SAMPLING AND ANALYSIS PLAN

Prepared for:

BLACK & DECKER (U.S.) INC.
Hampstead, Maryland

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SECTION 1
INTRODUCTION

Pursuant to the April 1995 Consent Order between MDE and Black & Decker (U.S.) Inc., this Sampling and Analysis Plan (SAP) provides a description of field and laboratory procedures to be followed during investigative activities at the Hampstead, Maryland facility. A description of the Field Sampling Plan is presented in Section 2. The Laboratory Quality Assurance Plan is presented in Section 3. The Site Health and Safety Plan is presented in Section 4.

SECTION 2
FIELD SAMPLING PLAN

2.1 SAMPLING LOCATIONS

Groundwater sampling will be performed on a quarterly basis. Monitor well locations to be sampled are included in Table 2-1. Surface water and sediment samples will be collected from both the east and west lagoons on a bi-annual basis for a period of one year. In addition, test pits are to be excavated in the brush pile area.

2.2 FIELD OPERATIONS

2.2.1 Soil Investigations

2.2.1.1 Test Pit Excavation

Test pit investigations will be performed using a backhoe. Test pits will be excavated to either the water table, to refusal, or to the maximum reach of the backhoe, whichever is encountered first. Test pit excavation will be supervised by a Weston geoscientist, and complete logs (including visual descriptions of lithology, observations of groundwater occurrence, and instrument readings) will be completed. All descriptions will be made by observations of downhole conditions from the surface, or by examination of material pulled to the surface by the backhoe bucket. The geoscientist will describe the soil after it has been deposited on a plastic sheet situated a minimum of 3 ft from the test pit opening. An HNu photoionization meter or OVA flame ionization detector will be used for air monitoring, and a combustible gas meter will be used to monitor gas emissions in all test pits. If entrance into test pits by Weston personnel is required for soil sampling, the excavation will be sloped or benched in compliance with OSHA requirements. Requirements for sloping are discussed in the HASP.

Table 2–1
Black and Decker
Quarterly Groundwater Sampling Locations

WELL ID NO.
EW–1
EW–2
EW–3
EW–4
EW–5
EW–6
EW–7
EW–8
EW–9
EW–10
RFW–1A
RFW–1B
RFW–2A
RFW–2B
RFW–3B
RFW–4A
RFW–4B
RFW–5A
RFW–6
RFW–7
RFW–8
RFW–9
RFW–10
RFW–11A
RFW–11B
RFW–12B
RFW–13
RFW–16
RFW–17
RFW–18
RFW–19
TOWN #22
TOWN #23
LEISTER DAIRY WELL
LEISTER RES. WELL #1
LEISTER RES. WELL #2
LEISTER RES. WELL #3
JOS. A BANK PROD. WELL #1
JOS. A BANK PROD. WELL #2
"SHOPPING CENTER" WELL*

* proposed location

Soil samples will be collected from the identified depths using the backhoe bucket. The backhoe will deposit the material to be sampled on plastic sheeting, and the geoscientist will collect samples using dedicated stainless steel trowels and/or scoopulas. Each test pit will be photographed during excavation and/or upon completion.

If field screening indicates the potential for soil contamination, excavated soils will be segregated into two separate piles, one for potentially contaminated soils and another for soils showing no signs of contamination. Samples will be collected for analysis from each of these piles.

Upon completion, test pits will be backfilled using the soil removed during test pitting pending results of laboratory analysis of those soils, and/or with clean soil from an off-site source. The fill will be compacted with the backhoe to ensure that no cave-ins occur. All test pit locations will be tied horizontally to a coordinate system and vertically to a U.S. Coast and Geodetic Survey (USCGS) or U.S. Geological Survey (USGS) benchmark.

2.2.2 Groundwater Investigation

2.2.2.1 Water Level Measurements

Groundwater level measurements will be taken in wells on a monthly basis and prior to purging or sampling, using an electric water level probe graduated to 0.01 ft. Measurements will be referenced to a surveyed point marked on the top of the PVC or steel riser. The reference point will be described in the records for each well. The total depth of the well will be available from previous measurements. These data will determine the amount of water to be evacuated from each well prior to sampling. Water level measurements will be taken three times per well or until measurements are within ±0.01 ft. Measurements will be recorded in the field notebook and on field sampling sheets.

2.2.2.2 Monitor Well Sampling

Groundwater samples will be collected from monitor wells on a quarterly basis during the months of February, May, August, and November. Upgradient wells will be sampled first and wells suspected of having low levels of contamination will be sampled prior to those suspected of having medium or high levels. Procedures for sampling monitor wells are as follows:

- Water level measurements will be taken to the nearest 0.01 ft with respect to the established survey point located on top of the well casing. All measuring devices used in the well will be decontaminated as specified in Subsection 2.2.4.1 prior to use at each well. The total depth of the well will be measured previously and recorded. The depth to the static water surface will be subtracted from the total casing depth to determine the height and, subsequently, the volume of standing water in the casing.

- To ensure that samples are representative of groundwater quality, a submersible pump will be used to remove a minimum of three times the calculated volume of water in the well casing. The pump will be equipped with a foot-operated check-valve to prevent purged water from flowing back into the well. Wells that become dewatered prior to producing three casing volumes will be sampled as soon as practical once they recover sufficiently.

- Purge water will be containerized if previous analytical data indicate that contaminant levels exceed MCLs.

- Temperature, pH, and electrical conductivity (EC) will be measured and recorded during purging. A visual observation of turbidity (i.e high, medium, low) will also be recorded. A sample will be taken after a minimum of three well volumes have been removed and when the temperature, pH, and EC have stabilized. If these parameters do not stabilize within three purge volumes, a maximum of six well volumes will be removed.

- The groundwater sample will be collected using a clean, dedicated Teflon bailer.

- All samples for chemical analysis will be placed in laboratory-prepared bottles. The bottles will be filled to the top and capped securely. The types of sample containers and preservatives required for VOC analysis are described in Subsection 2.3.1. If required, preservatives will be placed in the sample containers prior to collecting the samples. Extra care will be used in filling VOCs sample vials to ensure that the Teflon liner of the septum is facing inward and that no air bubbles are entrapped. Each sample bottle will be placed in an insulated cooler chest immediately after sampling and maintained at 4°C until extraction.

- All sample equipment will be decontaminated after sampling to prevent cross-contamination between wells, as detailed in Subsection 2.3.4.2. The bailer line will be disposed of at each well and will consist of polypropylene rope. Sampling bailers will be protected from contamination between sampling points by wrapping them in aluminum foil.

2.2.2.3 Extraction Well Sampling

The extraction wells will be sampled on a quarterly basis. Sampling of the extraction wells will be performed by running the spigot located at each well head to purge the lines between sampling. The spigot will be flushed for approximately two minutes prior to sampling. After water quality parameters (pH, temperature, and specific conductance) are measured, VOC samples will be collected directly from the spigot. Each sample bottle will be placed in an insulated cooler immediately after sampling and maintained at 4°C until extraction.

2.2.3 Surface Water and Sediment Investigation

2.2.3.1 Surface Water Sampling

A total of three surface water samples will be collected from each of the two surface impoundments located in the southern part of the site. These samples will be collected on a bi-annual basis for one year. Sampling of the impoundment will be performed by

use of a Kemmer Sampler or a similar device, permitting the collection of water samples from discrete depths in the water column. Samples will be collected at depths of approximately two-thirds of the distance from the surface to the bottom of the lagoon. Each location will be sampled for VOCs.

2.2.3.2 Sediment Sampling

Sediment samples will be collected using a Ponar dredge sampler or equivalent device. These sample devices will allow for collection of discrete samples of the sediment with minimal disturbance to the sediment. Three samples will be collected from each of the two surface impoundments. Each sample will be analyzed for VOCs.

2.2.4 Decontamination Procedures

All material and equipment will arrive at the site in clean condition. Procedures for equipment decontamination are described in the following subsections. Equipment decontamination will be performed at the wastewater treatment plant except as specified below.

2.2.4.1 Water Level Indicator Decontamination

Water level indicators used in wells will be decontaminated after use at the well location by flushing the electrical probe with ASTM Type II reagent water.

2.2.4.2 Water and Soil Sampling Equipment Decontamination

Bailers, bowls, spatulas, trowels, etc., will be decontaminated between sampling points. Pumps used for well purging will be decontaminated by submerging the pump intake in a washing solution (laboratory-grade detergent) and pumping this solution through the

pump system. The pump will then be placed in clean potable water and run until the discharge is detergent-free.

The procedure for decontaminating sampling equipment is:

- Rinse equipment in potable water to remove surface dirt and mud, if necessary.
- Scrub equipment with a bristle brush in laboratory-grade detergent and potable water.
- Rinse off soap with potable water.
- Rinse with ASTM Type II reagent water.
- Allow equipment to air dry before use.

2.3 SAMPLE HANDLING AND ANALYSES

2.3.1 Sample Containers, Sample Volumes, Preservation, and Holding Times

All samples submitted for analyses on this project will be collected by Weston personnel. Sampling containers and preservatives will be provided on request by the contracted analytical laboratory. For water samples, the specific requirements for sample containers, preservatives, and sample volumes for VOCs (Method 8260) are 40 ml clear glass vials with Teflon-lined septum caps, preserved with hydrochloric acid. For soil samples, 120 ml clear glass bottles with Teflon-lined caps, unpreserved, are required for VOC analysis.

Once samples have been collected, field personnel will return to the laboratory with the analytical samples and a completed chain-of-custody record.

The holding times for all required analyses are measured from time of sample collection. Holding time for VOC samples (Method 8260) is 14 days.

Upon sample receipt at the project laboratory, all sample collection dates are noted by the sample custodian. The required dates for completion of analyses (or extractions) are noted on the chain-of-custody record and are keyed to the holding times.

2.3.2 Sample Custody

The purpose of sample custody procedures is to document the history of sample containers and samples (and sample extracts or digestates) from the time of container preparation through sample collection, shipment, and analysis. An item is considered to be in one's custody if:

- It is in the physical possession of the responsible party.
- It is in view of the responsible party.
- It is secured by the responsible party to prevent tampering.
- It is secured by the responsible party in a restricted area.

2.3.2.1 Sample Labels

All samples will be identified with a label that will be attached directly to the container. Sample labels will be completed using waterproof ink. The labels will contain the following information:

- Sample number.
- Time and date of collection.
- Site name (Black & Decker).
- Parameters to be analyzed.
- Preservative (if any).
- Sample source/location.

As each sample is collected it will be placed in a labeled container.

2.3.2.2 Chain-of-Custody Records

To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, a chain-of-custody record will be completed for each sample at each sampling location. Each time the samples are transferred, the signatures of the persons relinquishing and receiving the samples, as well as the date and time of transfer, will be documented.

2.3.2.3 Transfer of Custody and Shipment

Prior to shipment of samples, the chain-of-custody record will be signed and dated by a member of the Weston field team who has verified that those samples indicated on the record are indeed being shipped. After packaging has been completed, custody seals, signed and dated by a member of the Weston field team, will be placed on the cooler.

2.3.3 Sampling QA/QC Protocols

Field QA/QC samples will be collected and analyzed as part of all field sampling activities, including surface and subsurface soils and groundwater sampling. The following protocols will be followed for collection of QA/QC samples.

A trip blank consists of a sample bottle filled with ASTM Type II reagent water prepared in the laboratory, brought to the site with the sample bottles, and handled as a sample. One trip blank will be sent to the laboratory each day that VOC samples are collected. The trip blank for soils is also a Type II reagent water.

One equipment blank will be collected during each sampling round for soil and groundwater and analyzed for the same parameters as the corresponding soil or

groundwater samples. These equipment blank samples will be collected by pouring ASTM Type II reagent water through the sampling device (e.g., bailer) and into the appropriate sampling container.

Field duplicates will also be collected for water samples and soil samples. The number of field duplicates collected will equal 5% of the total number of samples. A field duplicate will be collected as a separate sample immediately after collection of the field sample that it is intended to duplicate. Collection procedures for field duplicates will be identical to the original samples.

Duplicate groundwater samples will be collected from the same bailer. Duplicate surface water samples will be collected as separate grab samples from the same location, one immediately after another.

2.4 FIELD MEASUREMENTS

2.4.1 Field Parameters

Several parameters will be tested in the field as part of the analytical protocol for water samples. All liquid samples will be tested for temperature, pH, and EC. Turbidity, color and odor will also be noted on the field logs. The following subsections describe the procedures for analysis of field parameters.

2.4.1.1 pH Measurement

The pH of liquid samples will be measured using a Fisher Model No. 107 portable water pH meter (or equivalent). The pH meter will be calibrated and checked against the standard buffer solutions before analyzing a sample. The probe will then be rinsed with distilled water and placed in the sample to be tested. The meter will stabilize for 1 minute before the pH is measured. After the measurement, the probe will be rinsed with

distilled water and placed in 7.0 buffer solution until the next test. Results will be recorded in the field logbook.

2.4.1.2 Electrical Conductivity and Temperature Measurement

Measurements of EC and temperature of liquid samples will be collected using a YSI Model 33 meter (or equivalent). When not in use the meter probe will be placed in a jar of distilled water. Prior to placing the probe in the sample and after measuring the EC and temperature of the sample, the probe will be rinsed with distilled water. The temperature will be taken with the knob set on "temperature" and the EC measured using the appropriate range of the "conductance" setting. A period of 1 minute will be allowed for the instrument to stabilize prior to taking the measurement. Results will be recorded in the field logbook.

2.4.2 Equipment Calibration Procedures and Frequency

2.4.2.1 pH Meter

The Fisher Model No. 107 pH Meter, or equivalent, is a portable pH monitoring instrument for determining pH in surface water and groundwater, waste systems, and other water quality applications.

The instrument requires field calibration daily or each time the meter is turned on (if more than once per day). The calibration will be checked at mid-day and at the end of the work day if it is left on all day. Distilled water and buffer solutions (pH 7, pH 4, and pH 10) are required for field calibration. All solutions must be at the same temperature to reduce meter stabilization time and to maintain accuracy. The instrument is calibrated as follows:

1. Rinse the electrode in distilled water.

2. Place the electrode in the pH 7 buffer solution and allow the meter reading to stabilize.

3. Adjust the control using the knob on the front panel of the instrument until the meter reads pH 7.

4. Rinse the electrode in distilled water.

5. Place the electrode in pH 4 solution and allow the meter readout to stabilize.

6. Adjust the control knob until the meter reads the correct value of the pH 4 solution.

7. Place the electrode in pH 10 solution and allow meter readout to stabilize.

8. Adjust the control knob until the meter reads the correct value of the pH 10 solution.

9. Record results in logbook.

2.4.2.2 Electrical Conductivity Meter

The YSI Model 33, or equivalent, is a portable, battery-operated, transistorized instrument used to measure salinity, EC, and temperature in surface water, groundwater, and wastewater systems. The meter is calibrated daily or each time the meter is turned on (if more than once per day) by turning the MODE control to REDLINE and adjusting the REDLINE control so that the indicator lines up with the redline on the meter face. The meter will also be calibrated with two solutions with concentrations ranging from 10 to 1,000 µmhos. The calibration will also be checked at the end of the work day if the meter is left on all day.

SECTION 3

ANALYTICAL LABORATORY QUALITY ASSURANCE PROGRAM PLAN

ANALYTICAL LABORATORY QUALITY ASSURANCE PROGRAM PLAN (QAPP) ROY F. WESTON, INC.

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Full Signature Approvals Are Kept on File
with WESTON®'s Analytics Division
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QUALITY ASSURANCE PLAN

FOR

ROY F. WESTON, INC.

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Eff. Date: 09/01/94 Initiated By: R. J. Frederici Approved By: E. M. Hansen Authorized By: A. M. Henry SP No. 21-06A-001

3.0 QUALITY ASSURANCE POLICY

It is the objective of Roy F. Weston, Inc. (WESTON®) to be acknowledged as an organization that provides high-quality services. WESTON provides high-quality services because it takes pride in its work and because providing such services is a sound business practice.

Quality is the most significant criterion influencing the viability and well-being of WESTON. It is the criterion that distinguishes the best organization from the others.

WESTON is a professional services company and as such the quality of its services and deliverables are dependent on their reception by the client. The quality objective is mutually defined between WESTON and the client and is an inherent part of the quality assurance program.

Within relatively narrow limits, the level of excellence required may vary from project to project and from work element to work element. This is dependent on the technological and the financial risk to either the client or WESTON. There shall be a WESTON "standard of quality" established at a level of excellence to assure attaining a reputation as a quality organization.

The attainment of a reputation as a quality organization does not just happen. It results from a successful concerted effort over a long period of time. Therefore, the effort must be well planned and supported both organizationally and individually. It must be credible and rigorous, yet flexible to respond to the ever-changing needs of WESTON and the client.

Organizational support for accomplishing this quality goal is derived from Policy Directives and Operating Practices. Within these documents, the development and implementation of appropriate accountabilities, duties, and authority by organizational positions are clearly delineated. Line organizations achieve and verify quality, QA organizations overview the quality achievement and verification process through reviews, audits, and surveillances. Top management leadership, support and/or pressure insures that the Corporate Policies and Practices are appropriately implemented.

Individual support for accomplishing this quality goal is derived from pride and professionalism. The individuals directing, managing, supervising, conducting, reviewing, monitoring, and approving work are individually and collectively accountable for the quality of the work. Pride in one's own effort and professionalism within the organization can assure quality.

3.1 Quality Assurance/Quality Control (QA/QC)

Quality, as the term is used herein, is defined as the level of excellence needed to conform to an established standard. Generally, quality will refer to the excellence of end results and/or the excellence of performance required to attain the established standard.

Quality Assurance (QA) is defined as those planned and systematic actions necessary to provide adequate confidence to WESTON and its clients that the services provided meet mutually accepted quality standards consistent with project scope and budget. Quality assurance is attained through the implementation of a quality control program.

Quality Control (QC) is defined as the operational processes employed to ensure an objective level of excellence. Established performance criteria are defined for all areas, including

- administrative and technical methods and procedures,
- position accountability, duties and authority,
- performance monitoring, and
- peer and supervisory review, check, approval, and sign-off.

QC provides the tools to measure and evaluate the conformance of the operational procedures to criteria.

3.2 Standard of Quality

Standard of quality refers to a specific, defined, pre-established level of excellence. The phrase "standard of quality" will usually be preceded by a descriptive word or phrase such as "WESTON," "EPA," "USATHAMA," "USAFOEHL/TS," "NFESC," "USACE," etc. which references documented descriptions of the level of excellence to be achieved.

A standard of quality shall be established for every Analytics Division project and work element. The vehicle through which this standard is documented and communicated for standard analytical services is this Quality Assurance Program Plan (QAPP) for the Analytics Division, in conjunction with a Project Technical Profile and/or Quality Assurance Project Plan (QAPjP).

The Project Technical Profile will summarize basic project requirements, such as, QC and deliverables requirements, analyte lists, certification requirements, turn-around-times, and miscellaneous project information (e.g., the project manager, work order number, subcontracting restrictions, hazard restrictions, etc.).

The QAPjP allows for customized, client-specific quality control measures that can be added to or that can supersede the basic laboratory QAPP guidance to satisfy the needs of individual programs with specialized requirements. Laboratory personnel are available to discuss the design, advantages, and disadvantages of other quality control options, and to aid the data user in developing a project specific Quality Assurance Project Plan (QAPjP). Generally, the minimum information to be provided in these project specific plans will include the following:

- background and overall project objectives,
- intended use of the acquired data,
- list of measurement parameters,
- number of samples to be taken,
- kinds of samples to be taken (e.g. soil, surface water, groundwater, biological, sludge, drums, etc.), and
- dates anticipated for project start and completion.

3.3 Document Authorities

This plan has been prepared based on the guidelines and principles set forth in the following documents:

- QAMS-005/80, "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans", QAMS-005/80, 29 December 1980 (for format and content),
- ASME NQA-1-1989 Edition, "Quality Assurance Program Requirements for Nuclear Facilities," American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017 (for the 18 criteria, but not necessarily all supplements and appendices),

- WESTON Standard Practices Manual, Chapter 10: "Quality Assurance" (for policies and procedures), and

- "Quality Assurance Manual for Industrial Hygiene Chemistry," prepared by the Analytical Chemistry Committee of the American Industrial Hygiene Association (AIHA), 1988 (for general content).

Tables 3-1 through 3-3 provide matrices showing the correlation of sections in the Analytical Laboratory QAPP with sections of the following documents:

- Table 3-1, QAMS-005/80
- Table 3-2, ANSI/ASME NQA-1
- Table 3-3, AIHA.

TABLE 3-1

Correlation of WESTON's Analytics Division Quality Assurance Program Plan with EPA QAMS-005/80

EPA QAMS-005/80 REQUIREMENT		ANALYTICS QAPP SECTION	
1.0	Title Page	1.0	Title Page
2.0	Table of Contents	2.0	Table of Contents
3.0	Project Description	3.0	Quality Assurance Policy
4.0	Project Organization and Responsibility	4.0	Organization and Responsibilities
5.0	QA Objectives for PARCC	8.0	Quality Assurance Targets for Precision and Accuracy
6.0	Sampling Procedures	5.0	Sampling Procedures
7.0	Sample Custody	6.0	Chain of Custody
8.0	Calibration Procedures and Frequency	10.0	Calibration Procedures and Frequency
9.0	Analytical Procedures	7.0	Analytical Procedures
10.0	Data Reduction, Validation and Reporting	11.0	Data Reduction and Reporting
11.0	Internal Quality Control Checks	9.0	Internal Quality Control Checks: Laboratory
12.0	Performance and Systems Audits	14.0	Performance and Systems Audits
13.0	Preventative Maintenance Procedures	12.0	Preventative Maintenance
14.0	Specific Routine Procedures to Assess Data PARCC	9.0	Procedures Used to Assess Data Quality
15.0	Corrective Action	13.0	Corrective Action
16.0	Quality Assurance Reports to Management	15.0	Quality Assurance Reports to Management

TABLE 3-2

Correlation of WESTON's Analytics Division Quality Assurance Program Plan with ANSI/ASME NQA-1

ANSI/ASME NQA-1 CRITERIA*		ANALYTICS QAPP SECTION	
1.0	Organization	4.0	Organization and Responsibilities
2.0	Quality Assurance Program	3.0	Quality Assurance Policy
3.0	Design Control	7.0 8.0 9.0 10.0 11.0	Analytical Procedures Quality Assurance Targets for Precision and Accuracy Internal Quality Control Checks Calibration Procedures and Frequency Data Reduction and Reporting
4.0	Procurement Document Control	7.0	Document Control
5.0	Instructions, Procedures, and Drawings	(same as NQA-1, item 3.0 Design Control)	
6.0	Document Control	1.0 2.0	Title Page Table of Contents
7.0	Control of Purchased Items and Services	7.0	Document Control
8.0	Identification and Control of Items	7.0	Document Control
9.0	Control of Processes	3.0 5.0 7.0 9.0 11.0	Quality Assurance Policy Sampling Procedures Analytical Procedures Procedures Used to Assess Data Quality Data Reduction and Reporting
10.0	Inspection	14.0	Performance and Systems Audits
11.0	Test Control	9.0	Internal Quality Control Checks
12.0	Control of Measuring and Test Equipment	10.0 12.0	Calibration Procedures and Frequency Preventative Maintenance
13.0	Handling, Storing and Shipping	6.0	Chain of Custody
14.0	Inspection, Test, and Operating Status	12.0 14.0	Preventative Maintenance Performance and Systems Audits
15.0	Control of Nonconforming Items	9.0 10.0 12.0 14.0	Internal Quality Control Checks Calibration Procedures and Frequency Preventative Maintenance Performance and Systems Audits
16.0	Corrective Action	13.0	Corrective Action
17.0	Quality Assurance Records	10.0 11.0	Calibration Procedures and Frequency Data Reduction and Reporting
18.0	Audits	14.0 15.0	Performance and Systems Audits Quality Assurance Reports to Management

* addresses the intent of NQA-1 as specified in the above 18 criteria, but not necessarily pulling in all the supplements and appendices. Refer to content of referenced section of the Analytics QAPP for extent of implementation of the 18 NQA-1 criteria.

TABLE 3-3

Correlation of WESTON'S Analytics Division Quality Assurance Program Plan with AIHA

AIHA CRITERIA		ANALYTICS QAPP SECTION	
1.0	Description of QA Policies	3.0	Quality Assurance Policy
2.0	Organization Chart	4.0	Organization and Responsibilities
3.0	Personnel Qualifications	4.0	Organization and Responsibilities
4.0	Training	15.0	Quality Assurance Reports to Management
5.0	Sampling Considerations	5.0	Sampling Procedures
6.0	Chain of Custody for Samples	6.0	Chain of Custody
7.0	Sample Processing Procedures	5.0	Sampling Procedures
8.0	Reagents	9.0	Internal Quality Control Checks
9.0	Preparation and Storage of Standards and Samples	6.0 10.0	Chain of Custody Calibration Procedures and Frequency
10.0	Analytical Methodology	7.0	Analytical Procedures
11.0	Method Validation	7.0 11.0	Analytical Procedures Data Reduction and Reporting
12.0	Data Reduction Including Statistics	8.0 9.0 11.0	Quality Assurance Targets for Precision and Accuracy Procedures Used to Assess Data Quality Data Reduction and Reporting
13.0	Record Keeping	11.0	Data Reduction and Reporting
14.0	Calibration and Maintenance of Equipment	10.0 12.0	Calibration Procedures and Frequency Preventative Maintenance
15.0	Internal Quality Assurance Procedures	2.0 14.0	Table of Contents Performance and Systems Audits
16.0	External Quality Assurance Procedures	2.0 14.0	Table of Contents Performance and Systems Audits
17.0	Quality Assurance Audit Procedure	14.0	Performance and Systems Audits
18.0	Corrective Action Plan	13.0	Corrective Action

4.0 ORGANIZATION AND RESPONSIBILITIES

4.1 General

Analytics, WESTON's environmental laboratory services division, was established to provide the organizational structure to enhance the attainment of Corporate goals. Corporate goals are to enhance the quality of human life and the physical environment through the creative and sound application of human, economic, and natural resources; advanced science; and applied technology. Our objective is to provide comprehensive and integrated professional services effectively and efficiently. Quality analytical services is a primary WESTON goal.

Within the Analytics Division, the infra-structure provides maximum availability of senior, expert personnel for supervision, technical consultation, and project review for effective planning and implementation of analytical assignments. Additionally, WESTON Corporate resources in engineering, design and construction, industrial hygiene, geosciences, management and computer sciences, radiological services, air quality management, asbestos monitoring, regulatory compliance, and field operations enhance the Analytics Division capabilities to consult, trouble-shoot, and solve analytical problems. Project specific plans provide the organizational structure for operations with unique environmental situations, as appropriate.

The organization of WESTON's Analytics Division is shown in Figures 4-1 through 4-5. A description of the QA infra-structure describing QA reporting functions outside the laboratory is given in Section 4.2. Line management responsibilities and accountabilities with respect to ensuring that quality goals are met are summarized in Section 4.3. Professional qualifications and experience for the individuals filling these positions are maintained with the laboratory's training records. A description of WESTON's three analytical laboratories are summarized in the following subsections.

4.1.1 WESTON's Lionville Laboratory

The laboratory in Lionville, PA, which is located approximately 25 miles west of Philadelphia and 5 miles from WESTON's corporate offices in West Chester, is staffed by 180 professionals and managed by J. Peter Hershey, Ph.D.. The laboratory has two physical facilities. The first laboratory, located at 208 Welsh Pool Road, is a 39,000 square foot state-of-the-art commercial laboratory capable of performing thousands of environmental chemical analyses a year. The second Lionville laboratory, located at 256 Welsh Pool Road, is designed to handle samples containing high concentrations of contaminants such as PCBs and/or dioxin as well as co-mixed (low level radioactive) waste. It is equipped with a "clean room" designed specifically for handling high-hazard materials such as dioxins.

All mixed waste samples are received and screened for radioactivity at this facility. Samples containing above-background levels of radioactivity are extracted or digested here. Only non-radioactive extracts/digestates are returned to the 208 facility for analyses; others are completely processed in the 256 facility.

The laboratory is physically divided into separate work areas to facilitate sample throughput. These areas include the following:

- Sample Receipt and Refrigerated Storage.
- Organic Sample Preparation.
- Glassware Preparation.
- Metals Digestion.
- Wet Chemistry Laboratory.
- Instrumentation Laboratories.

The main instrumentation laboratories include the following:

- Atomic Absorption Spectroscopy Laboratory.
- Inductively Coupled Plasma Emission Laboratory.
- Gas and Liquid Chromatography Laboratory.
- Gas Chromatography/Mass Spectrometry Laboratory.

Each of these areas has separate heating, ventilation, and air conditioning systems. Non-destructive gas chromatographic detectors, GC autosampler flush solvent, and GC/MS rotary pumps are vented out of the instrumentation laboratories through charcoal filters. The main laboratory at 208 Welsh Pool Road was designed and the construction was managed by the laboratory managers and staff who pooled their accumulated laboratory experience to construct a highly functional, efficient facility which is one of the premier environmental laboratories in the country. It boasts a number of unique features such as the layout of the organic extraction area, the design of the GC/MS laboratories, and an energy-efficient water recirculation system.

The organic sample preparation laboratory, one of the largest in this business, has capacity for performing 80 Soxhlet or 80 continuous liquid-liquid extractions, 100 sonication extractions, and/or 50 separatory funnel extractions each day. The unique configuration of the extractors and the specially constructed fume exhausts were designed by the laboratory staff and managers to facilitate rapid, efficient sample preparation.

4.1.2 WESTON's Gulf Coast Laboratory

The WESTON-Gulf Coast facility is located approximately 30 miles south of Chicago in University Park, Illinois, is staffed by 120 professionals and managed by Michael J. Healy. This laboratory has the instrumentation, personnel and expertise to handle almost any analytical requirement. The laboratory, located at 2417 Bond Street, comprises 45,000 square feet of laboratory and office space and provides environmental services to industrial and governmental clients including the Illinois Environmental Protection Agency. WESTON-Gulf Coast, Inc., is also actively involved in field sampling of quarterly groundwater sampling at more than 500 monitoring wells per year.

The laboratory is physically divided into separate work areas to facilitate sample throughput. These areas include the following:

- Sample Receipt and Refrigerated Storage.
- Organic Sample Preparation.
- Glassware Preparation.
- Metals Digestion.
- Wet Chemistry Laboratory.
- Instrumentation Laboratories.
- Data Report Preparation and Production.

The main instrumentation laboratories are:

- Atomic Absorption Spectroscopy Laboratory.
- Inductively Coupled Plasma Emission Laboratory.
- Gas and Liquid Chromatography Laboratory.
- Gas Chromatography/Mass Spectrometry Laboratory.

Instrumentation laboratories have separate heating, ventilation, and air conditioning systems. Nondestructive gas chromatographic detectors, GC autosampler flush solvent, and GC/MS rotary pumps are vented out of the instrumentation laboratories through charcoal filters.

4.1.3 WESTON's Stockton Laboratory

The Stockton Laboratory is located approximately 80 miles east of San Francisco and 50 miles south of Sacramento, is staffed by 60 professionals and managed by Bosco M. Ramirez. The laboratory, located at 212 Frank West Circle, Suite A, consists of 25,000 square feet of laboratory and office space and is divided into separate areas for organic sample preparation, inorganic sample preparation; instrumentation rooms for GC/VOA and GC/MS VOA, GC/MS BNA, ICP, HPLC, and AA; sample receipt and storage; and data

management. This facility is dedicated to provide rapid turnaround of specific analysis to support programs such as remediation. The Stockton Laboratory performs CLP analyses for inorganic and organic TCL constituents. In addition, the Stockton Laboratory has provided analytical services to a variety of other governmental agencies including the U.S. Air Force OEHL, the Bureau of Land Management and numerous industrial clients.

4.2 Quality Assurance Infra-Structure

The chief Corporate Quality Assurance (QA) Officer is the Executive Vice President, Quality Assurance/Finance. Corporate QA managerial and implementation responsibilities and authorities are held by the Vice President, Corporate Quality Assurance. The position has the authority to organize, initiate, and monitor quality assurance programs. The Corporate QA Vice President can review and approve/disapprove all Division Quality Assurance Plans; can initiate, man (e.g., teams and committees), and allocate costs of the audit process for the purpose of identifying problems and determining compliance with Corporate policies and practices; and is obligated to recommend corrective action depending upon the situation.

Within the Analytics Division, the Division QA Manager and the QA personnel in the individual laboratories are responsible for implementing and monitoring the divisional QA Program. These individuals have sufficient authority, access to work areas, and organizational freedom (including sufficient independence from cost and schedule considerations) to:

- identify problems affecting quality;
- initiate, recommend, or provide solutions to problems through designated channels;
- verify implementation of solutions; and
- assure that further work is stopped or controlled until proper resolution of a non-conformance, deficiency, or unsatisfactory condition has occurred.

The Quality Assurance Section in each laboratory reports to the Laboratory Manager, where appropriate action can be affected. However, should a situation arise where acceptable resolution of identified problems cannot be agreed upon at the laboratory level, the QA Section has direct access to Divisional and Corporate QA Management. This provides laboratory QA personnel non-laboratory management support, if needed, to ensure that QA policies and procedures are enforced.

4.3 Description of Laboratory Personnel Responsibilities

The specific duties and responsibilities of the Division Manager, Project Director, Laboratory Manager, Project Manager, Technical Manager, Section Managers and Unit Leaders, Quality Assurance Personnel, Health and Safety Manager, Waste Management Personnel, and Analysts are as follows.

4.3.1 Analytics Division Manager

The Analytics Division Manager is ultimately responsible and accountable for establishing and implementing the Division's quality policy, as well as ensuring performance and profitability of the Division. The Division Manager reports directly to the Chief Operating Officer of the Corporation.

4.3.2 Project Director

The laboratory Project Director (PD) is responsible for the overall direction of a project from a divisional level and has primary responsibility for project quality assurance. The PD is accountable for the following:

- Defining the level of excellence for the project performance and/or results.
- Assuring the preparation of a tailored Project Technical Profile and/or Quality Assurance Project Plan (QAPjP).
- Ensuring peer review of the adequacy of QAPjP's.
- Ensuring allocation of proper quality control budgets.
- Attaining concurrence with Section (e.g., Laboratory) Managers on performance and/or results objectives.
- Achieving acceptable project implementation performance.
- Approving the quality of the project results (e.g., data, reports).

The PD reports to the Division Manager and does not have line authority over those performing the work.

4.3.3 Laboratory Manager

The ultimate responsibility for the generation of reliable laboratory data rests with the Laboratory Manager, who is accountable to the Division Manager for this function. The Laboratory Manager has the authority to effect those policies and procedures to ensure that only data of the highest attainable quality is produced. It is the Laboratory Manager's responsibility to see that all tasks performed in the laboratory are conducted according to the requirements of this Quality Assurance Program Plan (QAPP), the Project Technical Profile and/or the appropriate QAPjP; to assure that the quality of service provided complies with the project's requirements.

The Laboratory Manager supports a QA Section which is not subordinate to or in charge of any person having direct responsibility for sampling and analysis, and that has additional reporting responsibilities to Corporate QA.

4.3.4 Project Manager

WESTON recognizes the importance of efficient project management. The laboratory Project Managers (PMs) are responsible for preparing the Project Technical Profile summarizing QA/QC requirements for the project, maintaining the laboratory schedule, ensuring that technical requirements are understood by the laboratory, and advising the Project Director and Laboratory Manager of all variances.

The laboratory PM will provide technical guidance and the necessary laboratory related information to the preparer of project specific Quality Assurance Project Plans (QAPjP) are (generally prepared by the client), and provide peer review of the final document to ensure accuracy of the laboratory information.

4.3.5 Technical Manager

Technical Managers report to the Laboratory Manager and serve as the technical expert on assigned projects, provide technical liaison, and assist in resolving any technical issues within the area of their expertise. They are responsible for providing input and review in the development and implementation of the QA/QC program; and for providing the critical review of proposal and project work for programs as directed by the Laboratory Manager. They will coordinate these activities with the Project Manager and Quality Assurance Section.

4.3.6 Section Managers/Unit Leaders

To assist the Laboratory Manager in achieving section goals, the Laboratory Section Managers and Unit Leaders are responsible for the implementation of established policies and procedures. They possess the authorities commensurate with their responsibilities for the day-to-day enforcement and monitoring of laboratory activities.

Section Managers have the responsibility for ensuring that their personnel are adequately trained to perform analyses; that equipment and instrumentation under their control is calibrated and functioning properly; and that system audits are performed on an as-needed basis. These system audits will include the analysis of external check samples to determine the analyst/instrument capability to identify and quantify routine analyses.

4.3.7 Data Management Section Manager

The Data Management Section Manager is responsible for coordinating receipt of all data from the various service groups within the laboratory, reviewing data for compliance to laboratory QC criteria and/or criteria in the Project Technical Profile, and ensuring that data are reported in a timely manner and in the proper format.

4.3.8 Quality Assurance Manager

The Quality Assurance Manager has the full-time responsibility to evaluate the adherence to policies and to assure that systems are in place to produce the level of quality defined in the Quality Assurance Plan. In addition, the QA Manager may assist in the preparation, compilation, and submittal of quality assurance plans. The Quality Assurance Manager reviews program plans for consistency with organizational and contractual requirements and will advise appropriate personnel of deficiencies. The Quality Assurance Manager maintains a sufficient staff to initiate and oversee audits and corrective action procedures, performs data review, and maintain documentation of training. In addition, the Quality Assurance Manager has the authority to stop work on projects if QC problems arise which affect the quality of the data produced.

4.3.9 Quality Assurance Personnel

The Laboratory Quality Assurance Personnel have responsibility for conducting and evaluating results from system audits. In addition, the preparation of operating practices and quality assurance documentation for the laboratory shall be coordinated by the QA Section. The QA Section will review program plans, as requested, for consistency with organizational and contractual requirements and will advise appropriate personnel. The group also performs data review responsibilities, Performance Evaluation Sample Tracking,

Personnel Training Tracking, Document Control, MDL/IDL Studies, Solvent Check Tracking, and Certifications.

4.3.10 Health and Safety/Waste Management

The Health and Safety Manager is responsible for the safety and well-being of all employees while at the laboratory. This includes, but is not limited to, developing a safety plan that complies with Federal Regulations, conducting laboratory safety tours for all new employees, providing instructions on safety equipment, cleaning up laboratory spills, and instructing personnel of laboratory procedure for emergency situations. The Health and Safety Manager or designee is on-call 24-hours a day, 7-days a week for all laboratory situations.

The Health and Safety Manager responsibilities additionally include waste management of laboratory generated hazardous waste in accordance with appropriate regulations. This includes maintenance of required documentation, such as waste manifests, segregation of waste in accordance with requirements, and training of personnel in proper segregation of waste.

4.3.11 Chemists/Technicians

Any effective laboratory quality assurance/quality control program depends on the entire organization, including management and every individual on the laboratory staff. The initial review for acceptability of analytical results rests with the analysts conducting the various tests. Observations made during the performance of an analytical method may indicate that the analytical system is not in control. Analysts must use quality control indicators to assure that the method is in-control before reporting results.

4.4 Personnel Qualification and Training

4.4.1 Basic Requirements

Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Once on board, each employee participates in a comprehensive training program coordinated by the Laboratory's QA Section. This program is designed to provide an introduction to laboratory policies and procedures, define training mechanisms, and document the processes that provide proof of an analyst's proficiency. Highlights of the program include an orientation process, initial training to attain requisite proficiency, continual monitoring of the employee's progress, opportunity for career enhancement seminars or training courses, and documentation files to track each analyst's progress.

Orientation provides the employee with a basic introduction to WESTON and to the laboratory. Company and laboratory goals and expectations are presented and explained, applicable QA and Health and Safety items are discussed, key laboratory staff are introduced, available resources are discussed, and the employee receives an orientation manual to store introductory materials and/or Operating Practices (OPs).

Following orientation, training in the specifics of the task to be performed is the first major laboratory assignment. The trainee, under supervision of a qualified analyst, receives on-the-job instruction which culminates in sign off of a method training record to document the training. Details of this training program are in related OPs.

Documentation of training (internal and external) is maintained by the QA Section in the employee's training file.

4.4.2 Project-Specific Requirements

Prior to work on a new project, task specific training will occur to discuss schedules and unique aspects of the project. This may be accomplished at the production unit level, or at a job opening meeting. Items to be discussed may include the project Technical Profile, turn around times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special protocol requirements.

FIGURE 4-1

Analytics Division Organizational Chart

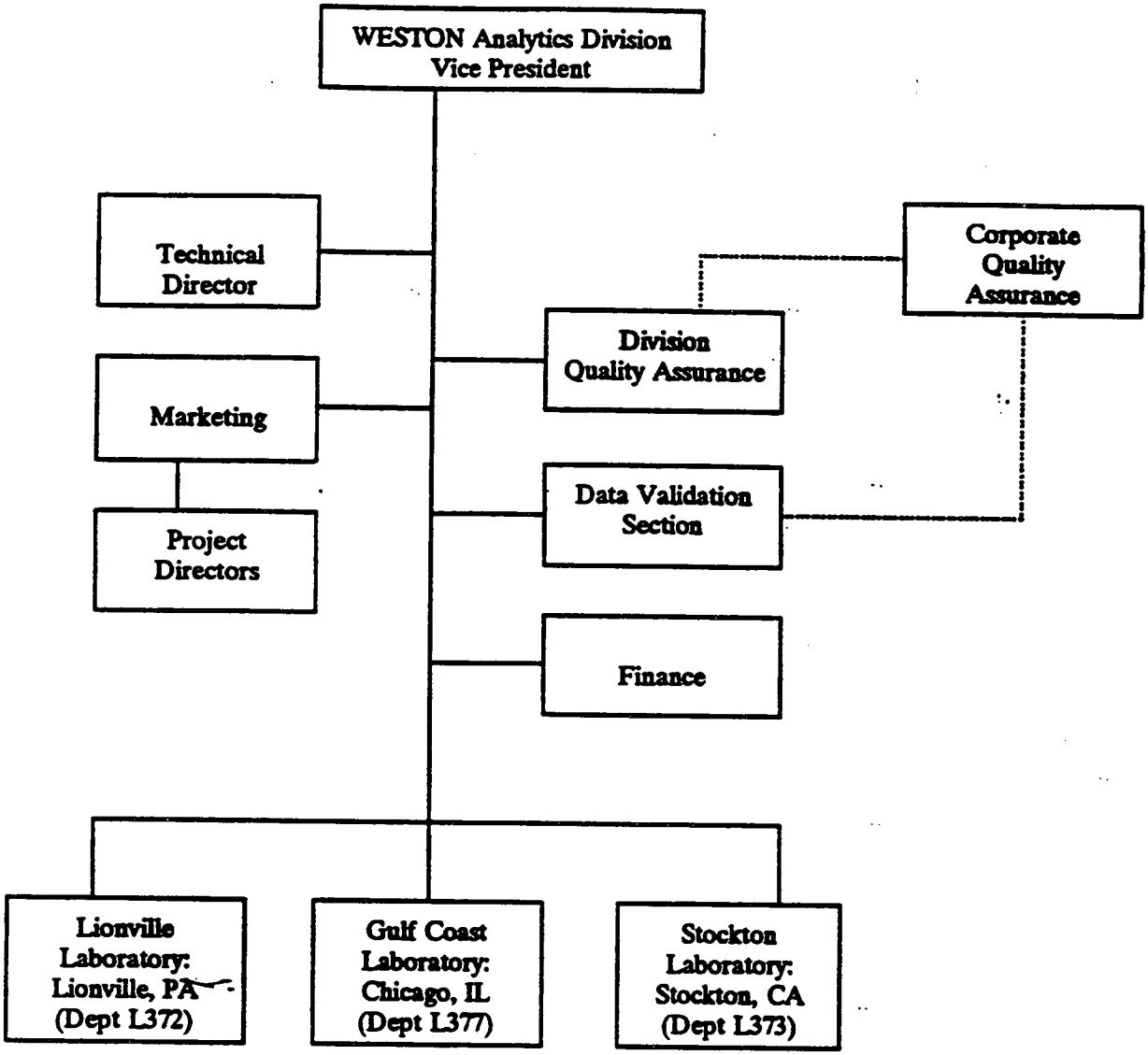


FIGURE 4-2

Laboratory Organizational Chart
Lionville Laboratory: 0072

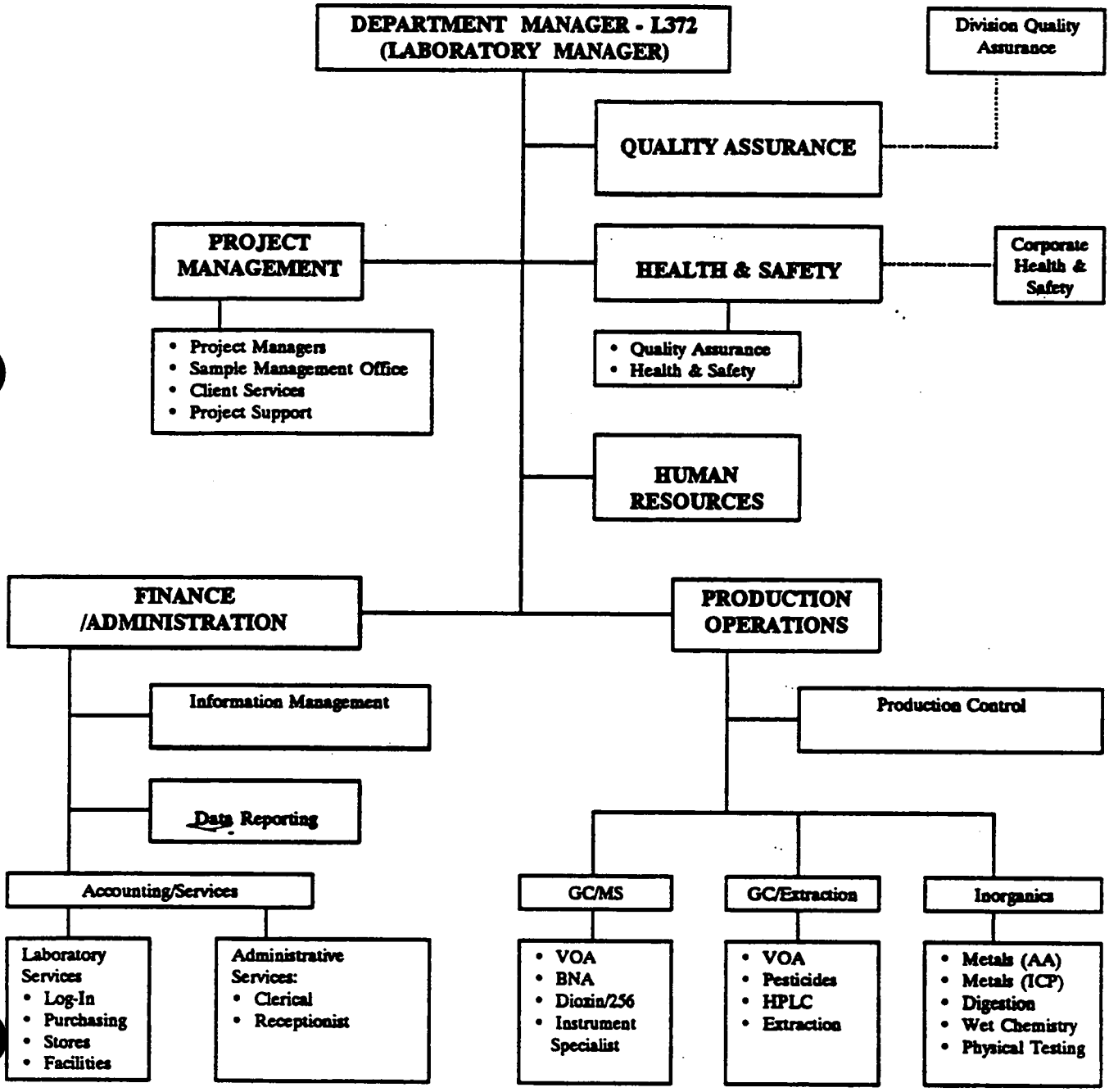


FIGURE 4-3

Laboratory Organizational Chart
Stockton Laboratory: 0073

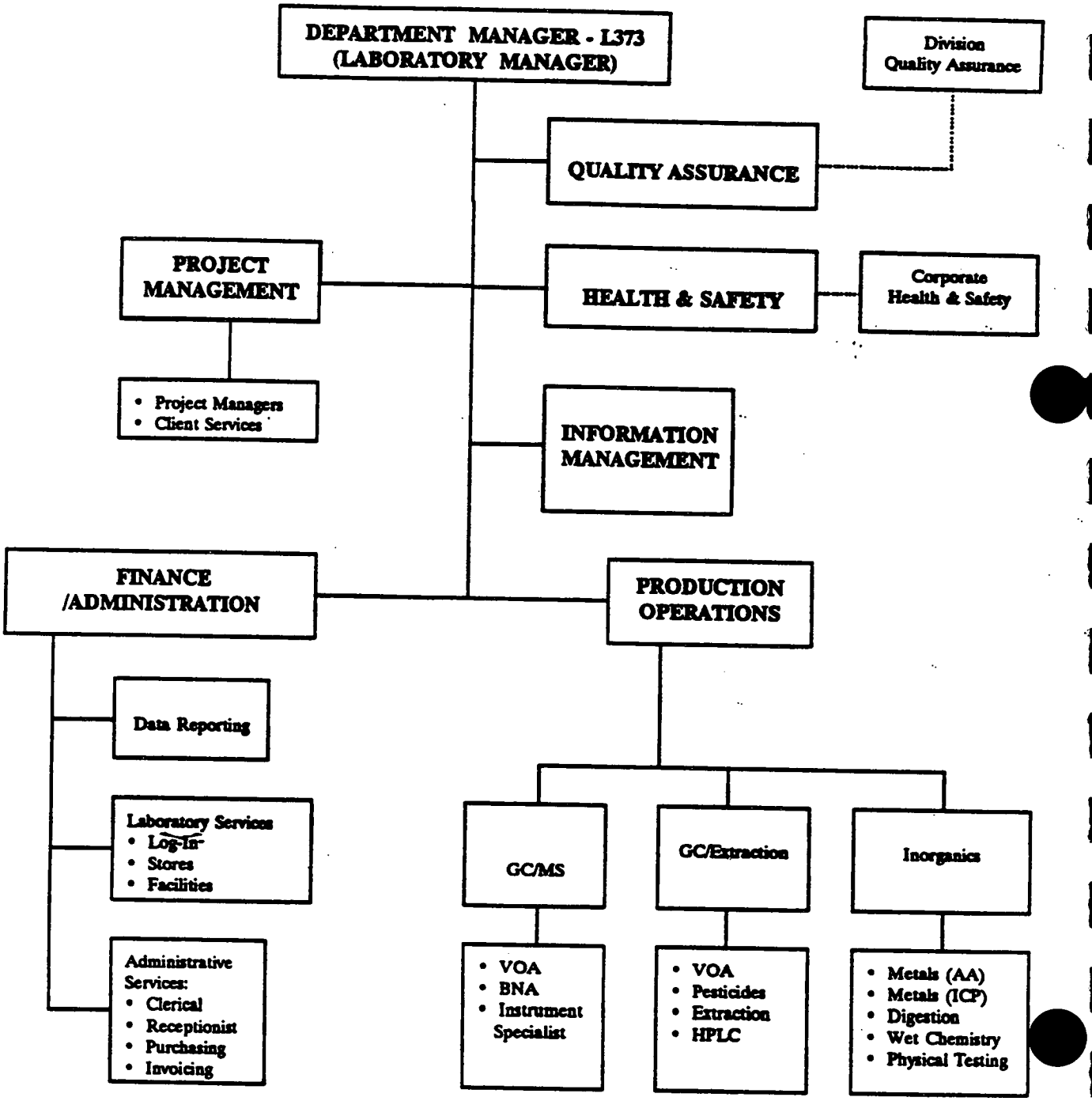
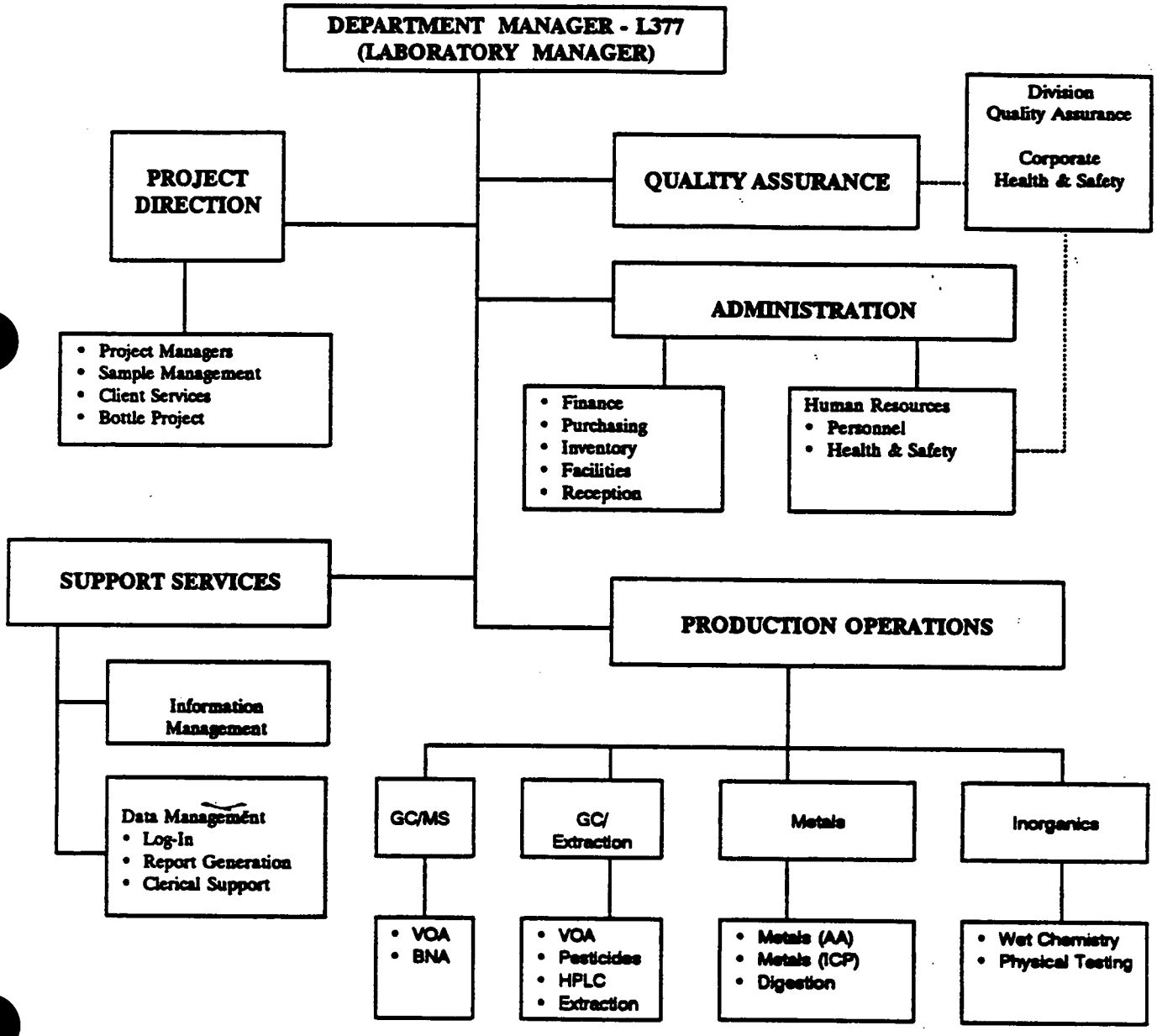


FIGURE 4-4

Laboratory Organizational Chart
Gulf Coast Laboratory: 0077



5.0 SAMPLING PROCEDURES

WESTON has the capability to conduct field sampling in accordance with specific agency guidelines, established operating practices, and/or project specific Sampling and Analysis Plans (SAPs). When field sampling is requested the sampling protocols are selected to correspond with the project scope and objectives.

5.1 Sample Preservation and Holding Times

Depending on the selected methods and regulatory program, the Analytics Division adheres to sample preservation requirements as stated in Table II of 40 CFR Part 136, Manual for Certification of Laboratories Analyzing Drinking Water, USEPA CLP Document Nos. OLM01.8 and ILM02.1, as updated, and SW846 3rd Edition, July 1992. All samples are required to be preserved in the field prior to or immediately following sample collection. Upon sample receipt and log-in, the samples are maintained in a temperature controlled environment to insure sample integrity.

The project manager is contacted whenever any sample received is not appropriately preserved. The project manager contacts the client for a decision on preserving the sample in the laboratory or refers to instructions in the Technical Profile/Quote which may delineate the client's requirements regarding actions for sample(s) not appropriately preserved. With either action, the sample's preservation status at the time of laboratory receipt is noted on the chain-of-custody form or other documentation record. For additional information regarding sample receipt and integrity, refer to Section 6.0.

The analysis holding time is the maximum time that may elapse before sample preparation or analysis. It is measured from the date of sample collection in the field, unless the sample analyses are requested for compliance to specific programs (e.g., USEPA CLP) in which holding times are determined by verified time of sample receipt (VTSR). Generally, drinking water, wastewater and RCRA program analyses require holding times measured from sample collection. These holding times are listed in 40 CFR Part 136 and/or the EPA Manual for the Certification of Laboratories Analyzing Drinking Water: Criteria and Procedures, Quality Assurance, Change 2 - September 1992; SW846 3rd Edition, Methods of Chemical Analysis of Water and Waste; Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992; or other established program requirements.

Holding times are tracked in the laboratory with the aid of the Laboratory Information Management System (LIMS). Each laboratory section may have additional tracking systems to ensure that holding times are met. All sample collection dates and receipt dates are recorded on the chain-of-custody. This information is transferred into LIMS by sample log-in personnel and LIMS calculates the appropriate holding time for each parameter (GC/MS

Sections monitor their holding times). This information is then available to laboratory personnel for tracking and scheduling purposes.

The LIMS backlog reports list sample preparation and analysis due dates for each method based on the requested reporting date or the holding time, whichever is earlier.

All analyses which have holding times of 48 hours or less are identified by the sample custodian(s). Log-in then notifies the appropriate operating section or unit that short hold time samples have been received by the laboratory and are ready for analysis.

5.2 Sample Bottles

WESTON provides sample bottles and preservatives to clients upon request. Each laboratory maintains a bottle preparation section that coordinates the assembly and shipment of sample bottles, preservatives and shipping coolers.

The laboratories may procure sample bottle types with varying levels of supporting quality control (QC). For the most rigorous QC, bottles are cleaned according to USEPA washing procedures and each bottle lot is analyzed for purity. The lot number is labeled for traceability to a certificate of analysis. For less rigorous supporting QC, bottles are cleaned according to USEPA washing procedures, but a certificate of analysis is not provided with the bottles. All bottles used by the Division are washed in accordance with EPA guidance and contain a certificate of analysis, or the laboratory randomly tests and documents the purity of supplied bottles.

Other than sample bottles and preservatives, the following items are included in sample shipping coolers: packing materials, custody seals, chain-of-custody forms and zip-lock bags (for paperwork). Supplies are checked regularly to insure that ample amounts are available to support the Division's analytical projects.

5.2.1 Bottle Washing

All sample bottles are cleaned using USEPA guidance. Typically, the bottle suppliers use one of three procedures described further in this section or cleaning procedures which produce equivalent results as determined by the laboratory's QA Manager or designate through the review of the suppliers certificate of analysis.

5.2.1.1 Cleaning Procedure A

Bottles cleaned by Procedure A are Boston Round, amber glass bottles (1-liter) and jugs (1-gallon).

- Bottles, liners and caps are washed in laboratory-grade, non-phosphate detergent.
- Rinsed 3 times with distilled water.
- Rinsed with 1:1 Nitric Acid.
- Rinsed 3 times with ASTM Type 1 organic-free water.
- Oven-dried for 1 hour.
- Rinsed with hexane.
- Oven-dried for 1 hour.

5.2.1.2 Cleaning Procedure B

Bottles cleaned by Procedure B are 40-mL vials; 1000-mL, 4-oz., and 8-oz. clear wide-mouth glass jars.

- Vials, septa and caps are washed in laboratory-grade, non-phosphate detergent.
- Rinsed 3 times with distilled water.
- Rinsed 3 times with ASTM Type 1 organic-free water.
- Oven-dried for 1 hour.

5.2.1.3 Cleaning Procedure C

Bottles cleaned by Procedure C are the 1-liter, 250-mL, and 500-mL plastic bottles.

- Bottles, liners and caps are washed in laboratory-grade, non-phosphate detergent.
- Rinsed 3 times with distilled water.
- Rinsed with 1:1 Nitric Acid.

- Rinsed 3 times with ASTM Type 1 organic-free water.
- Air-dried.

5.2.2 Bottle Preservatives

The Division's laboratories use preservatives that are prepared internally from reagent-grade chemicals or pre-measured reagents in ampules purchased from suppliers.

All preservatives are shipped in a manner consistent with local and federal shipping regulations.

The internally prepared reagents are added to the sample bottles prior to shipping or pre-measured ampules are shipped with the sample bottles and are added at the time of sampling. Ampuled preservatives obtained from suppliers are received with quality control documentation verifying purity. These records are maintained by the laboratory and are available for inspection. Each shipment of preservatives are custody sealed and contain a certificate of analysis. An identifying lot number is on each ampule to assure preservative traceability.

5.2.3 Placement of Bottle Orders

Requests for sample bottles are initiated with a bottle request form and then forwarded to the bottle preparation section. All bottle order forms are maintained by the bottle section. Typically, this form includes the following information: Client name, company contact, shipping address, telephone number, date, WESTON contact, courier used, date needed, date sent, number of samples, bottle type(s), parameter requested, preservative needed, shipping costs, facility/I.D., matrix, no. of coolers used, and space for additional comments.

5.2.4 Sample Cooler Preparation

Coolers having a unique identification code are pulled from stock and the identification code is recorded in a cooler log book or on the bottle request form and the chain of custody during log-in. When coolers are used, the client name and date are noted in the log book to allow tracking of the cooler.

All bottles are packed and arranged to minimize breakage during transport. Depending on the client need and regulatory program requirements, blue ice or ice is shipped with the cooler. All documentation information is enclosed in a plastic zip-lock bag and placed inside the cooler to prevent water damage. The cooler is then closed and sealed.

5.2.5 Sample Cooler Shipment

Coolers are shipped to the sampling site by various means: a common courier service may be used; the laboratory's field personnel may take coolers to the site; or the client may pick up coolers at the laboratory. All shipment of sample coolers are performed in accordance with the guidelines established by the International Air Transport Association (IATA) and the Department of Transportation (DOT).

Typically, orders requiring next day air delivery (e.g., internal clients) are shipped via Federal Express. In this event the Federal Express Power Ship II computer tracking system is used to track all shipments. For orders not requiring next day delivery, regular United Parcel Service (UPS) or Federal Express is typically used. (Delivery times vary from one to seven days for receipt of shipment.) UPS or other common couriers may be used to provide next-day air and second-day air delivery.

5.2.6 Sample Cooler Maintenance

Sample coolers returned to the laboratory are emptied of packing materials, ice (both water and blue ice), and any extra or broken bottles or other materials. The coolers are washed and placed back into stock. WESTON marked "blue" ice is washed in tap water before being reused. Typically, empty client coolers are returned via regular UPS or Federal Express.

Each laboratory maintains a tracking system to determine where each cooler is sent. If a cooler has not been returned, the client is contacted via letter or phone call regarding the status of the cooler(s) return. Records are periodically reviewed to locate coolers that have not been returned to the laboratory.

6.0 SAMPLE CUSTODY

6.1 Sample Receipt

Designated sample custodian(s) and staff are responsible for samples received at the WESTON laboratories. In addition to receiving samples, the sample receipt staff is also responsible for documentation of sample receipt, storage before and after sample analysis. The operating practices for sample receipt are described in detail in Lionville, Stockton, and Gulf Coast OPs 21-08L-002, 21-08S-002 and 21-08G-0002 respectively. A summary of these procedures follows.

Upon receipt, the sample custodian signs, dates, and documents the time of sample receipt on the air bills received from the couriers. The sample custodian signs the chain-of-custody assuming custody of the samples. If a chain-of-custody is not received with a set of samples, a "Custody Transfer/Lab Work Request" form is initiated. Refer to Figure 6-1 for an example of a "Custody Transfer/Lab Work Request". The sample custodian inspects the sample cooler for integrity and then documents the following information: the type of courier, shipped or hand delivered (copies of the airbills are maintained); sample temperature, ambient or chilled; the presence of leaking or broken containers; and documentation of sample preservation.

Additionally, the sample holding time and date collected are checked. If all samples were received within the appropriate holding time, it is documented on the custody transfer record.

Any additional comments are documented in the designated "Notes" section on the chain-of-custody. Any errors made on the chain-of-custody are corrected by drawing a single line through the incorrect entry, initialing and dating the cross out.

The sample custodian or designee matches the sample container information (e.g., sample tag/label), log book information, chain-of-custody records, and all pertinent information associated with the sample. The sample custodian then verifies sample identity to assure that all information is correct. Any inconsistencies are resolved with the client through the project manager and corrective action measures are documented before sample analysis proceeds.

The sample custodian assigns a unique RFW # (as described in Section 6.4) to each sample received. The RFW # is recorded on the chain-of-custody and on the container labels using a permanent marker. The RFW # is the primary means of tracking a sample through the laboratory.

The chain-of-custody form is maintained at the laboratory. Copies of the chain-of-custody are provided to the sample custodian or project manager, section managers, and sample preparation personnel. In addition, the sample custodian notifies the appropriate production unit(s) of any analyses requiring immediate attention due to short holding times.

The sample custodian logs the sample information into the Laboratory Information Management System (LIMS). These data include laboratory number, field sample identification, dates collected and received, project or client identification, and parameters requested for analysis.

6.2 Sample Containers

Sample containers are verified against the requested analysis to ensure compatibility. For example, organic extractables must be sampled in glass jars with Teflon®-lined caps, since plastics can contaminate the sample.

6.3 Sample Custody

Chain-of-custody procedures document the historical possession of sample containers and samples, sample extracts and sample digestates. The associated documentation provides traceability of sample containers from the time of preparation (e.g., NJDEPE), through collection, shipment, storage, analysis and disposal of the sample. Custody, as defined by this document, is referred to as:

- It is in someone's actual possession, or
- It is in someone's view, after being in their physical possession, or
- It was in someone's possession and then locked, sealed or secured in a manner which prevents unsuspected tampering, or
- It is placed in a designated and secured area.

WESTON recognizes that all laboratory data has the potential to be used as evidence for litigation, and that an evidentiary trail is necessary to prove that the samples collected in the field was the sample actually analyzed. An appropriately documented chain-of-custody form provides the essential evidentiary trail that maintains sample integrity. Chain-of-custody procedures are described within this section. Listed below are typical laboratory and field records used to establish chain-of-custody and sample identification.

- Field chain-of-custody forms, field sampling forms or other information which arrives with the sample.

- The laboratory's "Custody Transfer Record/Lab Work Request" form. The sample custodians document relinquish and return-receipt of samples to the analyst for analysis or preparation/extraction procedures. Final custody is transferred upon sample disposal.

- Sample labels or tags that may be attached to sample containers may contain such information as: sample date/time of collection; sample description; sample matrix; filtration, preservation and other known hazards; sample management (disposal information); and parameter groupings. Any sample labels/tags are verified for accuracy against the associated information received with the samples. The signed chain-of-custody form serves as documentation of this information verification. If directed by the client or program requirements, sample tags are removed and placed in the sample/project file.

- Custody seals may be attached to sample containers and/or the transport coolers. Custody seals also prevent the containers or coolers from being unsuspectedly opened without authorization.

- Sample preparation logs, e.g., organic extraction and metals digestion, or separate chain-of-custody logs, e.g., electronic chain of custodies, document the custody transfer of the sample extracts/digestates from the preparation group to the analyst. These preparation logbooks are hard-bound laboratory books that are documented in legible hand-writing, and signed and dated by the analyst. The sample extracts remain in refrigerated storage while in the custody of the analytical section. Custody is transferred upon sample disposal.

- Sample storage log (same as the laboratory's "Custody Transfer Record/Lab Work Request" chain-of-custody form).

- Sample disposition log, which documents sample disposal by a contracted waste disposal company.

- Errors in all documentation are deleted with one line through it, the appropriate correction made, initialed and dated by the person making the correction. All documentation/logbooks are signed/initialed by the appropriate personnel.

6.4 Sample Identification

The sample custodian organizes the sample containers, chain-of-custody records, and all pertinent information associated with the sample. The sample custodian then verifies the sample identity against all associated sample information. Any inconsistencies are resolved

and corrective action is taken prior to assigning an internal identification number to the sample. This unique identification number (RFW #) is an eleven digit number in the following format: YYMMLBBB-XXX,

where YYMMLBBB is the RFW batch #, and

YYMM = year/month, e.g., 9401.

L = Laboratory identifier, e.g., L = Lionville; S = Stockton; G = Gulf Coast.

BBB = a computer assigned consecutive batch number which typically rolls over after 999 to 001. It may roll over sooner to assure project continuity or as otherwise documented.

XXX = a consecutively assigned sample number unique to a specified field sampling point. Because of preservation and volume requirements for requested analytes, a sample from one field sampling point may arrive in more than one containers. In this case, each bottle from the same sampling point is assigned the same number.

Samples are maintained in refrigerated storage coolers (maintained at 4 ± 2°C) prior to analysis.

6.5 Sample Storage

The standard operating practices for sample storage are described in detail in OPs 21-08L-002, 21-08S-002 and 21-08G-0002. A summary of these procedures is described below.

Refrigerated storage coolers are maintained at 4 ± 2°C. The temperature is recorded twice daily during business days in a hard-bound logbook. Additionally, some storage systems are monitored by the laboratory security system. Quality assurance personnel or sample custodians monitor these temperatures. If equipment failure occurs during working hours (e.g., compressor failure, door left open, circuit breaker) and temperatures exceed the upper or lower control limits, the appropriate personnel are notified. If the temperature can not be returned to an in-control status, the samples are moved to a suitable storage cooler until the problem is corrected.

Cooler storage is designed to segregate samples in such a way as to minimize the possibility of cross-contamination. This includes the storage of volatile samples separate from semi-volatiles and inorganic samples. Within each cooler, samples are organized by RFW batch # for easy retrieval.

Refrigerators and freezers are used for storing analytical standards. Within the refrigerators or freezers, standards are stored by an internal identification number for easy retrieval. Standards are stored separately from samples.

Access to laboratory facilities is restricted to laboratory personnel or escorted guests, as described in Section 6.8. Therefore, once sample possession is relinquished to the laboratory, the sample is in a designated secure area (e.g., the laboratory facility) accessible only to authorized personnel.

6.6 Sample Tracking

Sample Tracking Procedures are summarized in the following sections.

6.6.1 Organic Extraction/Analysis

The organic sample preparation section receives samples for extraction prior to analysis by gas chromatography, GC/MS, or liquid chromatography. A sample preparation batch number is assigned and all pertinent data are recorded in a bound laboratory notebook. The first two characters of the extraction/preparation batch number are the last two digits of the current year and followed by an unique laboratory code.

The extraction information is transferred to LIMS and a hard-copy Sample Extraction Record is generated. Original records are used for internal laboratory custody transfer when required. Copies provided to analysts are notification that extracts are ready for analysis. Extracts are maintained in refrigerated storage until needed for analysis.

6.6.2 Metals Digestion/Analysis

The metals sample preparation section receives samples for digestion prior to elemental analysis by Atomic Absorption Spectroscopy, Inductively Coupled Plasma Spectroscopy or Mercury autoanalyzer. Before samples are prepared, a sample preparation batch number is assigned and all pertinent data are recorded in a bound laboratory notebook. The first two characters of the digestion batch number are the last two digits of the current year and followed by an unique laboratory code.

Digestion information is transferred to LIMS and a hard-copy Sample Digestion Record is generated. The Metals Analysis Section is notified and documentation of the transfer of digestates is maintained.

6.7 Record Keeping

All data related to sample preparation, analysis, and general observations are recorded in appropriate hard-bound laboratory notebooks. These logbooks are pre-formatted notebooks which are issued and controlled by the laboratory's Quality Assurance Section. Laboratory notebook pages are reviewed, signed and dated by laboratory analysts and receive a secondary review by a trained data reviewer or supervisor who signs/initials and dates the data pages. After these first two reviews are completed, the data is entered into the Laboratory Information Management System (LIMS).

Corrections to notebook entries are made by drawing a single line through the erroneous entry and writing the correct entry next to the one crossed out. A reason for the correction is noted, as appropriate. All corrections are initialed and dated by the individual performing the correction.

All analytical data is either entered directly into LIMS or is transferred via spreadsheet. Using the latter form, the spreadsheet is reviewed by a supervisor or trained reviewer for transcription errors and acceptability of quality control measurements. Once approved, the data is transferred to LIMS.

A separate LIMS analytical batch number is established for each set of 20 or fewer samples for each type of analysis. This batch number is used to name spreadsheet files. All approved spreadsheets and laboratory data books are maintained as a historical record.

6.8 Building Security

The laboratories maintain controlled building access at all times. All non-WESTON laboratory personnel and service representatives are required to sign the visitors logbook in the reception area and are accompanied by laboratory personnel while in the building. The laboratory is locked at all times, unless a receptionist is present to monitor building access (e.g., between the hours of 8:00 a.m. and 5:00 p.m. Monday through Friday). Laboratory employees may be granted access to the facility during non-routine working hours by the use of access cards. Security systems are installed to monitor building access.

6.9 Electronic Data Records

WESTON utilizes a Laboratory Information Management System, or LIMS, for the management of sample tracking, data storage, data reduction, and data reporting functions. The LIMS acronym actually refers to the WESTON-customized programs or software. Personal computers and/or a local area network are utilized to access data from LIMS, transfer data to LIMS, and utilize the various LIMS features for data management. File transfers comprise the predominant analyst use of LIMS.

6.10 LIMS Security System

All users log onto the system via the Multi-Terminal Monitor, or MTM. Security is controlled through individual user passwords which allow or deny access into specific accounts (e.g., Metals, Wetlab, Reports, etc.). Each account may further allow or deny access to specific programs or tasks.

While entry or modification of information in the data base is controlled by these security measures, the data base itself has some built in safeguards. When a sample is logged in for specific analyses, the analysis for that sample is assigned a status code by LIMS. The following is a list of typical status codes used by LIMS. Other codes may be established to assist project tracking.

Status	Meaning
1	Sample and Test are logged into LIMS
2	Sample is on hold
3	Sample extraction is in process
4	Sample has been subbed out
5	Extraction/Digestion/Prep is complete
6	Analyzed but not yet reviewed
7	Completed (results reviewed by analyst)
8	Released to Data Management (results/deliverables in data reporting)
9	Canceled
88	Released to Client

These and additional codes are automatically updated via programs used by the analysts when reporting data to LIMS. When an analytical result has been entered into the data base and the status set to 8 (released), the result cannot be accidentally overwritten if a new result is submitted. The result can only be changed by person(s) with the proper security clearance to change the status to a lower level. For example, a request from a Section Manager and full written documentation of the change is required to change a LIMS status code. Once the status has been reset, the results for that analysis can be updated.

The status of a result does not reach 8 (Released) until the result and its related Quality Control (QC) has been reviewed and approved by the Section Manager (or designee, e.g.,

Unit Leader) of the section generating the result. A data summary report can be used by the supervisor to review results and associated QC. If the supervisor approves the data, the status code is then set to 8.

6.11 System Preventative Maintenance

The System Operator makes daily, weekly, and monthly checks on the system performance. A daily check is made of the computer's system log which records all activity regarding the computers OS/32 operating system. This log reveals problems with the basic system tasks that keep the system working. Some programs, aside from the Operating System, create their own logs which are also checked to verify they are performing properly.

A weekly on-line backup is made of the entire database,"on-line" meaning the system does not have to be stopped in order to backup all of the data base records to tape. In addition to backing up the database, all data files submitted by instruments or analysts used to upload analytical data into the database are also backed up to tape on a weekly basis.

A monthly Preventative Maintenance check from the computer manufacturer assures that the hardware is in good operating condition. This check requires that the system be brought down while the technician runs various diagnostic checks.

All system maintenance and problems are recorded in a bound system logbooks which are kept in the LIMS Section.

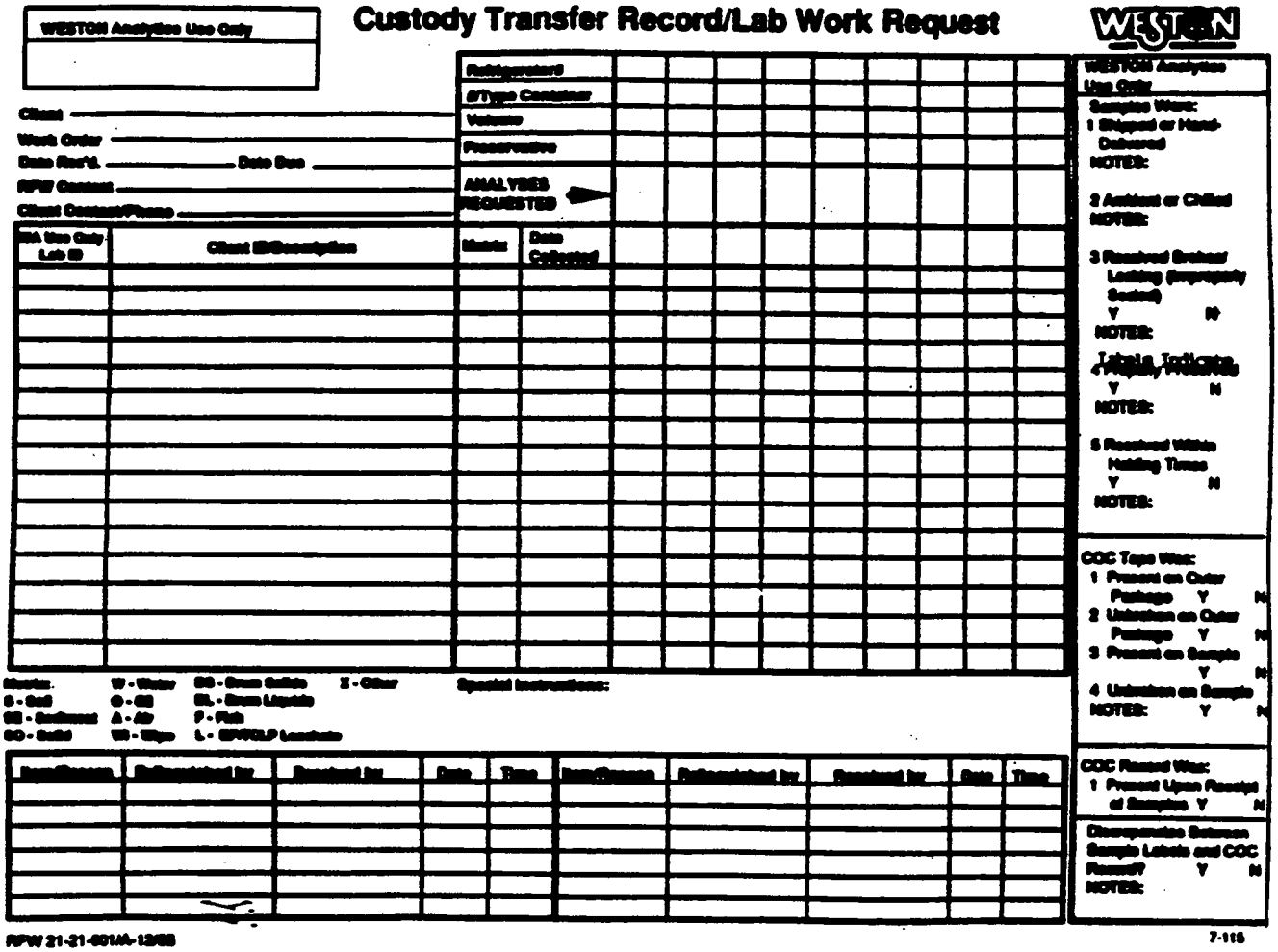
6.12 Software Updates and Revisions

WESTON has three laboratories, each with similar LIMS hardware and software. The Division Information Systems Manager works with Section Systems Managers to keep the three systems compatible.

Updates in WESTON software are done by distributing a Programming Completion Form to each laboratory by the laboratory preparing the modifications. This document is kept on file in the LIMS office along with the date the new software was loaded and implemented. New software is tested and verified for accuracy with dummy data before being implemented on the system. Software is approved for use by the Systems Operator and all documentation that it works correctly are maintained on a verification file. After implementation, all users are advised of the changes and requested to report any problems with the software to the System Operator.

When updates in software are received from manufacturers, this is noted in the bound LIMS logbook.

FIGURE 6-1
Example:
Internal Chain-of-Custody



7.0 ANALYTICAL PROCEDURES

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices.

Choice of method is determined by the type of samples and the client/agency program represented. These programs include, but are not limited to the following:

- Drinking Water.
- Wastewater.
- Hazardous Waste.
- Air.

For non-routine analytical services (e.g., special matrices, research projects, non-routine compound lists, etc.), the method of choice is selected based on client needs and available technology.

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the laboratory Project Manager in a Technical Profile for the project. The Technical Profile is distributed to appropriate laboratory management, such as the Laboratory Director, Section Managers, Unit Leaders, and QA Manager, to ensure that the proper analytical methods are applied when the samples arrive.

7.1 Method References

The most commonly used method references for the analytical procedures used in the laboratory are listed below. These references are applicable to the analytical test methods used on a daily basis in the laboratory.

ASTM = Annual Book of ASTM Standards, American Society for Testing and Materials, updated yearly.

CLP-O = EPA Contract Laboratory Program (CLP) Statement of Work (SOW) for Organics Analysis, Multi-Media, Multi-Concentration: Document Number OLM01.8 and as updated.

CLP-I = EPA Contract Laboratory Program (CLP) Statement of Work (SOW) for Inorganics Analysis, Multi-Media, Multi-Concentration: Document Number ILM02.1 and as updated.

E = EPA 600/4-79-020, Methods for Chemical Analysis of Water and Wastes, March 1989; EPA 600/4-88-039, Methods for Determination of Organic Compounds in Drinking Water, August 1993.

40CFR = 40 CFR Part 136, Guidelines for Establishing Test Procedures for the Analysis of Pollutants. Appendix A to Part 136 - Methods for Organics Chemical Analysis of Municipal and Industrial Wastewater.

Appendix C to Part 136 - Inductively Coupled Plasma - Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes Methods 200.7.

NIOSH = NIOSH Manual of Analytical Methods, 3rd Edition, February 1984, updated through Supplement 4, August 1990.

SW = EPA SW846, Test Methods for Evaluating Solid Waste, 3rd Edition, promulgated update I, dated July 1992 and proposed Update II, dated November 1992.

SM = Standard Methods for the Examination of Water and Wastewater: 15th Edition, 1980, 16th Edition, 1985, 17th Edition, 1989, 18th Edition, 1992 (Note method numbers changed format with 17th Edition)

THAMA = USATHAMA PAM 11-41, United States Army Toxic and Hazardous Materials Agency (USATHAMA) Quality Assurance Program, Revision 0, January 1990. Methods certified per requirements set forth in Section 5.

Methods performed routinely are delineated in Operating Practices (OPs). The OPs applicable to any set of preparatory or analytical procedures are in area-specific manuals that are immediately available to analysts (Lionville and Stockton laboratories) or are furnished in individual manuals to the analysts (Gulf Coast laboratory). Methods that are performed only rarely for special requests are photocopied and furnished directly to the analyst. In no case is an analyst to perform a preparatory or analytical procedure, whether for quality control or on client samples, without a copy of the client or laboratory-approved method readily available.

7.2 Document Control

Each laboratory maintains a document control system that tracks the distribution of both administrative and laboratory Operating Practices (OP). This system, maintained in a data base, tracks the OP Number, copy number, distributee, document revision number, date of distribution, and the reason for distribution. Upon revision to a document, this database is used to identify previous distributees to ensure that all are provided appropriate updates and the database is then updated accordingly.

Document distribution is processed as a controlled or uncontrolled status. Controlled status is defined as the continuous distribution of document updates. Uncontrolled status is defined as the single distribution of the current OP. Document updates are not distributed to uncontrolled status holders. For tracking purposes, a control copy number is assigned to documents distributed with a controlled status. All copy numbers are written in red ink to easily identify the OP as a controlled copy.

Each laboratory maintains original historical copies of OPs specific to the originating laboratory. Original-signature Divisional OPs are maintained by the Division QA Manager, currently located at the Gulf Coast Facility. For local laboratory distribution, a master copy of the Divisional OP is control-copied to each laboratory and becomes that laboratory's historical copy for subsequent distribution and archiving is conformance with the document control system procedures. By use of a prefix in the assigned document copy number, WESTON is able to track the origin of the OP's distribution. The following prefixes are used for OP distribution:

A	=	Analytics Division (distributed by the Division QA Manager)
G	=	Gulf Coast
L	=	Lionvillle
S	=	Stockton

7.3 Material Procurement and Control

In conformance with the Corporate policy of Roy F. Weston, Inc. (WESTON®), it is the policy and practice of the Analytics Division to conduct its procurement activities with the highest integrity, under the most favorable terms to WESTON and its clients, and in full compliance with applicable Government Laws and Regulations.

This will be accomplished through the effective utilization and implementation of the system of procedures contained in WESTON's Procurement Procedures Manual. These procedures are applicable to all WESTON purchasing operations, including Corporate and Regional

Offices, that place procurements under Government Contracts and Federal Acquisition Regulation (FAR).

Procurement activities are designed to assure a systematic approach to the procurement process. Suppliers are selected based on their capabilities to provide items or services in accordance with the laboratory requirements. The measurements for evaluation and selection of suppliers include the following:

- Evaluation of supplier's history of providing an identical or similar product.
- Supplier's current quality records supported by documented qualitative and quantitative information that can be objectively evaluated.
- Supplier's technical and quality capabilities as determined by a direct evaluation of his facility, personnel and implementation of his quality assurance program.

7.3.1 Acceptance of Items and Services

Items used by WESTON Analytics Division laboratories undergo inspection upon receipt, e.g., verify conformance with the requirements of the purchase order and freedom from damage during shipment. Analytical standards and critical-specification solvents, acids, and reagents are
supported by a certificate of quality and/or on-site analytical verification, as applicable. Items not meeting these requirements are returned to the supplier.

7.3.1.1 Certificate of Conformance

For items such as standards, solvents and acids a certificate of conformance may be acceptable. The certificate must at a minimum contain the following information: identity of the item, the pertinent information required (e.g., concentration, log number, expiration date), and signature and date.

7.3.1.2 Solvent Lot Verification

Pre-purchase approval is performed for all solvents purchased in large quantities unless a certificate of conformance has been furnished. These may include acetone, acetonitrile, ethyl ether, freon, hexane, iso-octane, methanol, methylene chloride, toluene, bottled deionized water, and bottled HPLC water. Prior to purchase, a sample case of the solvent is provided by the vendor to the laboratory for testing. If the solvent passes acceptance criteria, the vendor is notified and holds the respective lot in reserve for laboratory use.

The approved lot is shipped to the laboratory in increments until the entire lot has been received. Prior to exhaustion of the reserve lot, the process will be repeated with a new lot to ensure a constant supply of approved solvent.

Supplier-provided samples of each solvent lot requiring pre-purchased approval are submitted to sample log-in and tracked through LIMS. Acceptance criteria and parameter lists are found in each laboratory's solvent approval procedures. A copy of the results and raw data will be filed in the Quality Assurance Section.

Each lot of incoming supplies of solvents requiring pre-approval is checked against an approved lot number list. If the lot number is not on the approved list, the lot is refused. If the case of solvent is an approved lot number, it is accepted and documented.

Near depletion of the lot, a sample from a new lot is requested for pre-approval testing, received and analyzed prior to the solvent use in the laboratory. The entire process is then repeated. With review and approval of the managers of the service group using the solvent, and the laboratory QA Section, vendor-performed assays may be used.

7.3.2 Control of Materials

All supplies are purchased through the laboratory purchasing agent and received and distributed through the shipping/receiving unit of the laboratory.

7.4 Laboratory Glassware

All glassware must be thoroughly cleaned prior to use to ensure that sample integrity is not affected from artifacts caused by contaminated glassware. The laboratory maintains detailed Operating Practices for cleaning glassware documented in Gulf Coast Laboratory OP 21-06G-0007, Lionville Laboratory OP 21-15-0001 (inorganics) and OP 21-16-0001 (organics), and Stockton Laboratory OP 21-15S-0001 (inorganics) and OP 21-16S-0001 (organics). These OPs shall be posted in the appropriate glassware preparation areas.

For difficult to clean glassware, supervisory assistance is recommended. An attempt will be made to determine the composition of material so that appropriate cleaning procedures and safety measures can be taken. The following may be tried with proper precautions: NOCHROMIX, chloroform, acetone, strong base (50% NaOH), hot phosphorus, or other acids. Safety must be a primary concern. A summary of general cleaning procedures follows:

- General laboratory glassware is cleaned with a low- or non-phosphate detergent, followed by thorough rinsing with tap water and deionized water.
- Volumetric flasks and pipettes used for inorganics, test tubes and caps used for micro-COD procedures, phosphate glassware, and metals-related glassware include an acid-washing step.
- BOD glassware cleaning includes a nitric acid and/or a NOCHROMIX-washing step.
- Microbiological containers must be sterilized prior to use.
- Organic glassware includes a solvent-wash.
- Non-volumetric organic glassware may optionally be kiln dried at 450°C.

7.5 Reagent Storage

All laboratory chemicals are segregated according to group. For example, strong acids are never stored with strong bases. Upon receipt in the laboratory, all reagents are marked with the date of receipt, and are marked upon the date of opening.

Prudent safety practices are followed for possible accidental spills of laboratory reagents (e.g., sodium bicarbonate solutions for acid/base spills, or oil-drill/Xsorb for oil spills, etc.). Table 7-1 summarizes the general storage protocols for reagents.

TABLE 7-1

Reagent Storage

Reagent	Method of Storage
Acids	Acid storage lockers, segregated according to acid type.
Bases	Base storage cabinet.
Solvents	Solvent storage lockers, segregated by group: Extractions, VOAs, Semi-VOAs, and Pesticides/Herbicides.
Dry Granular or Powder Reagents	Reagents are stored in each respective laboratory

Note: All Reagents are documented with the date received, date opened, date expired (as applicable), and the analysts initials.

8.0 QA TARGETS FOR PRECISION AND ACCURACY

8.1 Precision

Precision is the level of agreement among repeated independent measurements of the same characteristic, usually under a prescribed set of conditions (e.g., under the same analytical protocol). The most commonly used estimates of precision are the relative percent difference (RPD) for cases in which only two measurements are available, and the percent relative standard deviation (%RSD) when three or more measurements are available. In both cases, the quantitative measure of the variability of the group of measurements is compared with their average value. This is especially useful in normalizing environmental measurements to determine acceptability ranges for precision, since it effectively corrects for the wide variability in sample analyte concentration.

Precision control limits are established by duplicate analysis of Laboratory Control Samples (LCS). These LCSs may be purchased commercially or prepared at the laboratory. For organic analysis, they are typically referred to as blank spikes (BS). For multi-analyte methods, including preparation methods such as metals digestions, LCSs may only contain a representative number of target analytes rather than the full list. For organic analyses, the LCS pair may be surrogate compounds in the blank and the blank spike and/or a select number of target analytes in duplicate fortified blanks (blank spike/blank spike duplicate: BS/BSD). The duplicate LCSs are subjected to all sample preparation steps. The RPD of the duplicate analysis is recorded and evaluated by statistically generated warning and control limits or established program requirements that precision be $\leq$ 20 RPD. The calculations of the limits are defined in Section 11.0.

The RPD for duplicate investigative sample analysis provides a tool for evaluating how well the method performed for the respective matrix. These values are used by the client to further assess a reported result within the context of the project Data Quality Objectives (DQOs). For results outside control limits provided as requirements in the QAPP, corrective action appropriate to the project will be taken and the deviation will be noted in the case narrative accompanying the sample results.

8.2 Accuracy and Bias

Accuracy is the degree of agreement of an analytical measurement with the true or expected concentration. When applied to a set of observed values, accuracy will be a measure of both random error and systematic error (bias).

Bias is systematic error inherent in an analysis caused by some artifact of the measurement system or deviation from protocol. Temperature effects and extraction inefficiencies are examples of the first kind; contamination, mechanical losses, and calibration errors are examples of the latter kind.

Accuracy control limits are established and controlled by the analysis of Laboratory Control Samples (LCS), which are of water and/or solid/waste matrices. These LCSs may be purchased commercially or prepared at the laboratory, and are identified as blank spikes (BS) for organic analysis. For multi-analyte methods, including preparation methods such as metals digestions, the LCS may only contain a representative number of target analytes rather than the full list. For organic analyses, in particular for multi-analyte methods, the LCS may be surrogate compounds in the blank or a select number of target analytes in fortified blanks (blank spike: BS). The LCSs are subjected to all sample preparation steps. Additionally, an LCS in each matrix will be analyzed to demonstrate control of the analysis for water and soil samples. The amount of each analyte recovered in LCS analysis is recorded and entered into a method- and matrix-specific database to generate statistical control limits for percent recovery of that LCS. These empirical data are compared with available method reference criteria and available databases to establish control criteria.

The % R for fortified (spiked) investigative sample analysis provides a tool for evaluating how well the method worked for the respective matrix. These values are used by the client to assess a reported result within the context of the project DQO's. For results outside control limits provided as requirements in the QAPP, corrective action appropriate to the project will be taken and the deviation will be noted in the case narrative accompanying the sample results.

Accuracy for some procedures is evaluated as the degree of agreement between a new set of results and a historical database or a table of acceptable criteria for a given parameter. This is measured as percent difference (%D) from the reference value, and is primarily used by the laboratory as a means for documenting acceptability of continuing calibration or of standards.

The quality assurance objectives for organic and inorganic analyses are tailored to the analytical technique used and are discussed in the ensuing subsections. The number and types of quality control samples for precision and accuracy and their associated acceptance criteria will be specified by the individual methods or project specific DQO's.

8.2.1 Metals/Inorganics Analysis

For metals and inorganics analysis, analytical accuracy is obtained from the analyte recovery measured in a laboratory control standard, QC check sample, and/or a field sample fortified with the element of interest. See also Section 9.0 for further information on matrix QC indicators.

Laboratory-derived control limits will be developed after at least 20 points have accumulated, but only if the data set appears to be random. If there are insufficient points to develop such control limits, or if charts of the data show a pattern or trend that places their credibility as a source of control limits in question, the control limits below will be used. Out-of-control situations and the actions taken to return the system to a control status will be documented in a Corrective Action Report (CAR) or Sample Discrepancy Report (SDR).

The temporary default values will apply to routinely analyzed metals (e.g., metals included in the following lists: drinking water, priority pollutant, RCRA, Appendix IX, and EPA's Contract Laboratory Program target analyte list for hazardous waste) and inorganics. In the case of unusual analytes or infrequently used methods, control limits may be based on fewer than 20 data points if the data exhibit a random graphic pattern.

Laboratory Control Standard (LCS)	80-120% Recovery
Fortified Field Sample (matrix spike)	75-125% Recovery

8.2.2 Organic Analysis (GC and GC/MS)

For organic analysis, analytical accuracy is based on a select set of analytes measured in a laboratory control standard, or a QC check sample. These recovery measurements comprise both target compounds and surrogate compounds, and are representative of compound lists analyzed routinely (e.g., compounds from the following lists: drinking water, priority pollutant, RCRA, Appendix IX, and EPA's Contract Laboratory Program target analyte list for hazardous waste). Refer to Tables 8-1 and 8-2 for accuracy objectives. See Section 9.0 for further information on matrix QC indicators.

Laboratory-derived control limits will be developed after at least 20 points have accumulated, but only if the data set appears to be random. If there are insufficient points

to develop such control limits, or if charts of the data show a pattern or trend that places their credibility as a source of control limits in question, the published control limits for the respective CLP, EPA, or SW-846 methods will be utilized. Out-of-control situations and the actions taken to return the system to a control status will be documented in a Corrective Action Report (CAR) or Sample Discrepancy Report (SDR).

Fortification of the sample with target analytes prior to extraction (matrix spike) provides recovery data for the actual target compound as affected by the respective sample matrix. and requires analysis of a second sample, unspiked, to allow correction for any of the compound indigenous to the sample when evaluating recoveries.

8.3 Representativeness and Comparability

For laboratory procedures, an attempt will be made to ensure that all data are representative of the matrix and conditions of the sample being measured. The data will be calculated and reported in units consistent with standard reporting conventions to enable comparability to existing data, standards, and/or regulatory action limits.

A measure of inter-laboratory comparability is obtained through the laboratory's participation in performance evaluation programs established with Round Robin suppliers and the USEPA Water Supply (WS) and Water Pollution (WP) programs. In addition, the laboratories employ the use of NIST or EPA traceable standards, when available, to provide an additional measure of assurance of the comparability of data.

Project representativeness and comparability are dependent on the sampling plan on a project specific basis, and therefore are not covered in this laboratory plan. Assessment of site and collection representativeness and comparability is performed by the field engineer.

8.4 Method Detection Limits

The method detection limit is the lowest concentration that can be seen for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to Appendix B of 40 CFR 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants". MDL's reflect a calculated value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually.

8.5 Reporting Limits

Reporting Limits are defined as the lowest concentration of an analyte determined by a given method in a given matrix that the laboratory feels can be reported with acceptable quantitative error. Because of the high level of quantitative error associated with determinations at the level of the MDL, WESTON endeavors to keep reporting limits significantly higher than the MDL, although client requirements may necessitate reporting at such levels. Wherever possible, reporting is limited to values approximately 3x the respective MDL to ensure confidence in the value reported.

Method detection level studies are performed annually, and PQLs are calculated. If the MDL does not meet the routine laboratory reporting limit or the method specified limit, it is repeated. If the laboratory continually demonstrates that the method reporting limits are not achieved, equipment, technique, and the method are reviewed to assure optional performance or appropriate action is taken.

8.6 Completeness

Completeness is a measure of the relative number of analytical data points which meet all the acceptance criteria for accuracy, precision, and any other criteria required by the specific analytical methods. Project specific completeness goals account for all aspects of sample handling, from collection through data reporting. The level of completeness can be affected by loss or breakage of samples during transport, as well as external problems which prohibit collection of the sample. The ability to meet or exceed completeness objectives is also dependent on the nature of samples submitted for analysis. For example, if the analytical methods proposed for use (particularly for organics analyses) are intended for analysis of environmental samples of low and medium hazard, the applicability of these methods to non-routine matrices such as drum samples, wipes, air samples, etc. may result in poor method performance and therefore adversely impact on achievement of the data completeness goal. Completeness is variable and a project-specific requirement.

Completeness is calculated as follows:

$$\text{Completeness} \approx \frac{\text{Number of acceptable reported QC data}}{\text{Total number of reported QC data}} \times 100\%$$

Criteria for evaluating completeness will be in accordance with the specific data quality objectives for a given project, as defined by the relevant Project Quality Assurance Plan.

TABLE 8-1

Quality Assurance Objectives for Accuracy for Organic Surrogate Analyses[a]

Fraction	Surrogate Compound	Percent Recovery	
		Water	Soil/Sediment
VOA	Toluene-d_8	88-110	84-138
VOA	4-Bromofluorobenzene	86-115	59-113
VOA	1,2-Dichloroethane-d_4	76-114	70-121
BNA	Nitrobenzene-d_5	35-114	23-120
BNA	2-Fluorobiphenyl	43-116	30-115
BNA	p-Terphenyl-d_{14}	33-141	18-137
BNA	Phenol-d_5	10-110	24-113
BNA	2-Fluorophenol	21-110	25-121
BNA	2,4,6-Tribromophenol	10-123	19-122
BNA	2-Chlorophenol-d_4	33-110 (advisory)	20-130 (advisory)
BNA	1,2-Dichlorobenzene-d_4	16-110 (advisory)	20-130 (advisory)
PEST	2,4,5,6-Tetrachloro-m-xylene	60-150 (advisory)	60-150 (advisory)
PEST	Decachlorobiphenyl	60-150 (advisory)	60-150 (advisory)
PEST	Di-n-butylchlorendate	24-154 (advisory)	20-150 (advisory)

[a]This list includes selected compounds used for QA/QC accuracy and precision control in the groups (fractions) of analytes shown. Selected compounds are consistent with guidance presented in U.S.EPA SW-846, 3rd edition or the U.S. EPA Contract Laboratory Program (CLP) Statement of Work, Document No. OLM01.8. Stated control limits are based on performance and have been adopted from the cited SOW.

TABLE 8-2

QA Objectives for Accuracy and Precision for Organic Target Compound Analyses[a]

Fraction	Matrix Spike Compound	% Recovery Limits		RPD Limits[b]	
		Water	Soil/ Sediment	Water	Soil/ Sediment
VOA	1,1-Dichloroethene	61-145	59-172	14	22
VOA	Trichloroethene	71-120	62-137	14	24
VOA	Chlorobenzene	75-130	60-133	13	21
VOA	Toluene	76-125	59-139	13	21
VOA	Benzene	76-127	66-142	11	21
BN	1,2,4-Trichlorobenzene	39- 98	38-107	28	23
BN	Acenaphthene	46-118	31-137	31	19
BN	2,4-Dinitrotoluene	24- 96	28- 89	38	47
BN	Pyrene	26-127	35-142	31	36
BN	N-nitroso-di-N-propylamine	41-116	41-126	38	38
BN	1,4-Dichlorobenzene	36- 97	28-104	28	27
ACID	Pentachlorophenol	9-103	17-109	50	47
ACID	Phenol	12-110	26- 90	42	35
ACID	2-Chlorophenol	27-123	25-102	40	50
ACID	4-Chloro-3-methylphenol	23- 97	26-103	42	33
ACID	4-Nitrophenol	10- 80	11-114	50	50
PEST	Lindane	56-123	46-127	15	50
PEST	Heptachlor	40-131	35-130	20	31
PEST	Aldrin	40-120	34-132	22	43
PEST	Dieldrin	52-126	31-134	18	38
PEST	Endrin	56-121	42-139	21	45
PEST	4,4-DDT	38-127	23-134	27	50
PCB	Aroclor 1254	50-150	50-150	30	50

[a]This list includes selected compounds used for QA/QC accuracy and precision control in the groups (fractions) of analytes shown. Selected compounds are consistent with guidance presented in U.S.EPA SW-846, 3rd edition and/or the U.S. EPA Contract Laboratory Program (CLP) Statement of Work, Document No. OLM01.8. Stated control limits are based on performance and have been adopted from the cited SOW, with the exception of PCB. PCB limits are based on laboratory performance data.

[b]RPD = Relative Percent Difference

9.0 QUALITY CONTROL CHECKS AND ROUTINES TO ASSESS PRECISION AND ACCURACY AND CALCULATION OF METHOD DETECTION LIMITS

9.1 Quality Control Checks

The quality of analytical data generated at WESTON's laboratories is controlled through management systems, processes and procedures described in the Quality Assurance Program Plan. This section describes the minimal internal quality control checks used in each laboratory operating section. If method Quality Control (QC) is more stringent than these laboratory guidelines, the method QC will be followed except when a method modification or variance is authorized by the client or a project specific QAPjP. The Project Manager must obtain such exceptions in writing from the client.

9.2 Quality Control Indicators and Analysis Frequency

Quality control (QC) indicators, introduced in various phases of the analytical process, are tools used to evaluate method performance and to assist in the validation of analytical results. There are two basic types of QC indicators: (1) indicators to evaluate method performance at both the preparation and the measurement steps and (2) QC indicators to evaluate matrix effects. Refer to Section 13.0, Corrective Actions, for procedures to follow when QC indicators show deviation from acceptance criteria.

9.2.1 Method Performance QC Indicators: Preparation Batch

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Each prep batch has a maximum of 20 investigative samples.

QC indicators are added to each prep batch to monitor method performance. All QC indicators such as blanks, matrix spikes, matrix duplicates, blank spikes, control samples, or duplicates of these controls are processed through the entire analytical procedure with samples.

9.2.1.1 Preparation Blanks

The preparation blank (PB), also referenced as a method blank (MB) or reagent blank (RB), is used to monitor for potential contamination introduced during the sample

preparation and analytical processes. For organics, preparation (prep) blanks are prepared by processing laboratory pure water for water samples or a purified solid matrix for soil, sediment or solid samples (when available or when requested). The solid matrix for non-volatiles is generally sodium sulfate. The preparation blank volume/weights are selected to approximately equal the typical sample volume/weight used in sample preparation.

For metals, the prep blank consists of laboratory pure water for both water (PBW) and soil or sediment (PBS) samples. Final results are calculated as µg/L for the PBW in metals (exception: RCRA metals reported as mg/L) and mg/L for the PBW in wet chemistry. To facilitate comparison to actual field samples, final results for the PBS are calculated as mg/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding investigative samples.

Field blanks and trip blanks, when received, will be analyzed in the same manner as other investigative samples. However, a field blank should not be selected for matrix QC, as it does not provide information on the behavior of the target compounds in the investigative samples. Usually, the client sample ID will provide a information to identify the field blanks with labels such as "FB", "TB", "Rinse Blank".

9.2.1.2 Laboratory Control Samples and Blank Spikes

Laboratory control sample (LCS) used by the inorganics sections and blank spike (BS) used by the organics sections have the same connotation. The LCS and BS are prepared from a reference source of known concentration and processed through the entire preparation and analysis steps. These QC indicators are processed concurrently with investigative samples and are used to assess method performance independent of potential investigative sample matrix affects. LCSs are performed in duplicate for each preparation batch of 20 or fewer samples, except in some organic analyses when surrogates in the method blank and blank spike are compared to assess method precision. Blanks spikes and blank spike duplicates are not required by the method but are performed based on WESTON and client specific requirements.

For solid matrices, an aqueous LCS may be processed, unless a solid LCS is requested, through the soil/solids preparation method (e.g., digestion for metals or distillation for cyanide). To facilitate comparison with the actual field samples, final results for the LCSs are calculated as mg/kg or µg/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding investigative samples. For organic analyses, the BS may consist of a representative selection of target analytes. The solid matrix used for non-volatiles is generally sodium sulfate.

9.2.1.3 Known QC Reference Samples

QC reference samples containing known analytes or compounds are obtained from outside suppliers or agencies. QC reference samples are obtained from the National Institute of Standards and Technology (NIST), state agencies, or commercial suppliers. These QC reference samples generally require preparation from concentrated materials by dilution into a standard matrix as instructed by the supplier. However, several suppliers provide fully constituted samples ready to analyze as received. Control limits are provided by the vendor, extrapolated from other in-house control data, or determined from control charts or method reference limits.

QC reference samples may be used to comply with regulatory requirements; to check the accuracy of an analytical procedure; to troubleshoot method performance problems; to verify an analyst in training's ability to accurately perform a method; and to verify the return-to-control after method performance problems. It is particularly applicable when a minor revision or adjustment has been made to an analytical procedure or instrument. It may also be used as an LCS.

9.2.2 Matrix QC Indicators

Matrix QC indicators include sample duplicates (DUP), sample matrix spikes (MS), and sample surrogate spikes. Matrix QC indicators help monitor for potential physical and chemical effects which may interfere with the precision and/or accuracy of the selected analytical method. Since interferences can enhance or mask the presence of target analytes, matrix QC indicators measure the degree of interference and are used to assist in the interpretation of the analytical results. The laboratories avoid performing matrix QC on known field blank samples, such as trip blanks and rinsates, since these samples are not indicative of the sample matrix.

9.2.2.1 Matrix Spike (MS)

A matrix spike (MS) is an aliquot of an investigative sample which is spiked with the analytes or compounds of interest. When requested by the client or the analytical method, an MS is analyzed for each associated sample type (e.g., soil, water, oils, etc.) and is used to monitor the effects of the investigative sample matrix on the accuracy of the selected analytical method. The determination of MS percent recovery (% R) requires an analysis of a fortified sample and a non-fortified sample under the same procedural conditions (e.g., sample volumes, dilutions, procedural conditions, etc.). The concentration determined in the non-fortified sample is subtracted from the fortified sample concentration before determining percent recovery (%R).

9.2.2.2 Duplicates

Laboratory duplicate samples (DUP) are performed by analyzing two aliquots of the same field sample independently and then performing an independent analysis. A DUP, when requested by the client or the analytical method, is analyzed for each associated sample type (e.g., soil, water, soil, etc.) and is used to monitor the matrix affects on the precision of the selected analytical method. Precision may also be affected by the degree of homogeneity of the sample, particularly in the case of nonaqueous samples or aqueous samples with particulates. The DUP also provides a measure of the reproducibility of laboratory preparation and measurement techniques, but these steps are controlled by method QC indicators.

9.2.2.3 Matrix Spike Duplicates

A matrix spike duplicate (MSD) is an alternative to sample duplicates since it provides precision information. The MSD is preferable to a DUP if no target compounds are present in the sample. Generally, inorganic protocols specify an MS/DUP and organic protocols specify an MS/MSD. As with other matrix QC indicators, an MSD is analyzed when requested by the client or the analytical method.

9.2.2.4 Surrogate Spikes

Where required by the method, surrogates, compounds similar to the target analytes in structure, composition and chromatography, but not typically found in the environment, are added to each blank, blank spike and duplicate, matrix spike and duplicate, and sample, prior to preparation (e.g., extraction). Surrogates measure performance of the analysis in relation to the sample matrix. If the surrogates in an analytical batch do not all conform to established control limits, the pattern of conformance in investigative and QC samples is examined to determine the presence of matrix interference or the need for corrective action.

9.2.2.5 Internal Standards

Internal standards monitor the qualitative aspect of organic and inorganic analytical measurements. All internal standards are assessed after acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance. Internal standards are used to correct for matrix effects and to help troubleshoot variability in analytical response.

9.2.2.6 Matrix QC Frequencies

The frequency of matrix QC indicators depends on regulatory program compliance, a project's data quality objectives, or a client's requirements. The following frequency will be applied to samples when the regulatory programs are known and it does not conflict with project or client requirements.

For the Safe Drinking Water Act (SDWA) methods, a DUP is performed at a 10% frequency (1 per 10 samples) or one per preparation batch of 10 samples or less, whichever is more frequent.

For the Clean Water Act (CWA) 600 Series, MD/MSD or MS/DUP is performed at a 10% frequency (1 per 10 samples) or one per preparation batch of 10 samples or less, whichever is more frequent.

For EPA SW-846 methods, MS/MSD or MS/DUP is performed at a rate of 5% (1 per 20 samples) per client (independent of the preparation batch). For clients submitting less than 10 samples, the method matrix QC requirement may be satisfied by another clients sample within the same prep batch unless the Technical Profile indicates a client requirement for matrix QC. Matrix QC will only be reported to the client who owns the data.

For USEPA CLP Sample Delivery Groups (SDGs), MS/MSD or MS/DUP is performed at a rate of 5% (1 set per 20 samples), or one set per SDG per matrix, independent of the prep batch.

Matrix spikes (MS), matrix spike duplicates (MSD), and duplicates (DUP) may not be applicable to some analytical protocols because of the nature of the sample or protocol.

9.2.3 Method Performance Indicators: Instrument Measurement

Quality control indicators are used to ensure that optimum instrument performance is achieved. These indicators help ensure that the proper identification and quantitation of target compounds or analytes are achieved. The instrument QC indicators appropriate to each analytical technique are described in laboratory operating procedures for each respective method. A brief description of these checks is included in this section.

9.2.3.1 Initial Calibration Verification (ICV) (Inorganics)

The initial calibration verification is a calibration standard of known concentration prepared from a source other than that used for the calibration standards. The ICV is analyzed after the standard curve to confirm calibration.

9.2.3.2 Initial Calibration Blank (ICB) (Inorganics)

The ICB is composed of blank water or solvent that is analyzed immediately after the ICV to confirm the calibration and to assure that any potential contamination is less than the reporting limit.

9.2.3.3 ICP Interference Check Samples (ICSA/ICSAB) (Inorganics)

ICP Interference Check Samples (ICSA/ICSAB) will be analyzed consecutively at the beginning of each eight hour analytical sequence, after the ICV/ICB, and again at an eight hour frequency following a CCV/CCB. When CLP protocols are followed, the ICSA/ICSAB will be analyzed with the analytical sequence, before the final CCV/CCB. The ICSA/ICSAB are analyzed to verify the absence of spectral interferences.

Results for the ICP Interference Check Samples shall be within limits of 80-120% of the established mean value. If results for the ICSA/ICSAB do not fall within the control limit, the analysis will be terminated, the problem will be corrected, and the instrument will be recalibrated. If more than one ICSA/ICSAB was analyzed in an analytical sequence, any samples not bracketed by acceptable ICSA/ICSB will be reanalyzed.

Interferant elements for spectral interferences are not limited to Al, Ca, Fe, and Mg. Other elements may be added as needed and will be documented. The mean concentration is established by initially analyzing each lot of ICS Solution at least five times for the analytes of interest. The mean determination is performed during an analytical batch that meets all ICP QC specifications. Alternately, the ICSA/ICSB may be obtained from EPA or a commercial vendor with established mean values provided with the solution.

9.2.3.4 Detection Limit Verification Standard (Inorganics)

For Furnace AA, Flame AA, and Cold Vapor AA analysis, a standard at or near the detection limit is analyzed after the ICB to verify linearity near the reporting limit. Specific acceptance range criteria for the CRA are undefined by the EPA.

For ICP analysis, a standard at two times the reported detection limit (CRI) will be analyzed after the ICB to verify linearity near the reporting limit. The CRI is also analyzed at the end of the eight hour analytical sequence, prior to analysis of the final CCV/CCB. The CRI is not required for non-TAL metals Al, Ba, Ca, Fe, Mg, Na, or K. There are no established control limits for the CRA and CRI. In house acceptance criteria will be clarified in the individual laboratory OP.