
EPA 1664	Silica Gel Treated Hexane Extractable Material	mg/L	Aqueous	5	34%	64 - 132%
EPA 200.8	Silver, Dissolved	µg/L	Aqueous	0.0342	15%	70 - 130%
EPA 200.8	Silver, Total	µg/L	Aqueous	0.0452	15%	70 - 130%
EPA 200.7	Silver, Dissolved	mg/L	Aqueous	0.02	15%	85 - 115%
EPA 200.7 / EPA 200.7 Part 11.2	Silver, Total	mg/L	Aqueous	0.02	15%	85 - 115%
SW-846 6010C / SW-846 3050B	Silver, Total	ppm, dry weight	Soil	1	20%	75 - 125%
SW-846 6010C / SW-846 3050B	Silver, Total	ppm, dry weight	Sludge	Dependant on % solids / weight used for analyses	20%	75 - 125%
EPA 200.7	Sodium, Dissolved	mg/L	Aqueous	0.5	15%	85 - 115%
EPA 200.7 / EPA 200.7 Part 11.2	Sodium, Total	mg/L	Aqueous	0.5	15%	85 - 115%
SW-846 6010C	Sodium, Extractable	ppm, dry weight	Soil	10	20%	75 - 125%
SW-846 6010C	Sodium, Exchangeable	meq/100g	Soil	0.05	20%	75 - 125%
Std. Methods 20th Ed. 2510B	Specific Conductance	µmhos/cm @ 25 °C	Aqueous	5	15%	85 - 115%
Oregon State University	Total Soluble Salts, Conductivity	µmhos/cm @ 25 °C	Soil	5	20%	75 - 125%
EPA 300.0 or EPA 375.2	Sulfate, Low Level	mg/L	Aqueous	1	15%	85 - 115%

Table 7.1 Continued
Data Quality Objectives
Chemical and Microbiological Methods

General Chemistry / Water Chemistry

Method	Analyte	Units	Matrix	Method Reporting Limit Target	Precision (RPD)	Accuracy (% Recovery)
EPA 200.8	Thallium, Dissolved	µg/L	Aqueous	0.0317	15%	70 – 130%
EPA 200.8	Thallium, Total	µg/L	Aqueous	0.0458	15%	70 – 130%
EPA 180.1 Rev. 2.0	Turbidity	NTU	Aqueous	1	15%	85 - 115%
Std. Methods 20th Ed. 5560C	Volatile Acids	mg/L	Sludge	NA	20%	NA
EPA 200.8	Zinc, Dissolved	µg/L	Aqueous	0.0700	15%	70 - 130%
EPA 200.8	Zinc, Total	µg/L	Aqueous	0.106	15%	70 - 130%
EPA 200.7	Zinc, Dissolved	mg/L	Aqueous	0.1	15%	85 - 115%
EPA 200.7 / EPA 200.7 Part 11.2	Zinc, Total	mg/L	Aqueous	0.1	15%	85 - 115%
SW-846 6010C/ SW-846 3050B	Zinc, Total	ppm, dry weight	Sludge	Depends on % solids and weight	20%	75 - 125%
Colilert QT	*Escherichia coli*	Colonies per 100 mL	Aqueous	1	Specific to Matrix	NA
Std. Methods 20th Ed. 9222D	Fecal Coliform	Colonies per 100 mL	Aqueous	20 - 60 colonies	Specific to Matrix	NA
Std. Methods 20th Ed. 9222B	Total Coliform	Colonies per 100 mL	Aqueous	20 - 80 colonies	Specific to Matrix	NA
Enterolert	Enterococci	Colonies per 100 mL	Aqueous	20 - 60 colonies	Specific to Matrix	NA

Table 8.1 Laboratory Instrument Calibration Guidelines	
Instrument	**Calibration Guidelines**
pH Meters	Three point calibration.
Inductively Coupled Argon Plasma Spectrophotometer	Calibration curve constructed from at least three standards and blank.
Total Organic Carbon Analyzer	The baseline is first established and the analyzer is calibrated taking the average of three standard values.
Dissolved Oxygen Meter	Saturated air calibration, checked monthly by Winkler titration.
Chlorine Residual Analyzer	Checked against a known standard monthly.
Flow through Ion Analyzer	Calibration curve constructed from at least four standards and a baseline blank.
Ion Chromatagraph	Minimum of three concentration levels and a blank. Calibration Curve verified each working day. Recalibrate if response or retention times vary from expected values by more that +/- 10%
Cold Vapor Atomic Fluorescence Mercury (Low-Level Sytem)	Minimum of 5 non-zero points and the results of analysis of 3 system blanks. Low Cal. Point at the minimum level of quantification. Calibration Factor (CF) to be used to evaluate calibration acceptance. RSD of mean CF must be equal to or lower than 15%. The low standard must be in the range of 75-125% of the concentration.
Ovens, Refrigerators	Temperatures are recorded daily when the equipment is being used. Temperatures verified annually with certified reference thermometer. Liquid immersed thermometers are used in refrigerators.
Incubators	Temperatures are recorded daily (BOD incubators) and twice daily separated by at least four hours (bacteriology) when used. Liquid immersed thermometers are used, and checked annually against a reference thermometer.
Autoclave	Date, time, contents, and temperature recorded for each use cycle.
Analytical Balances	Serviced quarterly and checked with certified weights.
Ion Selective Electrodes	Calibrate as per procedure.
Spectrometers	Adjust wavelength for particular test. Set to: Concentration, Absorbance, or Transmittance. Warm up lamp approximately 30 minutes.
Inductively coupled Plasma Mass Spec	Calibration curve constructed from at least three standards and a blank.

Table 12.1 LIMS Qualifier Codes	
Abbreviation Code for Data Entry	**Full Description**
HBR	Blank Result higher than MRL. Associated Samples are greater than 10 times the Blank concentration. Results are not affected.
HBRQD	Blank Result higher than MRL. Suspect data as results are affected.
HRPD	High relative percent difference (RPD) due to analysis results near the method reporting limit (<5 times MRL). RPD Limits not applicable.
INHOM	High relative percent difference (RPD) due to non-homogeneous sample matrix. RPD Limits not applicable.
LCS	Laboratory Control Standard (LCS) “Out of Control”
LSRR	Spike Recovery out of range. Sample concentration exceeds the Spike concentration by a factor of 4 or more. Spike Recovery Limits not applicable.
SRMI	Spike Recovery out of range due to matrix interference.
SRND	Spike Recovery >115% reported sample results <MRL. Data is acceptable for use.
QCOUT	Quality Control data out of acceptable limits – data suspect
UNC	Uncharacteristic Sample

Table 14.1 Listing of Analytical Methods			
Analytical Code	**Analytical Name**	**Units**	**Reference Method**
AGD	Silver, Dissolved	mg/L	EPA 200.7
AGFMS	Silver, Dissolved	µg/L	EPA 200.8
AGT	Silver, Total	mg/L	EPA 200.7
AGTSO	Silver, Total	ppm dry wt.	SW-846 6010
AGUMS	Silver, Total	µg/L	EPA 200.8
ALD	Aluminum, Dissolved	mg/L	EPA 200.7
ALK	Alkalinity, as $CaCO_3$	mg/L	SM 2320 B
ALT	Aluminum, Total	mg/L	EPA 200.7
ASD	Arsenic, Dissolved	mg/L	EPA 200.7
ASFMS	Arsenic, Dissolved	µg/L	EPA 200.8
ASSO	Arsenic, Total	ppm dry wt	SW-846 7060
AST	Arsenic, Total	mg/L	EPA 200.7
ASTSO	Arsenic, Total	ppm dry wt	SW-846 6010
ASUMS	Arsenic, Total	µg/L	EPA 200.8
BEFMS	Beryllium , Dissolved	µg/L	EPA 200.8
BEUMS	Beryllium Total	µg/L	EPA 200.8
BOD	Biochemical Oxygen Demand	mg/L	SM 5210B
CAD	Calcium, Dissolved	mg/L	EPA 200.7
CAT	Calcium, Total	mg/L	EPA 200.7
CBOD	Carbonaceous Biochemical Oxygen Demand	mg/L	SM 5210B
CDD	Cadmium, Dissolved	mg/L	EPA 200.7
CDFMS	Cadmium, Dissolved	µg/L	EPA 200.8
CDT	Cadmium, Total	mg/L	EPA 200.7
CDTSO	Cadmium, Total	ppm dry wt	SW-846 6010
CDUMS	Cadmium, Total	µg/L	EPA 200.8
CECSO	Cation Exchange Capacity	Meq/100g	OSU 1989
CL	Chloride	mg/L	EPA 300.0
CL2	Chlorine Residual	mg/L	SM 4500-Cl D.
CLA	Chloride	mg/L	SM 4500-Cl E
CNA	Cyanide, Amenable to Chlorination	mg/L	SM 4500-CN-F/G

Table 14.1 Listing of Analytical Methods			
Analytical Code	**Analytical Name**	**Units**	**Reference Method**
CNTL	Cyanide, Total	µg/L	EPA 335.4
COD	Chemical Oxygen Demand	mg/L	Hach 8000
COE	*Escherichia coli*	Colonies per 100 mL	Colilert QT
COF	Fecal Coliform	Colonies per 100 mL	SM 9222D
CON	Conductivity, @ 25 °C	µmhos/cm	SM 2510B
CONF	Conductivity, @ 25 °C	µmhos/cm	SM 2510B
COT	Total Coliform	Colonies per 100 mL	SM 9222B
CRD	Chromium, Dissolved	mg/L	EPA 200.7
CRFMS	Chromium, Dissolved	µg/L	EPA 200.8
CRT	Chromium, Total	mg/L	EPA 200.7
CRTSO	Chromium, Total	ppm dry wt	SW-846 6010
CRUMS	Chromium, Total	µg/L	EPA 200.8
CUD	Copper, Dissolved	mg/L	EPA 200.7
CUFMS	Copper, Dissolved	µg/L	EPA 200.8
CUT	Copper, Total	mg/L	EPA 200.7
CUTSO	Copper, Total	ppm dry wt	SW-846 6010
CUUMS	Copper, Total	µg/L	EPA 200.8
DO	Dissolved Oxygen	mg/L	SM 4500-0 G
ECASO	Calcium, Extractable	ppm dry wt	SW-846 6010
EKSO	Potassium, Extractable	ppm dry wt	SW-846 6010
EMGSO	Magnesium, Extractable	ppm dry wt	SW-846 6010
ENASO	Sodium, Extractable	ppm dry wt	SW-846 6010
ENT	Enterococci	Colonies per 100 mL	EPA 1106.1
EPSO	Phosphorus, Extractable	ppm dry wt	OSU 1989
FED	Iron, Dissolved	mg/L	EPA 200.7
FET	Iron, Total	mg/L	EPA 200.7
FLUOR	Fluoride	mg/L	SM 4500-F-C-97
HEM	Hexane Extractable Material	mg/L	EPA 1664, REV A
HGT	Mercury, Total	mg/L	EPA 1631 E
HGSO	Mercury, Total	ppm dry wt	SW-846 7471
HGT	Mercury, Total	mg/L	EPA 1631 E

Table 14.1 Listing of Analytical Methods			
Analytical Code	**Analytical Name**	**Units**	**Reference Method**
HGU	Mercury, Total	µg/L	EPA 245.1/1631 E
HGLF	Mercury, Dissolved	µg/L	EPA 1631 E
HRD	Hardness, as $CaCO_3$	mg eq/L	SM 2340 B or C
KD	Potassium, Dissolved	mg/L	EPA 200.7
KNSO	Total Kjeldahl Nitrogen	% dry wt	OSU 1989
KT	Potassium, Total	mg/L	EPA 200.7
KTSO	Potassium, Total	ppm dry wt	SW-846 6010
MGD	Magnesium, Dissolved	mg/L	EPA 200.7
MGT	Magnesium, Total	mg/L	EPA 200.7
MOD	Molybdenum, Dissolved	mg/L	EPA 200.7
MOFMS	Molybdenum, Dissolved	µg/L	EPA 200.8
MOT	Molybdenum, Total	mg/L	EPA 200.7
MOTSO	Molybdenum, Total	ppm dry wt	SW-846 6010
MOUMS	Molybdenum, Total	µg/L	EPA 200.8
NAD	Sodium, Dissolved	mg/L	EPA 200.7
NAT	Sodium, Total	mg/L	EPA 200.7
NH3	Ammonia, as N	mg/L	SM 4500-NH3 D
NHSO	Ammonia, as N	ppm dry wt	MOSA 33-3.1
NID	Nickel, Dissolved	mg/L	EPA 200.7
NIFMS	Nickel, Dissolved	µg/L	EPA 200.8
NIT	Nickel, Total	mg/L	EPA 200.7
NITSO	Nickel, Total	ppm dry wt	SW-846 6010
NIUMS	Nickel, Total	µg/L	EPA 200.8
NO3	Nitrate + Nitrite, as N	mg/L	EPA 353.2
NOSO	Nitrate + Nitrite, as N	ppm dry wt	MOSA 33-3.1
OP	Phosphorus, Ortho	mg/L	EPA 365.3
PBD	Lead, Dissolved	mg/L	EPA 200.7
PBFMS	Lead, Dissolved	µg/L	EPA 200.8
PBT	Lead, Total	mg/L	EPA 200.7
PBTSO	Lead, Total	ppm dry wt	SW-846 6010
PBUMS	Lead, Total	µg/L	EPA 200.8

Table 14.1 Listing of Analytical Methods			
Analytical Code	**Analytical Name**	**Units**	**Reference Method**
PH	pH	pH Units	SM 4500 H^+ B
PHE	Phenols	mg/L	EPA 420.1
PHEL	Phenols	mg/L	EPA 420.1
PHF	pH Field	pH Units	SM 4500 H^+ B
PHSO	pH	pH Units	EPA 9045
SBFMS	Antimony, Dissolved	µg/L	EPA 200.8
SBUMS	Antimony, Total	µg/L	EPA 200.8
SED	Selenium, Dissolved	mg/L	EPA 200.7
SEFMS	Selenium, Dissolved	µg/L	EPA 200.8
SESO	Selenium, Total	ppm dry wt	SW-846 7740
SET	Selenium, Total	mg/L	EPA 200.7
SETSO	Selenium, Total	ppm dry wt	SW-846 6010
SEUMS	Selenium, Total	µg/L	EPA 200.8
SGTHEM	Silica Gel Treated, Hexane Extractable Material	mg/L	EPA 1664, REV A
SLAGT	Silver, Total	ppm dry wt	SW-846 6010
SLALK	Alkalinity, as $CaCO_3$	mg/L	EPA 310.1
SLAS	Arsenic, Total	ppm dry wt	SW-846 7060
SLCDT	Cadmium, Total	ppm dry wt	SW-846 6010
SLCN	Cyanide, Total	ppm dry wt	SW-846 9010
SLCRT	Chromium, Total	ppm dry wt	SW-846 6010
SLCUT	Copper, Total	ppm dry wt	SW-846 6010
SLHG	Mercury, Total	ppm dry wt	SW-846 7471
SLIAPA	IA/PA Ratio	Ratio	EPA 310.1 M
SLKN	Total Kjeldahl Nitrogen	% dry wt	SM4500–Norg B or C and SM4500–NH3 B.
SLKT	Potassium, Total	% dry wt	SW-846 6010
SLMO	Molybdenum, Total	ppm dry wt	SW-846 7481
SLMOT	Molybdenum, Total	ppm dry wt	SW-846 6010
SLNH	Ammonia-N	% dry wt	SM 4500-NH3B
SLNIT	Nickel, Total	ppm dry wt	SW-846 6010

Table 14.1 Listing of Analytical Methods			
Analytical Code	**Analytical Name**	**Units**	**Reference Method**
SLNO	Nitrate-Nitrite-N	% dry wt	EPA 353.2
SLP	Phosphorus, Total	% dry wt	EPA 365.2
SLPBT	Lead, Total	ppm dry wt	SW-846 6010
SLPH	pH	pH Units	SM 4500–H^+ B
SLPHE	Phenolics, Total	ppm dry wt	SW-846 9065
SLSE	Selenium, Total	ppm dry wt	SW-846 7740
SLTS	Total Solids	%	SM 2540 B
SLVOLACD	Volatile Acids	mg/L	SM 5560C
SLVS	Volatile Solids	%	EPA 160.4
SLZNT	Zinc, Total	ppm dry wt	SW-846 6010
SO4H	Sulfate	mg/L	EPA 375.4
SO4L	Sulfate	mg/L	EPA 300.0
SOLSO	Total Soluble Salts, @ 25 °C	µmhos/cm	OSU 1989
TDS	Total Dissolved Solids	mg/L	SM 2540 C
TEMP	Temperature	°C	SM 2550 B
TKN	Total Kjeldahl Nitrogen	mg/L	SM 4500–Norg B or C and SM 4500–NH3 B.
TLFMS	Thalllium, Dissolved	µg/L	EPA 200.8
TLUMS	Thallium, Total	µg/L	EPA 200.8
TOC	Total Organic Carbon	mg/L	SM 5310 B
TOX	Total Organic Halogens	mg/L	EPA 9020
TP	Phosphorus, Total	mg/L	EPA 365.3
TS	Total Solids	mg/L	SM 2540 B
TSS	Total Suspended Solids	mg/L	SM2540 D
TURB	Turbidity	NTU	EPA 180.1
UVT	UV Transmittance	%	NA
VOL	Sample Volume	mL	NA
VS	Volatile Solids	%	EPA 160.4

Table 14.1 Listing of Analytical Methods			
Analytical Code	**Analytical Name**	**Units**	**Reference Method**
XNASO	Sodium, Exchangeable	meq/100g	SW-846 6010
ZND	Zinc, Dissolved	mg/L	EPA 200.7
ZNFMS	Zinc, Dissolved	µg/L	EPA 200.8
ZNT	Zinc, Total	mg/L	EPA 200.7
ZNTSO	Zinc, Total	ppm dry wt	SW-846 6010
ZNUMS	Zinc, Total	µg/L	EPA 200.8

Figure 5.1

Example of Sample Label

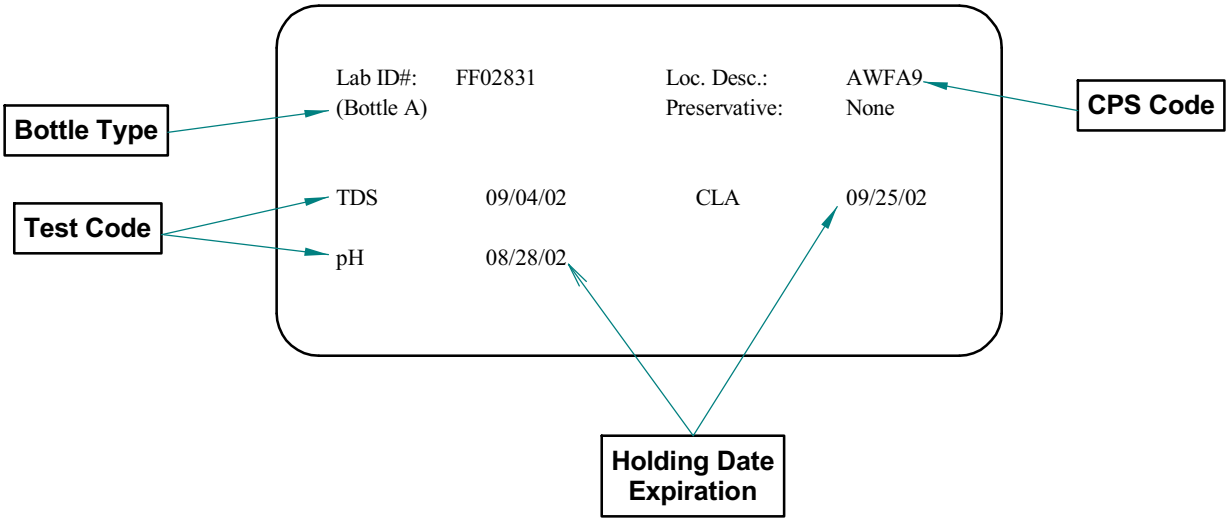

Figure 12.2
Evaluation of Method Calibration

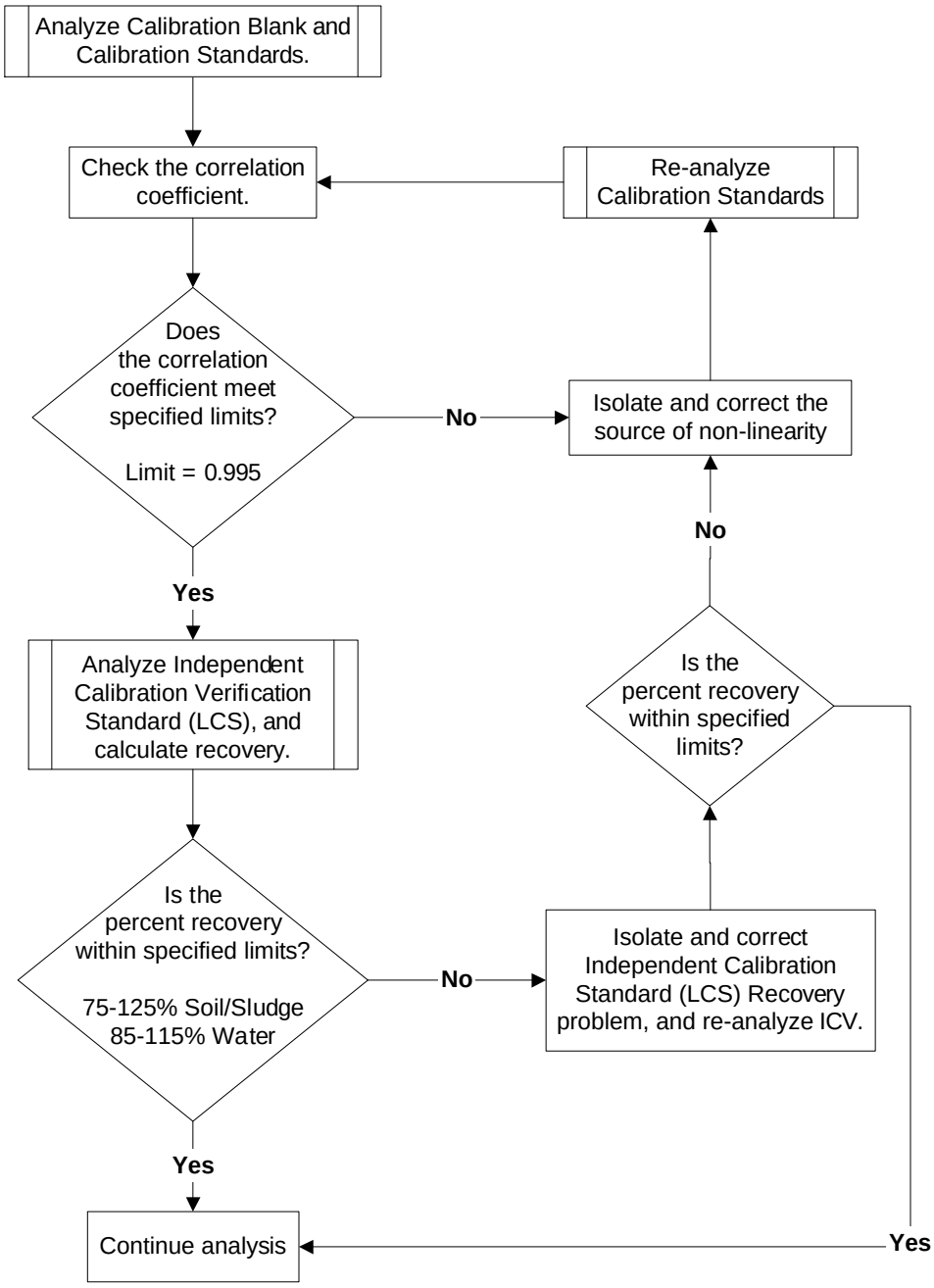

Figure 12.3
Evaluation of Method Blank and Instrument Blank

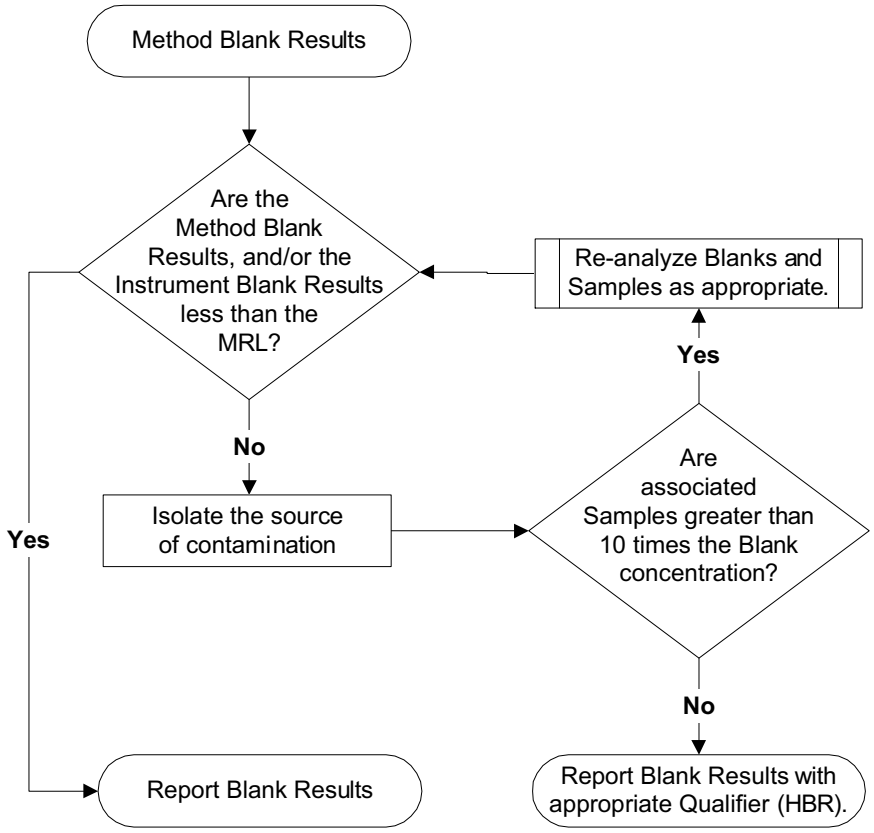

Figure 12.4
Evaluation of Continuing Calibration

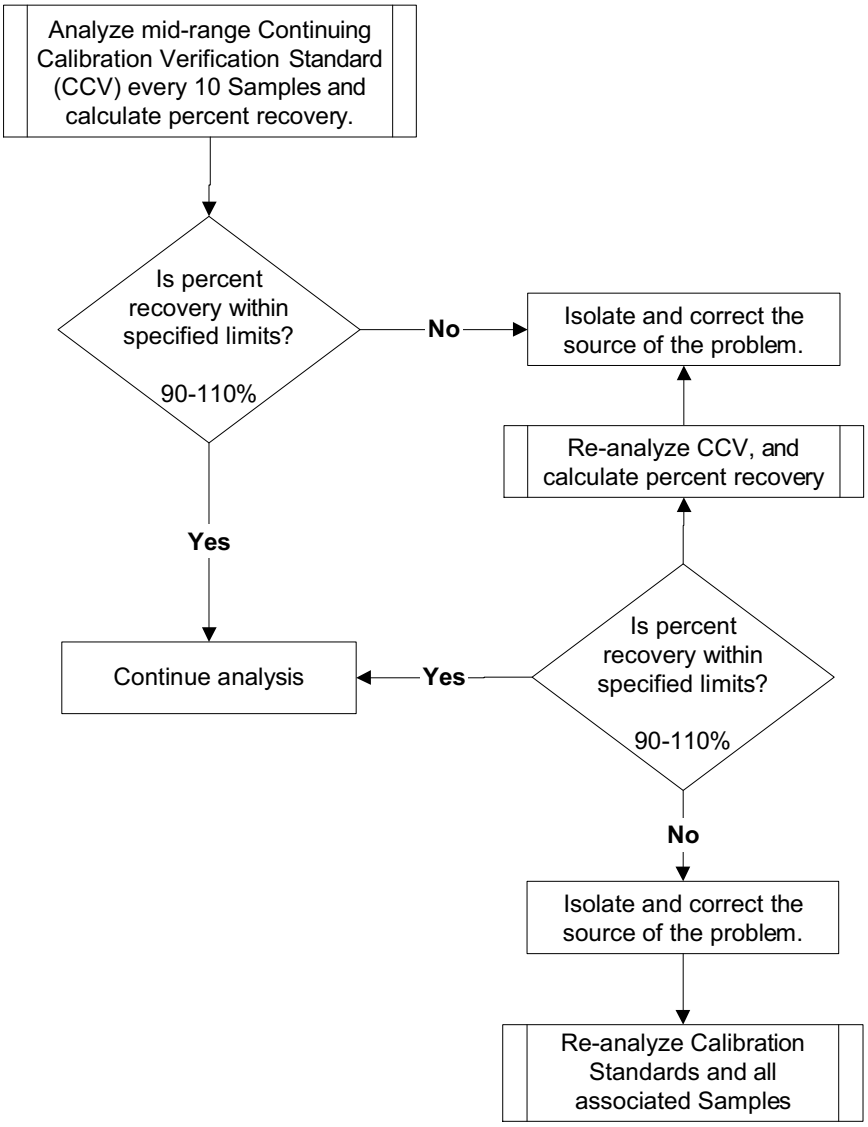

Figure 12.5

Evaluation of Duplicate Sample and/or Duplicate Matrix Spike Results

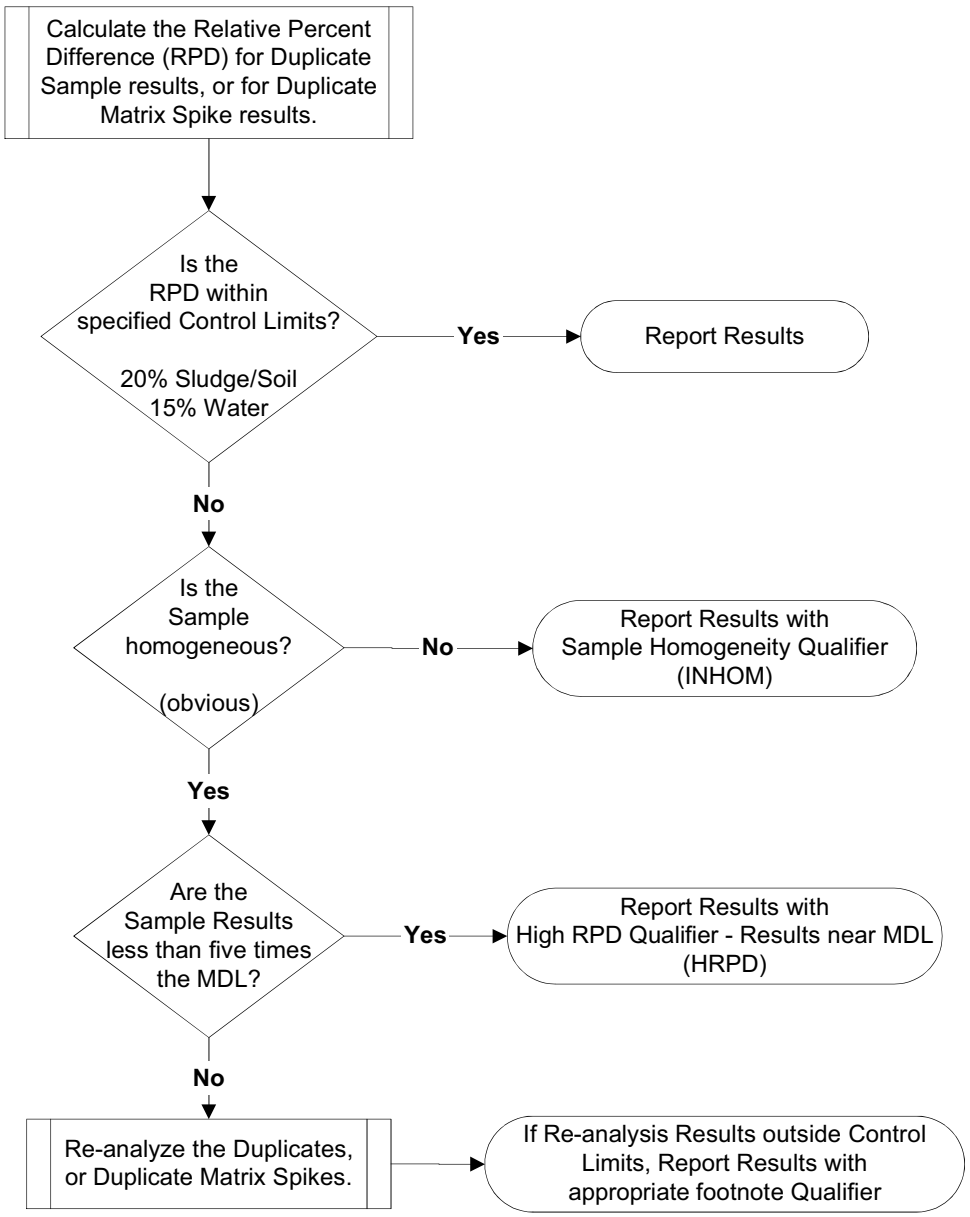

Figure 12.6
Evaluation of Laboratory Control Sample (LCS) Results

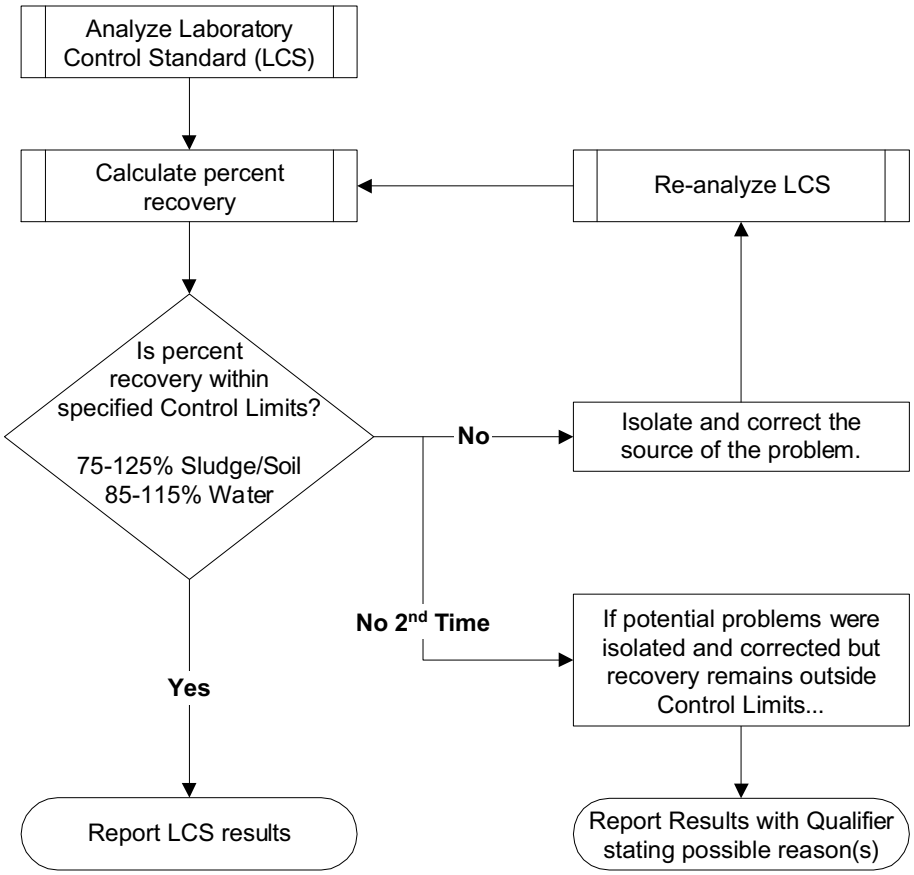

Figure 12.7
Evaluation of Matrix Spike Recoveries

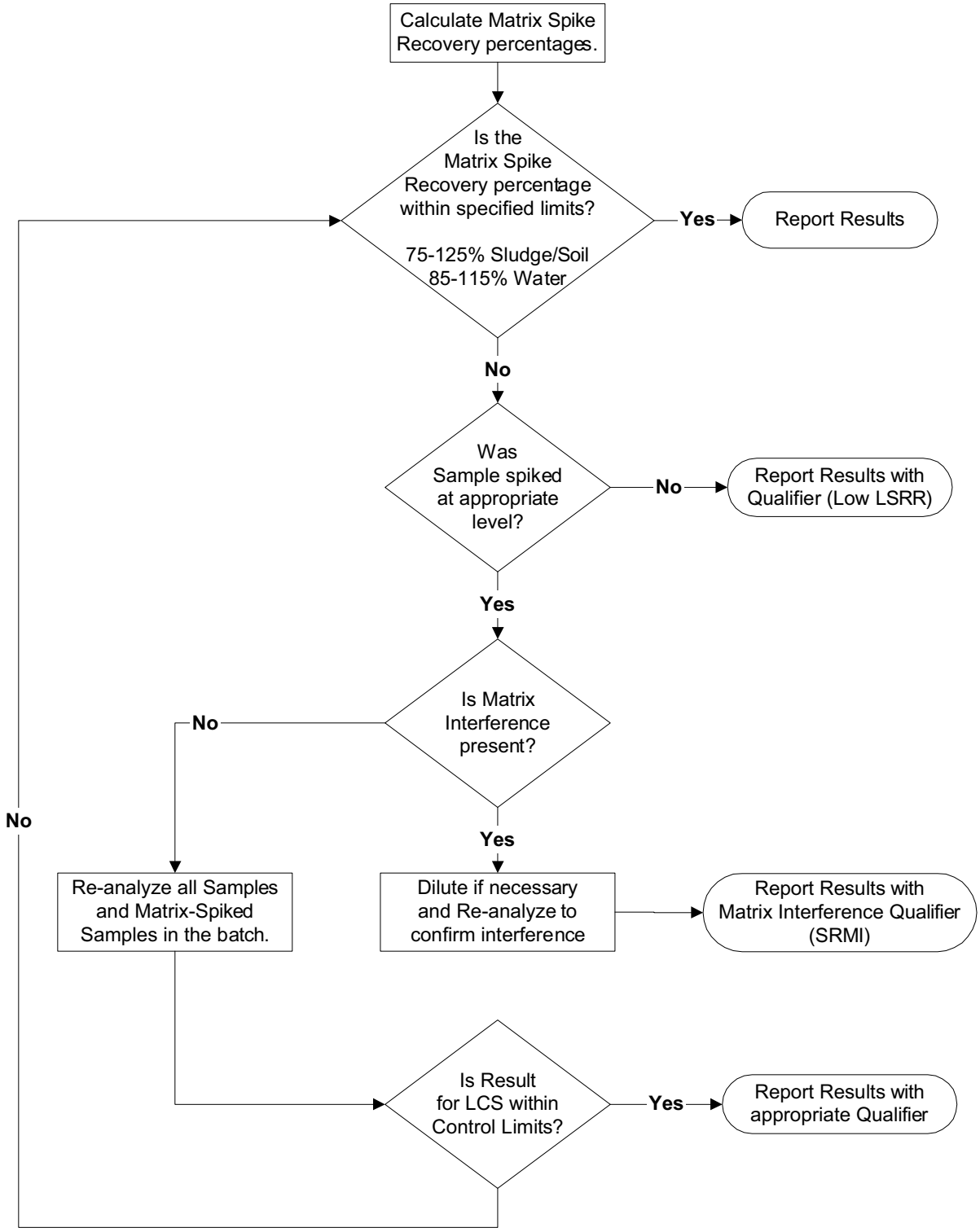
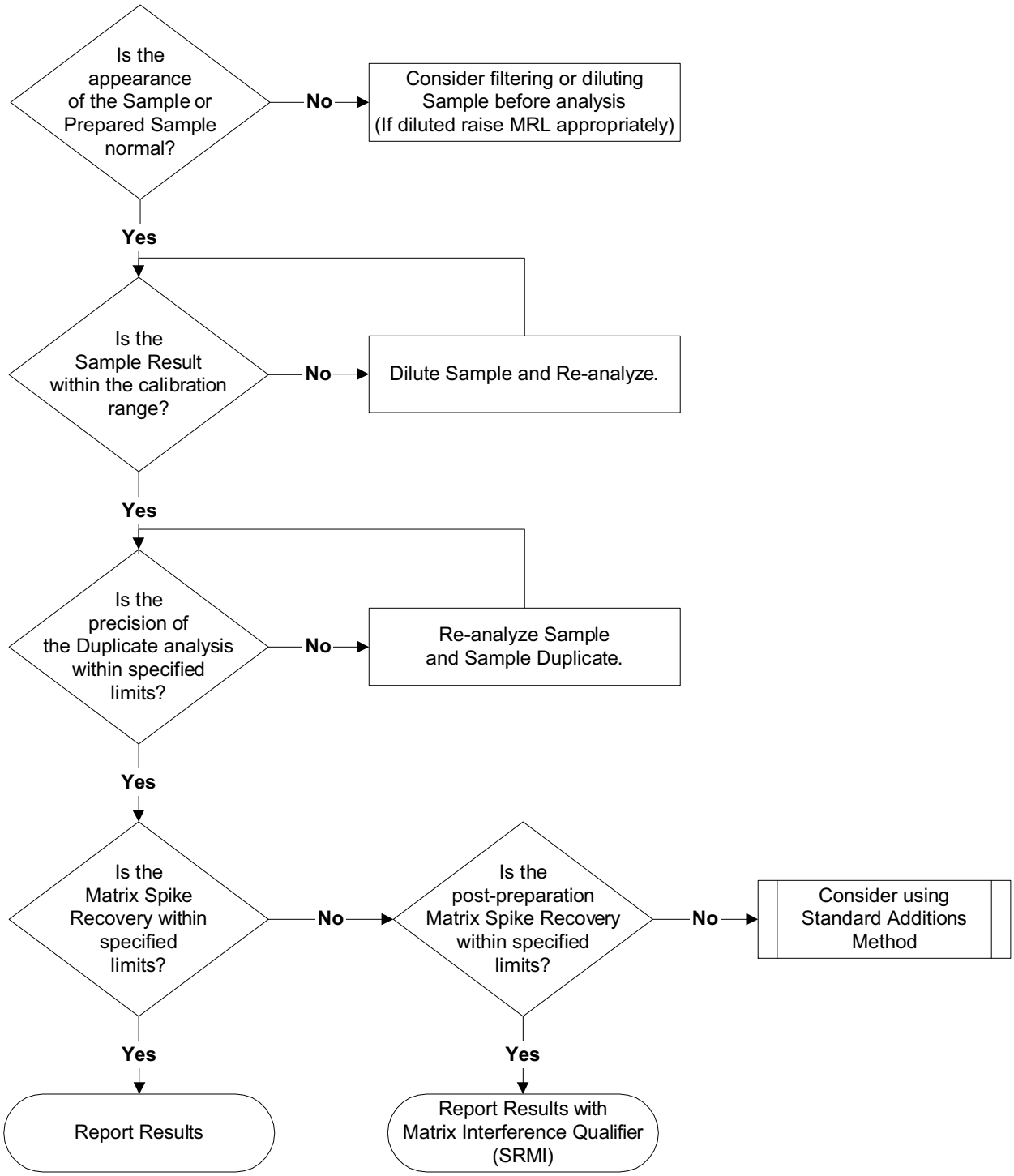
Figure 12.8
Evaluation of Sample Results for Inorganic Analyses