COMPREHENSIVE QUALITY ASSURANCE MANUAL

Version 31

For
MWH LABORATORIES,
A DIVISION OF MWH AMERICAS, INC.
750 Royal Oaks Drive
Suite 100
Monrovia, CA 91016
(626) 386-1100

ACCREDITED IN ACCORDANCE WITH nelac 01114CA

Controlled Copy____
of _____ copies
MWH Laboratories
Initials_____Date_____

COMPREHENSIVE QUALITY ASSURANCE MANUAL

Prepared by and for
MWH LABORATORIES,
A DIVISION OF MWH AMERICAS, INC.
750 Royal Oaks Drive
Suite 100
Monrovia, CA 91016
(626) 386-1100

Prepared by: Nilda B. Cox **Date** 07/06/09
Nilda Cox
Quality Assurance Officer

Approved by: Carol J Belt **Date** 07/06/09
Carol J. Belt
Asbestos Technical Director

Approved by: Andy Eaton **Date** 7/6/09
Dr. Andrew Eaton
Technical Director

Approved by: Ed Wilson **Date** 7/6/09
Ed Wilson
Laboratory Director

Issue Date: 7/6/09

Effective Date: 7/20/09

Revised April, 2009

ACCREDITED IN ACCORDANCE WITH nelac 01114CA

Controlled Copy____
of _____ copies
MWH Laboratories
Initials Date

2.0 TABLE OF CONTENTS

SECTION TITLE PAGE

3.0 STATEMENT OF POLICY 12

3.1. INTRODUCTION 12
3.2. QUALITY ASSURANCE POLICY 12
3.3. MISSION STATEMENT 13
3.4. CODE OF ETHICS AND POLICY/DATA INTEGRITY PROCEDURES 13
3.5. SERVICE TO THE CLIENT 14
3.5.1. Client Confidentiality 14
3.6. REVIEW OF REQUESTS AND CONTRACTS/CONTRACT AMENDMENTS 14
3.6.1. Procedure for the Review of Work Requests 14
3.6.2. Documentation of Review 15
3.7. MWH LABS STANDARD POLICY ON RESOLUTION OF COMPLAINTS 15
3.8. CAPABILITIES 16
3.9. CERTIFICATIONS 16
3.10. SUBCONTRACTED LABORATORY WORK 18
3.11. FACILITIES 19
3.11.1. ACCOMODATIONS 19
3.11.2. ENVIRONMENTAL CONDITIONS 20

4.0 PROGRAM ORGANIZATION AND RESPONSIBILITY 23

4.1. MWH LABORATORIES PERSONNEL 23
4.1.1. Laboratory Director: Mr. Ed Wilson 23
4.1.2. Technical Director/Marketing Director: Dr. Andrew Eaton 23
4.1.3. Asbestos Technical Director: Carol J. Belt 24
4.1.4. Client Services Manager: Mr. James Hein 24
4.1.5. Quality Assurance (QA) Officer/Regulatory Consulting Manager: Ms. Nilda B. Cox 24
4.1.6. LIMS Implementation Manager: Linda Geddes 25
4.1.7. Technical Manager/LCMS Supervisor: Mr. Ali Haghani 25
4.1.8. Extraction and GC/MS Supervisor: Mr. Charles Grady 25
4.1.9. GC/HPLC: Mr. Martin McNally 26
4.1.10. Inorganic Supervisor: Mr. Walter Hsieh 26
4.1.11. Microbiologist Supervisor: Ms. Polly Barrowman 26
4.1.12. LIMS Manager: Jerry Cooper 26
4.2. QUALITY ASSURANCE PROGRAM AND ITS MANAGEMENT 26
4.3. STAFF RESPONSIBILITY 29
4.3.1. Initial Training 30
4.3.2. On-going Training/Annual Competency Check 30
4.3.3. Training Records 31

5.0 QUALITY ASSURANCE OBJECTIVES 61

5.1. PRECISION 61
5.2. ACCURACY 62
5.3. REPRESENTATIVENESS/SAMPLING OF SUB-ALIQUOT 63
5.4. COMPARABILITY 64

5.5. COMPLETENESS 64
5.6. TIMELINESS 64
5.7. DOCUMENTATION 64

6.0 QUALITY OF TEST RESULTS 81

6.1. ESSENTIAL QUALITY CONTROL PROCEDURES 81
6.1.1. NEGATIVE CONTROL 81
6.1.1.1. Method Blanks 81
6.1.1.2. Travel Blanks 82
6.1.1.3. Field Blanks 83
6.1.1.4. Sample Blanks 83
6.1.1.5. Calibration Blanks 83
6.1.2. Positive Control 83
6.1.2.1. Laboratory Control Sample (LCS)/Laboratory Fortified Blank (LFB) 83
6.1.2.2. Matrix Spike and Matrix Spike Duplicate Samples (MS/MSD) 84
6.1.2.3. LCS and MS/MSD Concentration Levels 84
6.1.2.4. Selection of Spike Analytes 84
6.1.2.5. Sample Preparation of LCS/LFB and MS/MSD 85
6.1.2.6. Frequency of MS/MSD 86
6.1.2.7. Frequency of LCS/LFB 87
6.1.2.8. Evaluation Criteria of MS/MSD 87
6.1.2.9. Evaluation Criteria of LCS/LFB – Marginal Exceedances 88
6.2. Sample Specific Controls 89
6.2.1. Internal and Surrogate Standards 89
6.2.2. Spikes – Recoveries, RPDs 89
6.2.3. Duplicates, Duplicate Spikes 90
6.2.4. External Reference Samples 91
6.2.5. Confirmation 91
6.2.6. Retention Time Windows 91
6.3. DEMONSTRATION OF CAPABILITY (DOC) 91
6.3.1. Method Detection Limits (MDL) / Limit of Detection (LOD) 92
6.3.2. Minimum Reporting Limits (MRL) / Limits of Quantification (LOQ) 93
6.3.3. Demonstration of Capability 93
6.4. METHOD SPECIFIC QUALITY CONTROL 95
6.4.1. Gravimetry 95
6.4.2. Titration 95
6.4.3. Colorimetric Spectrophotometry 95
6.4.4. ICP Emission Spectroscopy & ICPMS 96
6.4.5. Radiochemistry 97
6.4.6. Gas Chromatography 98
6.4.7. Gas Chromatography/Mass Spectrometry 99
6.4.7.1. GC/MS Tuning Specifications 99
6.4.7.2. Quantitation of Identified Compounds/Quantitation from Initial Instrument Calibration 99
6.4.7.3. Internal and Surrogate Standards (IS and SS) 99
6.4.7.4. Criteria for Tentatively Identified Compounds (TIC's) 100
6.4.7.5. Control Samples 100
6.4.7.6. Blanks 101
6.4.8. Total Organic Carbon (TOC) 101
6.4.9. Total Organic Halogen (TOX) 101

6.4.10. General Microbiology - Use of Commercial Dehydrated Powder for Coliform Testing 102
6.4.11. Asbestos 104

7.0 SAMPLE COLLECTION, PRESERVATION, IDENTIFICATION, HANDLING, AND STORAGE 106

7.1. SAMPLE COLLECTION AND BOTTLE PREPARATION 106
7.2. CONTAINERS, PRESERVATIVES, HOLDING TIMES AND SAMPLE KITS 106
7.3. SAMPLE STORAGE 107
7.4. SAMPLE DISPOSAL 107

8.0 SAMPLE MANAGEMENT 121

8.1. SAMPLE RECEIPT AND LOG-IN/SAMPLE RECEIPT PROTOCOL 121
8.1.1. Sample Labeling System 121
8.1.2. Sample Receipt Acceptance Criteria: 122
8.2. CHAIN OF CUSTODY 123
8.2.1. Level I 123
8.2.2. Level II 124
8.3. SAMPLE STORAGE AND DISPOSAL 125
8.4. SAMPLE TRACKING 125
8.5. LABORATORY INFORMATION MANAGEMENT SYSTEM (LIMS) 126

9.0 ANALYTICAL PROCEDURES 141

9.1. SOURCES FOR METHODS 141
9.1.1. Standard Methods 141
9.1.2. Non Standard Methods 141
9.2. INITIAL TEST METHOD EVALUATION PROCEDURES 142
9.2.1. Limit of Detection (LOD) 142
9.2.2. Limit of Quantitation (LOQ) 142
9.2.2.4. Precision and Bias 143
9.2.2.5. Selectivity 144
9.2.3. Detection Limits 144
9.3. ESTIMATION OF UNCERTAINTY 144
9.4. VALIDATION OF METHODS [NELAC 5.5.4.5] 144
9.5. METHOD EVALUATION 145
9.6. METHODS USED/SCOPE OF TESTING 145
9.7. METHOD MODIFICATIONS 146
9.8. REFERENCES 146

10.0 PURCHASING SERVICES AND SUPPLIES/ MEASUREMENT TRACEABILITY 155

10.1. PURCHASING SERVICES AND SUPPLIES 155
10.2. REAGENTS AND REFERENCE STANDARDS 155
10.2.3. Calibration Standards 155
10.2.4. Policy on Verification of Standards 156
10.2.4.1. Mixtures 156
10.2.4.2. Neat Compounds 157
10.3. DOCUMENTATION RECORDS OF REAGENTS AND STANDARDS 157

10.4. REAGENT STORAGE AND DISPOSAL 158

11.0 CALIBRATION PROCEDURES AND FREQUENCY 161

11.1. INITIAL INSTRUMENT CALIBRATION 161
11.1.1. Applicability 161
11.1.2. Linearity 161
11.1.3. Selection of Quantitation Technique (Organics) 163
11.1.4. Selection of Calibration Method 164
11.1.5. Minimum Number of Calibration Levels 165
11.1.6. Selection of Calibration Levels 165
11.1.7. Calibration Analytical Sequence 166
11.1.8. Calibration Acceptance Criteria 166
11.2. CONTINUING INSTRUMENT CALIBRATION 166

12.0 EQUIPMENT 177

12.1. ANALYTICAL EQUIPMENT 177
12.2. SUPPORT EQUIPMENT 177
12.2.1. Balances 177
12.2.2. Temperature Monitoring 177
12.2.3. Pipets 177
12.2.4. Microbiology Volumetric Equipment [NELAC 5.Appendix D.3.8.b)3)] 178
12.2.5. Glassware 178
12.2.6. Water Quality File 178
12.2.7. Out of Service 179
12.3. PREVENTIVE MAINTENANCE 179
12.3.1. Routine Maintenance Activities 179
12.3.2. Documentation 179
12.3.3. Contingency Plans 180

13.0 DOCUMENT MANAGEMENT/CONTROL OF RECORDS 191

13.1. ANALYTICAL DOCUMENTATION 191
13.1.1. Analytical Data and Quality Control Forms 191
13.1.2. Chromatograms and Data Processing 191
13.1.3. Inventory Control Logs 191
13.1.4. Stock Standard Logs 191
13.1.5. Bacteriological Growth Media Log 192
13.1.6. Instrument Monitoring and Maintenance Logs 192
13.1.7. Corrective Action 192
13.2. CONTROL OF RECORDS 192
13.2.1. General Records 192
13.2.2. Technical Records 193
13.3. DATA STORAGE 194
13.4. DOCUMENT CONTROL 194
13.5. DOCUMENT CHANGES TO CONTROLLED DOCUMENTS 196
13.6. ARCHIVAL SYSTEM 196
13.7. STANDARD OPERATING PROCEDURES (SOP) 196

14.0 DATA REDUCTION, VALIDATION, AND REPORTING 203

14.1. DATA REDUCTION 203
14.1.1. GC AND GC/MS 203
14.1.2. GC/MS 204
14.1.3. METALS 204
14.1.4. HPLC / IC / SPECTROPHOTOMETRIC / POTENTIOMETRIC 204
14.1.5. MICROBIOLOGY 204
14.2. DATA VALIDATION 204
14.3. DATA REVIEW POLICY/CORRELATION OF RESULTS 205
14.4. DATA REPORTING 205
14.5. ELECTRONIC TRANSMISSION OF RESULTS 207
14.6. GOOD AUTOMATED LABORATORY PRACTICES (GALP) 208

15.0 CONTROL OF NON-CONFORMING WORK, CORRECTIVE ACTION, AND PREVENTIVE MEASURES 216

15.1. CORRECTION ACTION PROCEDURES, BY METHOD 216
15.2. CORRECTIVE ACTION PROCEDURES, ROOT CAUSE, PREVENTIVE MEASURES, DATA QUALIFIERS, AND REPORT COMMENTS 216
15.2.1. Selection and Implementation of Corrective Actions 216
15.2.2. Documentation of Corrective Actions 216
15.2.3. Monitoring of Corrective Action 217
15.2.4. Preventive Measures 217
15.3. ESTABLISHING WARNING/ACTION LIMITS 218
15.3.1. Approach to Setting Limits 218
15.3.2. Documentation of Limits 218
15.3.3. LCS Control Limits 219
15.4. CONTROL CHARTS 219
15.5. PROCEDURES FOR DETERMINING AND REPORTING OUT-OF-CONTROL ANALYSES 220
15.5.1. Defining an Out-of-Control Analysis 220
15.5.1.1. Criteria Used 220
15.5.2. Responding to an Out-of-Control Event 221
15.5.2.1. Roles and Responsibilities 221
15.5.2.2. Defining Suspect Samples 222
15.5.2.3. Ensuring that Suspect Data Are Not Reported 222
15.5.2.4. Corrective Action 222

16.0 PERFORMANCE AND SYSTEM AUDITS/MANAGEMENT REVIEW 247

16.1. INTERNAL AUDITS 247
16.1.1. Annual and Periodical Internal Audits 247
16.1.2. Data Package Reviews 248
16.2. EXTERNAL AUDITS 248
16.3. PERFORMANCE AUDITS 248
16.3.1. Internal Performance Evaluation Samples/Internal Check Sample Program/Internal Proficiency Testing Program 249
16.3.2. External Proficiency Testing (PT) Samples 249
16.3.3. Proficiency Testing Protocol 249

16.3.3.1. Frequency 249
16.3.3.2. Laboratory Handling 250
16.3.3.3. Not Acceptable PT Results 251
16.3.3.4. Reporting 251
16.3.3.5. Remedial PT 252
16.4. SYSTEM AUDITS AND MANAGEMENT REVIEW 252
16.4.1. System Audits 252
16.4.2. Management Review 252

2.1 LIST OF FIGURES

FIGURE TITLE **PAGE**

Figure 3-1 Floor Plan First Floor 21
Figure 3-2 Floor Plan 2nd Floor 22
Figure 4-1 QA Signature Page 32
Figure 4-2 SOP/Method Training Documentation Form 33
Figure 4-3 State of California Certification 41
Figure 4-4 List of California Certified Analytes 42
Figure 4-5 Laboratory Certificate - State of California (ELAP) 54
Figure 4-6 California (ELAP) Field of Testing 55
Figure 4-7 LA County Fire Department License to Operate 58
Figure 4-8 Drug Enforcement Administration Certificate 59
Figure 4-9 MWH Organizational Chart 60
Figure 8-1 Cooler Receipt Form 129
Figure 8-2 Price Quotation/Work Order Form 130
Figure 8-3 Example Sample Labels 131
Figure 8-4 Internal Custody Logbook 132
Figure 8-5 Internal Sample Disposal (Level II) 133
Figure 8-6 Chain-of-Custody Form 134
Figure 8-7 Run Logbook 135
Figure 8-8 Example Work Schedule Printout 136
Figure 8-9 Sample Acknowledgement 137
Figure 8-10 Operations Report 138
Figure 8-11 Weekly Lab Turnaround Time 139
Figure 8-12 Work Load Report by Test and Matrix 140
Figure 13-1 Sample Worksheet 201
Figure 13-2 Example Notebook 202
Figure 14-1 Example Analysis Report Form 209
Figure 14-2 Example Analysis Report Form (Report Comment) 213
Figure 14-3 Example QC Report Form 214
Figure 14-4 Example QC Report Form (QC Summary) 215
Figure 15-1 Data Qualifiers 224
Figure 15-2 Sample Quality Investigation Report (QIR) 244
Figure 15-3 Quality Investigation Report (QIR) Flow Chart 245
Figure 15-4 Example Surrogate Control Chart 246

2.2 LIST OF TABLES

TABLE TITLE **PAGE**

Table 3-1 State Certifications 17
Table 4-1 List of SOPs 34
Table 4-2 Other Certifications 40
Table 5-1 Precision and Accuracy for Drinking Water for Mid or High Level Spikes 66
Table 5-2 Precision and Accuracy for Wastewater for Mid or High Level Spikes 74
Table 5-3 Precision and Accuracy for Hazardous Waste for Mid or High Level Spikes 77
Table 6-1 Example of Surrogate Acceptance Limits 105
Table 7-1 Preservation and Holding Times for Drinking Water 109
Table 7-2 Preservation and Holding Times for Wastewater 115
Table 7-3 Preservation and Holding Times for Hazardous Waste (Aqueous Matrix Only) 119
Table 9-1 Method Description for Drinking Water 148
Table 9-2 Method Description for Wastewater 150
Table 9-3 Method Description for Hazardous Waste 153
Table 10-1 Reagent and Standard Storage 158
Table 10-2 Standard Storage and Holding Periods for Stock and Working Standard Solutions 159
Table 10-3 Sources of Standard Materials 160
Table 11-1 Minimum Calibration Frequency and Acceptance Criteria 168
Table 11-2 Calibration Procedures 174
Table 11-3 Ion Abundance Criteria 175
Table 11-4 Initial Calibration Acceptance Criteria 176
Table 12-1 Equipment 181
Table 12-2 Preventive Maintenance Requirements 186
Table 12-3 Glassware Washing Procedures 189
Table 12-4 Water Quality Parameters 190
Table 13-1 Laboratory Document Control 200
Table 15-1 Example Summary of Corrective Action Procedures 233

2.3 LIST OF APPENDICES

APPENDIX	CONTENTS	PAGE
I	Arizona Certification and Approval	254
II	Laboratory Organizational Chart	265
III	Glossary	267
	MWH Vendor List	267

3.0 STATEMENT OF POLICY

3.1. INTRODUCTION

MWH Laboratories, a Division of MWH Americas, Inc. is a premier, full-service drinking water and wastewater laboratory that serves a national and international clientele. MWH Laboratories provides organic, inorganic, microbial, and radiochemical analyses in support of the Clean Water Act (CWA), Safe Drinking Water Act (SDWA), National Pollutant Discharge Elimination Systems (NPDES), Resource Conservation and Recovery Act (RCRA), Food and Drug Administration (FDA), and the World Health Organization (WHO) as well as the EPA Unregulated Contaminant Monitoring Regulation 2 (UCMR2) Program (2007). The Quality Assurance Project Plan (QAPP) for UCMR2 is discussed in a separate document as an addendum to the laboratory's comprehensive QA Plan. The essential elements of the Quality Assurance Program of MWH Laboratories and the quality control procedures utilized by the laboratory to ensure compliance to the UCMR2 requirements are discussed in the UCMR2 QAPP.

MWH Laboratories takes an active role in supporting the promulgation of improved methodologies and the practice of differentiating laboratories based on quality of data. MWH Laboratories participates in the methods development and validation of Standard Methods.

3.2. QUALITY ASSURANCE POLICY

MWH Laboratories is committed to the production of quality analytical data. The methods by which this is ensured are: 1) meeting or exceeding method performance criteria, 2) providing deliverables to our clients in a timely manner and 3) fostering a spirit of continuous improvement in all areas of operations.

MWH Laboratories provides clients with data of known and documented quality with which to demonstrate regulatory compliance and for other decision-making purposes (NELAC 5.0).

This Quality Assurance Manual defines the performance criteria and support procedures by which quality analytical data are generated. Standard Operating Procedures (SOPs) for individual analytical methodologies supplement this Quality Assurance Manual. Together they provide the documentation framework for ensuring the generation of uniform, comparable and quality data over time.

The foundation of the quality policy is in the involvement and continuous improvement activities of all personnel at MWH Laboratories. Opportunities for improvement are showcased with a system of monitoring, auditing, and reviewing processes. The spirit of innovation is encouraged and viewed as paramount to the continued success of the laboratory in serving its clients.

3.3. MISSION STATEMENT

MWH Laboratories will provide outstanding client service and high data of known and documented quality to all clients at all times.

3.4. CODE OF ETHICS AND POLICY/DATA INTEGRITY PROCEDURES

MWH Laboratories was a founding member (1989) of actLABS, the California Association of Testing Laboratories and drafted one of the first lab ethics policies for actLABS. actLABS subsequently became part of ACIL (American Council of Independent Labs). Beginning in 1997 our increased geographic client base required us to give up our actLABS membership.

As a former actLABS member and a current NELAC (National Environmental Laboratory Accreditation Conference) accredited laboratory, MWH Laboratories is committed to ensuring the integrity of generated data, meeting the quality needs of clients, and setting high quality and ethical standards in the environmental industry. MWH Laboratories is committed to managing its businesses by agreeing to:

- Produce results that are accurate and include QA/QC information which meets client predefined Data Quality Objectives.
- Present services in a confidential, honest, and forthright manner.
- Provide employees with guidelines and an understanding of the ethical and quality standards of our industry.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Operate the laboratory to ensure its personnel are free from any commercial, financial and other undue pressure that might adversely affect the quality of the work.
- Obey all pertinent federal, state, and local laws and regulations, and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.

In addition any employee of MWH Laboratories identified as not conforming to the code of ethics of the laboratory, committing fraud or improper data manipulation, falsifying data, or deviating from the contractual requirements will be subject to disciplinary procedures, including suspension and up to termination of employment (NELAC 5.4.1.5.b). Any supervisor or employee applying undue pressure to another coworker that might adversely affect the quality of the work will be subject to the same disciplinary procedures outlined above.

In order to meet the requirements of the NELAC data integrity program (NELAC 5.1.7 & 5.5.2.7), the laboratory implements a proactive program for the prevention and detection of improper, unethical or illegal action. This program includes training courses on Laboratory Ethics and Data Integrity Procedures, and educating all personnel on questionable practices. Details of the Laboratory Ethics and Data Integrity Procedures

are found in the laboratory SOP. The laboratory SOP includes the implementation of Data Integrity Procedures outlined in NELAC 5.1.7 including:

- Management Responsibilities (NELAC 5.4.2.6, 5.4.2.6.1 & 5.4.2.6.2) on Data Integrity Procedures/Signed Contract/Ethics Agreement for all laboratory personnel.
- Control and documentation (NELAC 5.4.15) – Internal Audit/Periodic Monitoring of Data Integrity/Evidence of Vulnerabilities.
- Data Integrity Training (NELAC 5.5.2.7) and documentation of Examples of Improper Practices in the Laboratory Ethics SOP.

3.5. SERVICE TO THE CLIENT

The laboratory collaborates with clients and/or their representatives in clarifying their request and in monitoring of the laboratory performance related to their work. Each request is reviewed to determine the nature of the request and the laboratory's ability to comply with the request within the confines of prevailing statues and/or regulations without risk to the confidentiality of other clients.

3.5.1. Client Confidentiality

MWH recognizes its clients to be its contractors, the regulatory community, and the general public. The day to day operations are defined with considerations to the needs, goals and health of all clients. Protection of clients' confidential information and proprietary rights are considered. Where data are provided for external audits or for other similar reasons, the client's name and identity are concealed as necessary to protect client-confidential information.

In the event that the laboratory transfers ownership or goes out of business, the laboratory will notify all clients to ensure that records are maintained or transferred according to the client's instructions [NELAC 5.4.12.2.4.f and 4.1.8e].

3.6. REVIEW OF REQUESTS AND CONTRACTS/CONTRACT AMENDMENTS

MWH Labs agrees to assert competency only for work for which adequate preparation has been made. Before commencing new work, the laboratory reviews all new work to ensure that it has the appropriate capability, facilities, resources, and the test method is applicable to the customer's needs. This process assures that all work will be given adequate attention without shortcuts that may compromise data quality.

A contract may be any written or oral agreement to provide a client with environmental testing. The laboratory reviews contracts and informs clients if there are any potential conflicts, deficiencies, lack of accreditations or inability to complete client work.

3.6.1. Procedure for the Review of Work Requests

3.6.1.1. Requests, tenders and contracts received by the laboratory are reviewed to ensure that the laboratory has the necessary personnel, information resources, facilities, equipment, PT, MDLs, QC and current applicable accreditation status (NELAC 5.4.4).

3.6.1.2. For new clients and comprehensive testing contracts are generated and appropriate lab personnel, such as the Lab Director or Managing Director, review the Contracts to assure that the lab is capable of providing testing prior to the start of work (NELAC 5.4.4.2).

3.6.1.3. For repetitive, routine tasks the review needs to be made only at the initial inquiry stage or on granting of the contract for ongoing routine work performed under a general agreement with the client, provided that the client's requirements remain unchanged.

3.6.1.4. For any contract amendment for NELAC compliance, the laboratory repeats the review process. Also as per NELAC 5.4.4.5, if the laboratory's accreditation is suspended, revoked, or voluntarily withdrawn, the laboratory reports to clients any applicable changes of its accreditation status.

3.6.1.5. The designated Project Manager (PM) reviews client samples received by the laboratory and logged in the LIMS. Review of logged tests and methods are documented in the Sample Acknowledgement Report by affixing the PM's signature and/or initials and date of review. A Sample Acknowledgement Report is sent to the client to document approval of LOGGED samples and methods of analysis.

3.6.2. **Documentation of Review**

3.6.2.1. Records of reviews, including any significant changes, shall be maintained. Records shall also be maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract.

3.7. MWH LABS STANDARD POLICY ON RESOLUTION OF COMPLAINTS

3.7.1. MWH Labs reviews all complaints and determines appropriate action.

3.7.2. MWH Labs will, if it is feasible and within holding times, arrange for repeat of all analyses that do not meet regulatory requirements. We hold ourselves responsible for reporting or re-reporting all results in a format that complies with regulatory requirements, and will make every attempt to correct and when feasible will repeat work at no additional charge for all analyses compromised due to laboratory error in shipping, sample preparation, or analysis. In the event of a sample loss within the required sample collection window, we will discuss with clients the merits of available options for flagging data versus re-sampling for either the individual parameter or the entire suite of

samples. In all circumstances, MWH Labs will keep clients completely informed and aware of potential or actual problems as they arise, using e-mail or telephone.

3.7.3. Where a complaint or any other circumstance raises doubt concerning compliance with the laboratory's policies, with the requirement of the NELAC Standard or otherwise concerning the quality of the laboratory's data, the MWH Quality Assurance Department will conduct an audit of the affected areas of activity.

3.7.4. Documentation of the complaints or initiating event, internal audit findings and resulting corrective action will be maintained by the MWH Quality Assurance Department (NELAC 5.4.10.3) and as appropriate be conveyed to the client.

3.8. CAPABILITIES

MWH Laboratories has the capability to analyze drinking water and wastewater for clients in the private and public sector where work is dictated by the regulatory requirements for the Safe Drinking Water Act (SDWA), Resource Conservation and Recovery Act (RCRA), National Pollutant Discharge Elimination Systems (NPDES), Clean Water Act (CWA), Food and Drug Administration (FDA), World Health Organization (WHO) and the Superfund Amendments and Reauthorization Act (SARA) and the EPA Unregulated Contaminants Monitoring Regulations List 2 (UCMR2) Program (please see our UCMR2 Quality Assurance Program Plan for details on our UCMR2 methods and analytes). Our specialized laboratory services include;

- Analysis and identification of inorganic & organic disinfection by-products, taste and odor compounds in drinking water
- Identification and quantitation of coliphage in drinking water and wastewater
- Comparability of alternate test procedures for drinking water and wastewater analysis.
- Analysis of emerging contaminants such as Pharmaceuticals and Personal Care Products (PPCPs), Endocrine Disrupter Compounds (EDCs), and perfluoro octanesulfonate (PFOS).
- Analysis of bottled water and beverage matrices for FDA and WHO regulated analyes.

3.9. CERTIFICATIONS

MWH Laboratories is currently certified in 44 states or territories to perform various analyses for regulated parameters. Please refer to Table 3-1 for the list of the states, laboratory identification number, and the certification type. An updated list is available in the QA office.

Table 3-1 State Certifications

Item #	State	Lab ID	Drinking Water	Wastewater	Hazardous Waste
1.	Alabama	41060	X		
2.	Alaska	CA-06-03	X		
3.	Arizona	AZ0455	X	X	X
4.	California – NELAP	01114CA	X	X	
5.	California – ELAP	1422	X	X	X
6.	Colorado		X		
7.	Commonwealth of Mariana Island	0007; 0008	X		
8.	Connecticut	PH-0107	X		
9.	Delaware	CA 006	X		
10.	Florida – NELAP	E87748	X		
11.	Georgia	947	X		
12.	Guam		X		
13.	Hawaii		X		
14.	Idaho		X		
15.	Illinois – NELAP	1004	X		
16.	Indiana	C-CA-01	X		
17.	Kansas – NELAP	E-10268	X		
18.	Kentucky	90107	X		
19.	Louisiana – NELAP	LA 030009	X		
20.	Maine		X		
21.	Maryland	224	X		
22.	Massachusetts	M-CA006	X		
23.	Michigan	9906	X		
24.	Mississippi		X		
25.	Montana (Chemistry)	Cert. 0035	X		
26.	Nebraska		X		
27.	Nevada	CA-00006-2003-29	X	X	X
28.	New Hampshire – NELAP	295902	X		
29.	New Jersey – NELAP	CA 008	X		
30.	New York – NELAP	11320	X		
31.	North Carolina	06701	X		
32.	North Dakota	R-009	X		
38.	Oregon – NELAP	ORELAP-CA 200003	X		
33.	Pennsylvania – NELAP	68-565	X		
34.	Rhode Island	265	X		
35.	South Carolina	87016001	X		
36.	South Dakota		X		
37.	Tennessee	TN02839	X		
38.	Texas – NELAP	TX243-2003A	X		
39.	Utah - NELAP	MONT-1	X		
40.	Vermont		X		
41.	Virginia	00210	X		
42.	West Virginia	9943C	X		
43.	Washington	C324	X		

Item #	State	Lab ID	Drinking Water	Wastewater	Hazardous Waste
44.	Wisconsin	998316660	X		
45.	Wyoming		X		

MWH Laboratories may accept, analyze, and report results for samples from states in which it is not certified if the results are intended for non-regulatory monitoring.

When there is a change in lab location or ownership, the laboratory will report in writing to the accrediting authorities within 30 calendar days of the change.

3.10. SUBCONTRACTED LABORATORY WORK

3.10.1. On occasion laboratory work may be subcontracted to certified laboratories approved by MWH Laboratories. The subcontractor laboratory will be approved only if the laboratory meets all the necessary certification requirements required by the state where the samples are collected. For example, samples collected from Alaskan Public Water supplies for compliance monitoring must be analyzed by a laboratory certified by the State of Alaska or the USEPA (18 AAC 80.255). For any part of testing covered under NELAP, the laboratory sends the work to a subcontractor accredited under NELAP or to a laboratory that meets applicable satisfactory and regulatory requirements for performing the test and submitting the results of the tests performed [NELAC 5.4.5.1].

3.10.2. Under no circumstances will work be subcontracted without client approval. The laboratory advises the client in writing of its intention to sub-contract any portion of the testing to another laboratory during the project bid proposal or purchase order procurement [NELAC 5.4.5]. Test results provided by the subcontractor are identified by the subcontractor name or applicable accreditation number. The subcontractor shall report the results in writing or electronically. (NELAC 5.5.10.5). The laboratory shall make a copy of the subcontractor's report available to the client when requested by the client.

3.10.3. Subcontracted work is documented in the chain of custody (COC). The COC and other appropriate records are included with the final data package as part of the final deliverables. To comply with California ELAP regulations (Title 22, Division 4, Chapter 19, Article 10, Section 64819), MWH reports must include the original copies of reports prepared by the subcontracted laboratories. See section 14.4 for all the information required in the final test report.

3.10.4. To help ensure all subcontractors meet MWH Laboratories Data Quality Objectives and produce documented data of known and consistently high quality, the following documentation should be requested from the vendor and reviewed by MWH Laboratories:

(1) Laboratory QA Manual

(2) Proficiency Evaluation (PE)/Proficiency Testing (PT) Data and Corrective Action Report for unacceptable reported results
(3) Certifications and NELAP Accreditation, as applicable
(4) Laboratory state Non-NELAP onsite audit/NELAP assessment results and response to the audit/assessment findings for the applicable subcontracted methods
(5) Data Integrity/Ethics Policy, as applicable

3.10.5. At a minimum, the lab's accreditation status should be verified.

3.10.6. Data deliverables should meet MWH project needs and requirements. MWH is responsible to the Client for subcontractors' data except in the case where the client or a regulatory agency specifies which subcontractor is to be used (NELAC 5.4.5.3). At a minimum, laboratory deliverables submitted to MWH should include final report, QC results and acceptance limits. Level 4 data deliverables may be requested by MWH Laboratories for review as needed. Onsite audit of subcontract laboratory may also be conducted by MWH Laboratories as needed.

3.10.7. Project managers and the designated subcontracting administrator should ensure all documents to evaluate subcontractor's qualifications are submitted to MWH Laboratories for review by QA department and/or subcontracting administrator. Before subcontracting samples, the designated subcontracting administrator shall review certifications to ensure that the laboratory's subcontractor's certification/ accreditation is current. If certification is not current, the subcontracting administrator shall contact the vendor for a current copy of the vendor's certification before shipping samples.

3.10.8. A register of all subcontractors and a record of evidence (such as NELAP accreditation or appropriate compliance to applicable regulatory requirements) are kept by the designated subcontracting administrator [NELAC 5.4.5.4]. A list of subcontracted laboratories approved by MWH Laboratories is available in the File Maker Database.

3.11. FACILITIES

3.11.1. ACCOMODATIONS

MWH Laboratories main laboratory is located at 750 Royal Oaks Drive, Suite 100 in Monrovia, California. It has more than 20,000 square feet of analytical laboratory workspace plus almost 15,000 square feet of support space with a staff of 124. Figure 3-1 and Figure 3-2 contain the Floor Plans for the first and second floors, respectively of the Monrovia facility.

The Monrovia facility is controlled by access control locks which provide entry through plastic keycards stored with digital signatures of each employee.

Departments of the Main Laboratory include:

Asbestos
GC extractables/volatiles
GC/MS extractables/volatiles
Ion Chromatography
LC/MS/MS Extractables
Metals/Metals Prep
Microbiology
Organic extractions
Radiochemistry
Sample Disposal
Sample Receipt
Sample Storage
Shipping – sample bottle preparation
Wet Chemistry (including General Physical)

In addition to the Monrovia facility, there are three service centers that are a part of the laboratory.

- The Inland Empire/Microbiology Lab located at 1012 E. Cooley Dr., Ste P, Colton, California, 92324;
- The Southwest Center located at 15953 N. Greenway Hayden Loop, Ste. C, Scottsdale, Arizona 85260;
- The Northern California Center is located at 910 Riverside Pkwy, Ste. 30, West Sacramento, California 95605.

3.11.2. **ENVIRONMENTAL CONDITIONS**

3.11.2.1. The laboratory ensures that the laboratory environment conditions do not invalidate the results or adversely affect the required quality of any measurement.

3.11.2.2. The laboratory monitors, controls and records environmental conditions as required by the relevant specifications, methods and procedures, or where they influence the quality of the results.

3.11.2.3. Biological sterility and dust are monitored in microbiology to ensure that environmental conditions do not jeopardize the results of the environmental tests and/or calibrations. The laboratory micro walls, floors, work surfaces are non-absorbent and easy to clean and disinfect.

3.11.2.4. Incompatible areas such as Volatiles, Sample Extraction, Microbiology, culture handling or incubation areas are separated to prevent cross-contamination.

3.11.2.5. The laboratory work spaces are adequate, and appropriately clean to support environmental testing and ensure an unencumbered work area.

Figure 3-1 Floor Plan First Floor

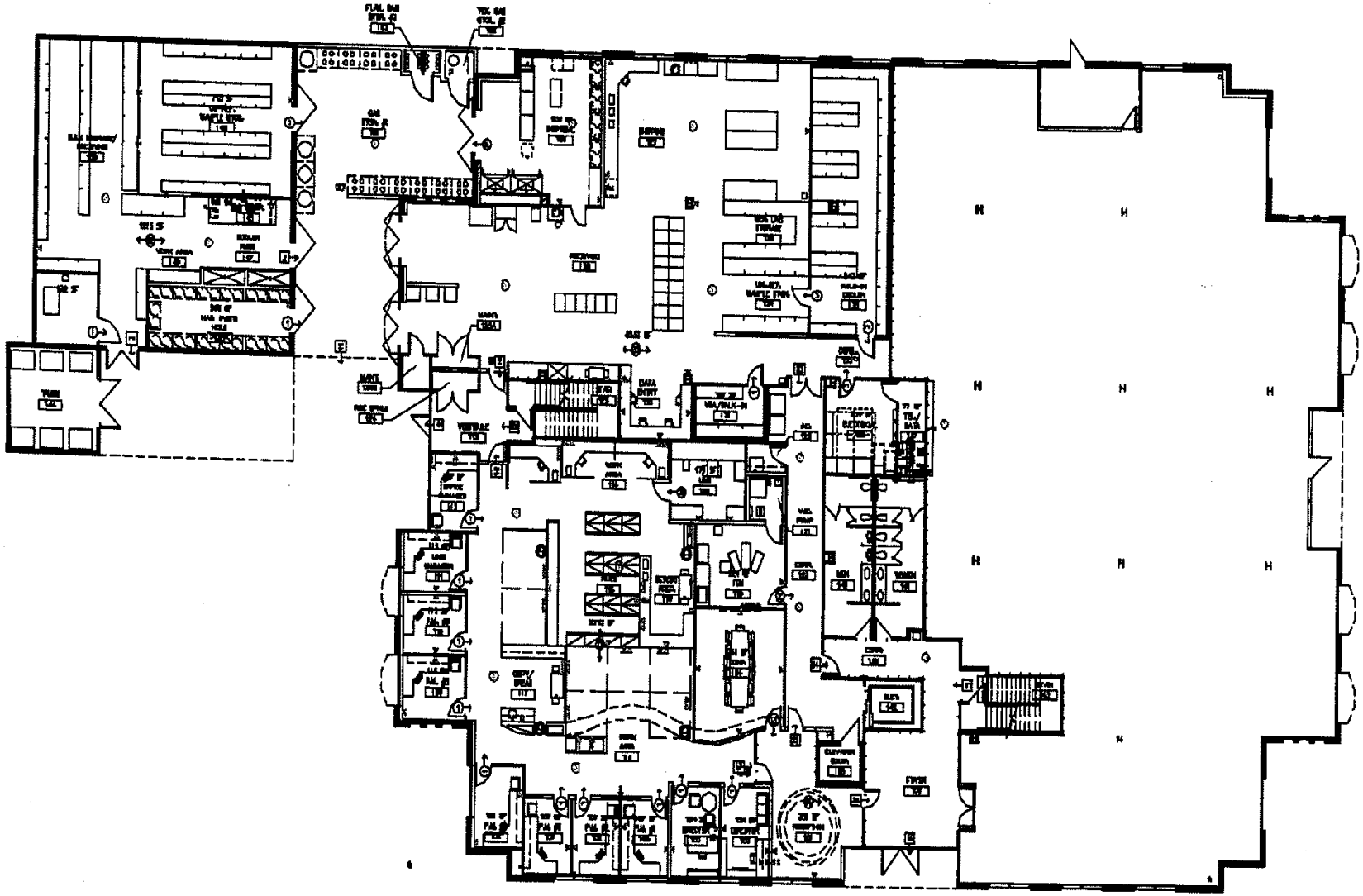
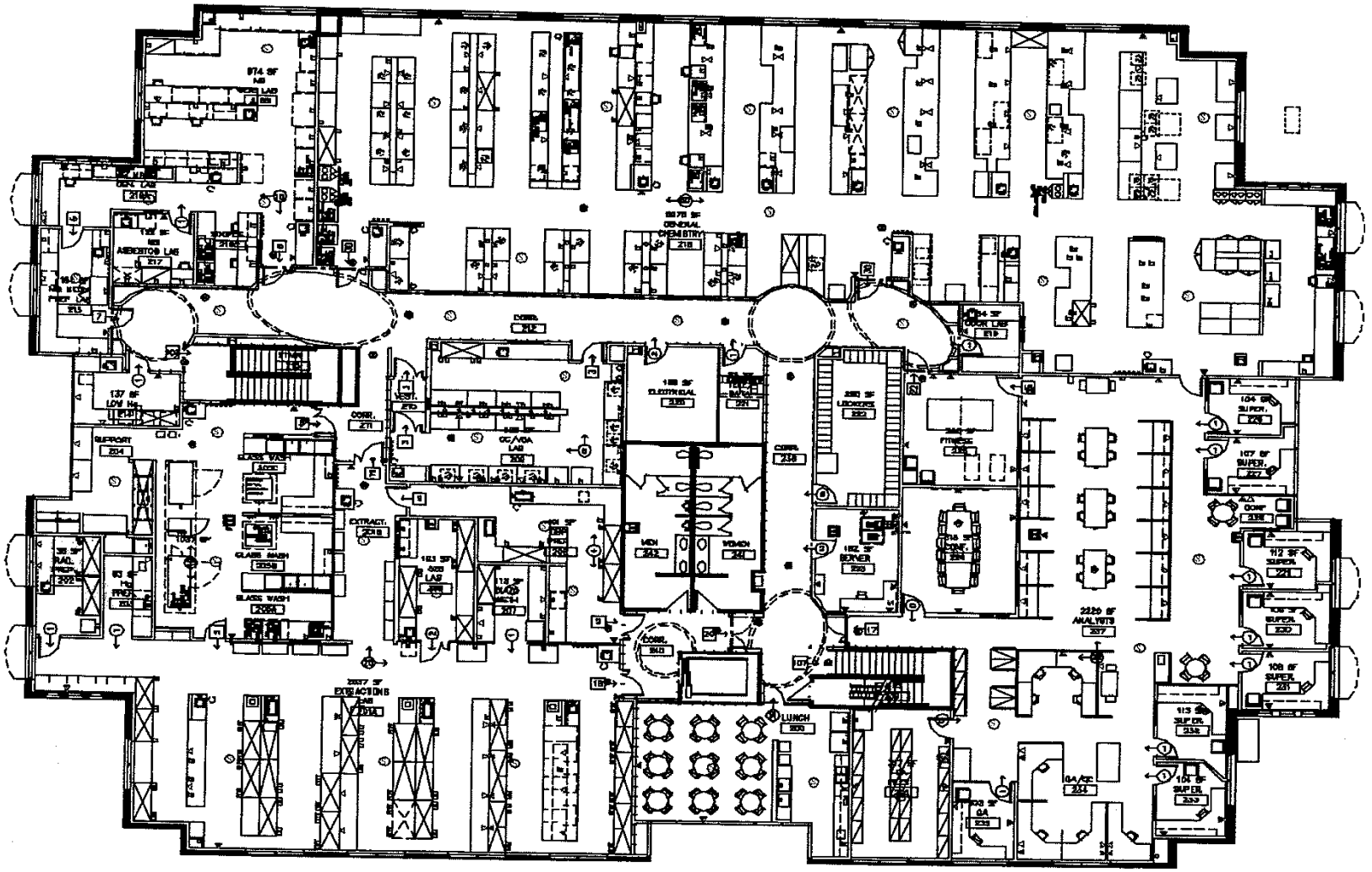


Figure 3-2 Floor Plan 2nd Floor



4.0 PROGRAM ORGANIZATION AND RESPONSIBILITY

All MWH analysts and technicians analyzing drinking water samples meet the minimum qualifications specified in the Manual for the Certification of Laboratories Analyzing Drinking Water, Criteria and Procedures, Quality Assurance, 5th Edition. The organization and chain of command for the laboratory is shown in Figure 4-3. Details of assigned positions, responsibilities and qualifications for senior management personnel are summarized below. The laboratory is organized in such a way that managerial staff has the authority and resources needed to discharge their duties. The QA Officer reports directly to the MWH Laboratory Director and has the authority to make independent technical judgment not influenced by production, marketing and financing issues. Qualified supervisors are certified as to their educational and technical background and experience, to ensure that supervision is provided by persons familiar with the calibration or test methods and procedures, the objective of the calibration or test and the assessment of the results.

4.1. MWH LABORATORIES PERSONNEL

4.1.1. Laboratory Director: Mr. Ed Wilson

Mr. Wilson has over 35 years of environmental chemistry and laboratory management experience to the laboratory. He sets laboratory policy and is responsible for overall laboratory performance and direction. In his role as Lab Director, he has ultimate responsibility for ensuring the operational efficiency and accuracy of laboratory procedures, cost analysis, overhead control, marketing, and project management. His guided management principles are based on achieving outstanding Customer Service and Technical Excellence. Under his direction and leadership, MWH Laboratories would have systems built on the most sophisticated information technology platform and would be proud to have the best technical staff in the industry.

4.1.2. Technical Director/Marketing Director: Dr. Andrew Eaton

Dr. Andrew Eaton has over 30 years of analytical experience including over 20 years of managerial experience. In his capacity as Technical Director, Dr. Eaton certifies that personnel with appropriate educational and/or technical background perform all tests for which the laboratory is accredited. Such certification for each personnel is documented in the analyst demonstration of capability (DOC) certification. The DOC certification statement was modified to include the certification for the analyst for having the appropriate educational and/or technical background. A copy of the certification statement is retained in the training files of each affected employee. Dr. Eaton is responsible for Project Management on large projects with significant technical issues, serves as a technical advisor to the laboratory staff and clients, works on special assignments such as productivity assessments and financial analyses, as well as marketing activities with clients whose projects are highly technical in nature. Dr. Eaton also serves as a member of the Joint Editorial Board for Standard Methods for the

Examination of Water and Wastewater (SM). In this capacity, he is responsible for recommending new methods for inclusion in SM and ensuring that all proposed methods include appropriate levels of QC and validation. He is a member of the TNI Advocacy Committee. Formerly on the Board of actLABS, Dr. Eaton also served as a member of The Methods and Data Comparability Board, which reports to the National Water Quality Monitoring Council.

4.1.3. Asbestos Technical Director: Carol J. Belt

Ms. Belt has over 20 years of environmental laboratory experience in MWH Laboratories conducting microbiology and asbestos analyses. Her expertise includes analysis of drinking water and wastewater samples for microbiological testing and asbestos analysis. She is responsible for training analysts in various microbiological procedures and in the analytical method for the determination of asbestos fibers in water. As the Technical Director for Asbestos analysis, Ms. Belt has the overall responsibility for the technical operation of the asbestos testing in the laboratory and currently oversees all aspects of the asbestos testing She is responsible for monitoring the performance of the entire procedure and accurate reporting of all samples received for asbestos analysis. She is also responsible to train other technicians on this methodology and to certify trained analysts as to their educational and technical background and demonstration of capability.

4.1.4. Client Services Manager: Mr. James Hein

Mr. Hein has over 20 years of environmental laboratory experience. His experience has encompassed analytical methods development for soils, sediments and water, the development of data assessment procedures for validation of analytical data, and the implementation of numerous bench scale treatment studies for the removal of various environmental pollutants. He has managed projects requiring coordination of schedule, personnel, budget and compliance to technical specifications for local, state and federal agencies as well as private sector companies. Mr. Hein is responsible for the daily supervision of 5 project managers.

4.1.5. Quality Assurance (QA) Officer/Regulatory Consulting Manager: Ms. Nilda B. Cox

Ms. Cox has over 25 years of experience in the Quality Control and Quality Assurance. She has over 15 years of environmental experience in Quality Assurance including hazardous waste management and safety compliance in the laboratory. Her experience also includes eight years as senior chemist and supervisor of QA/QC Methods Development Group, Chemistry Department and in-charge of the Industrial Hygiene Monitoring Program for a medical device company. Additional experience includes six years in Research and Development in the field of agriculture. Ms. Cox is responsible for providing QA solutions to our clients.

In addition to supporting internal QA/QC, Ms. Cox serves as a resource for numerous outside entities, providing consulting services in the area of QA/QC to assist them in the development of their own in-house QA Programs.

4.1.6. LIMS Implementation Manager: Linda Geddes

Ms. Geddes has over 27 years experience in the field of analytical chemistry related to environmental issues, including three years as the Quality Assurance Manager at another laboratory, over five years of experience in pharmaceutical chemistry, and 2 years as QA/QC Officer for MWH Labs. Her experience has encompassed analytical methods development and validation for soils, sediments and water, maintaining a quality assurance program and managing Department of Defense site assessment projects. These projects have required coordination of schedule, personnel, budget, and compliance to technical specifications for local, state, and federal agencies, as well as private sector companies. These included compliance monitoring under the Coliform Rule, the Lead and Copper Rule, Phase II and V, the Information Collection Rule (ICR), and the Unregulated Contaminant Monitoring Rule (UCMR). Prior to becoming the Quality Assurance Officer, Ms. Geddes was a Project Manager at MWH for eight years.

In the absence of the Technical Director or Lab Director, Ms. Geddes is designated as the Deputy Technical Director and Deputy Lab Director.

4.1.7. Technical Manager/LCMS Supervisor: Mr. Ali Haghani

As MWH Laboratories' Technical Manager, Mr. Haghani is responsible for method development of new methods and for asset management and currently supervising 4 analysts. Mr. Haghani was previously responsible for overseeing six supervisors and a staff of over 50 analysts performing sample preparation and analysis of environmental samples for organics and a wide range of inorganic parameters. He was also responsible for the day-to-day scheduling of analysts workloads, providing guidance and technical expertise to the analyst, and checking the validity of their work. Mr. Haghani has over 16 years of experience in the environmental monitoring business and has technical expertise in inorganic and organic analytical chemistry.

4.1.8. Extraction and GC/MS Supervisor: Mr. Charles Grady

Mr. Grady has over 20 years experience in environmental extraction, environmental wet chemistry, environmental GC and environmental GC/MS. He also has experience in hazardous waste, drinking water and waste water testing. Mr. Grady also has two years of experience as an instrument repair service technician.

As Extraction and GC/MS Supervisor for MWH, Mr. Grady is responsible for supervising 15 analysts, meeting quality control and method requirements, scheduling work, recruiting and training staff, and managing the group budget. He works closely

with Client Services, the Lab Directors and department managers to schedule incoming work and to meet QC requirements and specific client needs.

4.1.9. GC/HPLC: Mr. Martin McNally

As MWH Laboratories' GC/HPLC supervisor, Mr. McNally is responsible for day to day supervision of a staff of 14 analysts performing organic analysis by GC and HPLC (High Performance Liquid Chromatography). Mr. McNally schedules analysts' workloads to ensure that holding times are not exceeded, approves final data, and insures that all QA guidelines are met. Mr. McNally has over 18 years experience performing organic analyses.

4.1.10. Inorganic Supervisor: Mr. Walter Hsieh

As MWH Laboratories' Metals/Radiochemistry/Wet Chemistry supervisor, Mr. Hsieh is responsible for day to day supervision of a staff of 22 analysts performing inorganic analyses such as metals, radiochemistry and wet chemistry. Mr. Hsieh schedules analysts' workloads to ensure that holding times are not exceeded, approves final data, and insures that all QA guidelines are met. Mr. Hsieh has over 20 years experience performing metal and organic analyses in environmental laboratories.

4.1.11. Microbiologist Supervisor: Ms. Polly Barrowman

Ms. Barrowman has over 4 years of microbiology and biology experience. She obtained her BS in Biology and Chemistry at Western Michigan University in 2003 and her MS in Environmental Biology at University of Aberdeen, Scotland in 2005. She has been a Microbiologist at MWH Laboratories since June 2009, with experience performing water suitability, inhibitory residues, standard plate counts, and coliform analyses. Ms. Barrowman ensures that all holding times are not exceeded and that all QA guidelines are met. Ms. Barrowman is responsible for the daily supervision of a staff of 4 laboratory personnel.

4.1.12. LIMS Manager: Jerry Cooper

Mr. Cooper has over 19 years experience in analytical laboratory instrumentation, management, quality control and computer programming. This experience includes performing various analytical tests, development of computer programs for automated data reduction and direct data transfer to LIMS, supervising chemists and laboratory technicians and technical writing of standard operating procedures (SOPs) and method manuals for custom software applications. Currently he is in charge of programming and maintaining the LIMS system.

4.2. QUALITY ASSURANCE PROGRAM AND ITS MANAGEMENT

The Quality Assurance Program is dynamic and is updated frequently when changes to policy and procedures are necessary. The Quality Assurance Officer (QAO) has direct access to the highest level of management, which is the General Managing Director, where decisions are made on laboratory policy or resources [NELAC 5.4.1.5.i]. It is the responsibility of the QAO to oversee all aspects of this program and document the participation of all staff members. In order to administer and manage this program, the QAO must be knowledgeable in the NELAC Quality Systems Current Standards and their implementation. [NELAC 5.4.1.5.i, 5.4.2.5]. Attendance at the TNI/NELAC Interim and annual Conferences should be documented in the training files of the QAO.

Vital areas of the Quality Assurance Program include:

4.2.1. Preparing annual reports to management on QA related activities in the laboratory. Through the annual report, the QAO notifies the laboratory management of deficiencies in the Quality System and monitors corrective actions. This includes a periodic QA report, reports on internal and external PT samples, and verbal transmittal of QA information to the Laboratory Director and group supervisors during a weekly staff meeting. (Section 16.4)

4.2.2. **Coordinating analyses of Performance Evaluation (PE)/Proficiency Testing (PT)** (i.e. water supply study-WS, water pollution study-WP) or blind performance samples; investigating any problems associated with the results; reviewing results, problems and corrective actions with the analytical and supervisory staff; providing timely response to certification authorities with respect to any identified problem areas. (Section 16.3)

4.2.3. Implementing procedures that allow for adequate documentation and control of specific documents. These procedures use a unique identification system that allows for tracking and traceability of official copies and the time period the procedure or document was in force. To ensure that the QA Manual and SOPs remain controlled documents, the master SOPs and QA Manual (original official version of the SOP and QA Manual) and copies of the SOP and QA Manual will be identified. The cover page of each copy will contain a unique identification indicating that the document is controlled copy ___ of ____ copies, initialed and dated by the QA Officer (or designee) in red ink. This ensures that the analyst is using the current version.

4.2.3.1. The Quality Assurance Manual and Standard Operating Procedures (SOP) of MWH Laboratories are reviewed and updated if needed at least once a year. The laboratory's document control system allows for the amendment of documents by hand, pending the reissue of the documents. The changes are clearly marked, initialed and dated by the personnel that performed the original review. The revised document formerly reissued as soon as practicable (NELAC 5.4.3.3.3 & 5.4.3.3.1). All appropriate laboratory personnel signs the QA Plan Signature Page / SOP Training Documentation Form after the annual review of the QA Plan / SOPs. See

4.2.3.2. Figure 4-1 QA Signature Page for a copy of the QA Plan Signature Page. See Figure 4-2 SOP/Method Training Documentation for a copy of the SOP Training Documentation Form. See Table 4-1 for list of SOPs.

4.2.3.3. A SOP/ QA Manual Distribution Form is prepared for each SOP/ QAM that includes the SOP/QAM ID, control number, individual receiving the SOP/QA Manual, date of issue and the date of completion of the analyst's SOP/QAM training documentation.

4.2.4. Documenting participation and performance of the laboratory staff in initial and continuing training courses.

4.2.5. Overseeing and maintaining the training program files for each analyst at MWH Laboratories.

4.2.6. Providing guidelines for the QA orientation program to newly hired personnel and ensuring that they are familiar with the quality assurance program operating within the laboratory.

4.2.7. Interacting with auditors and certifying authorities for in-state programs, out-of-state programs, and internally to the laboratory. (16.2)

4.2.8. Serving as focal point for initiation, implementation, review and dissemination of QA/QC Guidelines to ensure that data quality meets the objectives of certifying authorities and maintaining documentation of those guidelines.

4.2.9. Maintaining copies of procedural write-ups and QA documentation files, and ensuring that all personnel working in the laboratory follow established standard operating procedures that do not compromise the quality of data submitted to clients or violate rules and guidelines from certifying agencies.

4.2.10. Ensuring that analysts are monitoring long-term quality control trends with quality control charts and insuring that corrective action is initiated whenever an out of control event occurs.

4.2.11. Ensuring that sample log-in and traceability are done correctly and that the chain of custody forms and other relevant documentation are properly maintained by periodic spot checks of the records.

4.2.12. Implementing a record management/archival system for control of laboratory notebooks; instrument logbooks; standard logbooks; records for data reduction, validation, storage, and reporting; training records for personnel no longer with the laboratory; outdated manuals and SOPs; and the eventual removal of outdated documentation. Archived information is stored physically or electronically in-house for 3 months and then physical files are transferred off-site, for storage for 2 years for Arizona or 3 years for Wisconsin. Electronically scanned files are stored for 5 years as per NEAP, and

additional 5 years as per Hawaii DOH. All hard copies and electronic files for Asbestos test method is stored for 30 years.

4.2.13. Maintain a log of names, initials and signatures for all individuals responsible for signing or initialing any laboratory records is maintained by the QA group.

4.2.14. Writing or reviewing project specific QA plans.

4.2.15. Providing the staff with quality assurance information and updates.

4.2.16. Ensuring that all laboratory procedures currently in use are acceptable and will not compromise quality.

4.2.17. Where QA oversight is needed, the QAO (or designee) functions independently from the laboratory operations. The QAO evaluates data objectively and performs assessments without managerial influence. The QAO may enlist the aid of various supervisors of the analytical groups in order to achieve these objectives. The QAO and/or a designee should perform periodic audits of laboratory data or procedures to insure that QA objectives are being met. The QA Officer or designee must have a general knowledge of the analytical test methods for which the data review is performed and will arrange for or conduct annual internal audits per NELAC 5.4.1.5.i.5 and 5.4.1.5.i.6.

4.2.17.1. Maintaining current certifications, licenses and accreditation materials.

4.2.17.1.1. MWH Laboratories participates in laboratory certification programs with California, and other states and territories, for a total of 44 separate programs. MWH Laboratories holds primary accreditation under California NELAP (01114 CA) and ELAP Program (Certificate No. 1422).

4.2.17.1.2. A copy of MWH Laboratories NELAP Accreditation plus NELAP fields of accreditation (Fig. 4-1, Table 14-1) and a copy of the CA ELAP plus Fields of Testing are attached (Figures 14-2 and 14-3).

4.2.17.1.3. Arizona Dept of Health Services requires that a copy of MWH Labs AZ certification and License (AZ0455) be attached in the Lab QAM. See the AZ License and list of license parameters in Appendix I.

4.3. STAFF RESPONSIBILITY

A comprehensive Quality Assurance Program requires the involvement of all laboratory personnel. The level of involvement for each staff member is dependent upon his or her assignment within the laboratory. Laboratory analysts are responsible for quality control parameters that are done at the time of analysis. Laboratory management is responsible for monitoring and evaluating the results of the quality control procedures performed by the analysts.

The minimum level for qualifications, experience, and skills necessary for each position varies by job position. A list for each position is available in QA for review. The laboratory follows minimum requirements as per the EPA Drinking Water Manual and NELAC Standards.

4.3.1. Initial Training

4.3.1.1. The objective for data generated by MWH Laboratories is that the quality and consistency of the data produced be independent of the analyst performing the analysis. This can only occur when all analyses are performed using SOPs, and the analyst performing the procedure has been properly trained and has demonstrated proficiency with the analysis. This is accomplished at MWH Laboratories by having a training checklist for each group or set of analyses within a group.

4.3.1.2. This checklist is followed for each trainee analyst by the group supervisor with the help of an assigned analyst mentor. The trainee is issued a set of training materials (i.e. safety information, SOP, Ethics SOP, method reference etc.) and is given hands-on training under the direct supervision of the mentor analyst or supervisor. Progress is monitored closely for the first three to six months by using frequent performance reviews, quality control check samples, performance audits and bench sheet reviews.

4.3.1.3. IDC Certification serves as a record of Authorization and Competence [NELAC 5.5.2.5]. All Analysts, including contracted personnel when hired, are required to undergo the same training (IDC, MDL Studies, ability to achieve a low background, the precision and accuracy required by the method and satisfactory performance on a PT sample), and IDC Certificate of Competence [NELAC 5.5.2]. A copy is filed in the analyst training record. Demonstration of Capability will also be done for analysts working as a unit. Examples are extraction analysts preparing the IDC and MDL samples and the prepared sample analyzed by the appropriate GC, GCMS, or HPLC analysts. IDC certification is completed for the group of analysts.

4.3.2. On-going Training/Annual Competency Check

The laboratory performs an annual competency check for each analyst to ensure that each technical employee demonstrates an initial and ongoing proficiency for the tests performed by the technical employee.

On-going proficiency checks are conducted to ensure that the training of personnel is kept up-to-date by the following:

4.3.2.1. A certification that the technical personnel have read, understood and agreed to perform the most recent version of the test method (the approved method or standard operating procedure) and documentation of continued proficiency by at least one of the following once per year:

4.3.2.1.1. Acceptable performance of a blind sample (single blind to the analyst).

4.3.2.1.2. Another initial demonstration of method performance

4.3.2.1.3. Successful analysis of a blind performance sample on a similar test method using the same technology (e.g., GC/MS Volatiles by purge and trap for 524.2, 624 or 5030B/8260) would only require documentation for one of the test methods. The laboratory must determine the acceptable limits of the blind performance sample prior to analysis (NELAC 5.5.2.6.c.3.i.) The laboratory uses the Provider acceptable NELAC limits of any blind PT sample that is used to document the annual proficiency documentation for each analyst (NELAC 5.5.2.6.c.3.iii.)

4.3.2.1.4. At least four consecutive laboratory control samples with acceptable levels of precision and accuracy as per method specified precision and accuracy limits.

4.3.2.1.5. If the previous item cannot be performed, because spiking is not an option or QC samples not available, analysis of authentic samples that have been analyzed by another trained analyst with statistically identical results or analysis of Proficiency Test samples obtained from NIST approved providers can be done.

4.3.2.1.6. For specialized situations where extraction analysts have to do the sample preparation for LCS and MDL samples and the analyses of the prepared samples are done by the analysts belonging to another group, such as GC or GCMS areas, the group as a unit completes a Demonstration of Capability.

4.3.2.2. Evidence on file that demonstrates that each employee has read, understood, and is using the latest version of the laboratory's in-house SOP documentation and all other documentation, which relates to his/her job responsibilities.

4.3.2.3. Training courses or workshops on specific equipment, analytical techniques or laboratory procedures shall all be documented.

4.3.3. **Training Records**

A training file for each analyst and method is kept in the QA department along with a training history form completed at the inception of the present training program or at the time of employment. Each analyst's training file includes; a resume indicating the analyst's qualifications, experience, transcript of records, job description, and an initial demonstration of capability (IDC) and continuing demonstration of proficiency for each analyst. Up-to-date training records of courses in ethical and legal responsibilities, including potential punishments and penalties for violations, are kept in the QA department.

Figure 4-1 QA Signature Page

This is to certify that I have read and understood MWH Laboratories' Quality Assurance Plan.

I further certify that I will comply with the laboratory procedures and practices described in the manual for the generation of high quality data.

If you know any deviations in the laboratory practices, please notify your supervisor or QA Manager to evaluate if the said deviation adheres to good laboratory practices and affects data quality.

If you find errors in any section applicable to you, please notify your supervisor or QA Manager to correct them appropriately. The Quality Assurance Manual will be revised annually to reflect current laboratory practices.

Signature: _____ Date: _____

Name (print): _____ Date: _____

QAM - Rev. #: 31 Date: _____

Figure 4-2 SOP/Method Training Documentation Form

SOP/METHOD TRAINING DOCUMENTATION

I certify that I have read, understood and agreed to perform the techniques and procedures, including those of the equipments, stated in the most recent version of the approved test method and the laboratory standard operating procedure.

SOP Title: _____

SOP ID: _____

SOP Revision No.: _____

Date Revised: _____

Date Issued: _____

EPA/SM Method No.: _____

Revision No.: _____

Date Revised: _____

Analyst(s) / Supervisor	Print:	Signature:
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____

Training Dates: Start: _____ Complete: _____ Duration: _____

Trainer/Instructor Signature: _____ Date: _____

Title (MWH Labs): _____

Supervisor Signature: _____ Date: _____

Table 4-1 List of SOPs

SOP No.	Analytes	Method
Micro 01	Determination of Asbestos Fibers in Water	EPA 100.2
Micro 02	Assimilable Organic Carbon Bioassay	SM 9217 B
Micro 05	Determination of Coliform in drinking water by the ONPG-MUG Method (Colilert)	SM 9223 B
Micro 06	Determination of Coliform in water, wastewater and soil by Multiple Tube Fermentation Technique	SM 9221
Micro 09	Determination of Fecal Streptococci and Enterococci in water, wastewater and soil	SM 9230
Micro 11	Heterotrophic Plate Count	SM 9215 A, B
Micro 13	Microscopic Particulate Analysis	EPA 910/9-92-029
Micro 16	Determination of Coliforms in Water by the CPRG-MUG Method / Colisure	SM 9223
Micro 17	Determination of Escherichia Coli in water and waste water by Multiple Tube Fermentation Technique	SM 9221 F
Micro 19	Water Suitability Test	SM 9020B
Micro 20	Inhibitory Residues	SM 9020B
Micro 21	Microbiology Demonstration of Capability	N/A
Micro 23	Male-specific (F+) and somatic coliphage in water by single agar layer (SAL) Procedure	EPA 1602 April 2000 Draft
Micro 24	pH Check of Clean Glassware Using Bromthymol Blue	SM 9020B
Micro 26	Determination of Coliforms in Drinking Water by the 18-hr on PG-MUG Method	SM 9223B
Rad 02	Radon by Liquid Scintillation Counter	SM 7500-Rn
Rad 06	Gross alpha and beta Radioactivity	EPA 900.0
Rad 07	Radium 228	EPA 904
Met 01	Analysis of Trace Elements by ICP Emission Spectroscopy	ICP, EPA 200.7/6010
Met 02	Trace Metals by ICP/MS	ICP/MS, EPA 200.8/6020
Met 04a	Mercury by Cold Vapor Atomic Absorption	SW846 Method 7470A, EPA 245.1
Met 19	Hexavalent Chromium, Colorimetric Method	EPA 7196 A / SM 3500
Met 26	Silica by the Molybdosilicate Method	SM 4500-SiO2C
Met 27	Hardness by Calculation	SM 240B
Met 28	pH / Turbidity Check for Metals	pH paper/180.1
Met 30	Heated Block Metals Digestion	EPA 200.7/200.8
HPLC 02	Glyphosate Analysis in Drinking Water by High Performance Liquid Chromatography	EPA 547
HPLC 03	Diquat /Paraquat Analysis in Drinking Water by HPLC	EPA549.2
HPLC 05	Carbamates Analysis in Drinking Water by HPLC with post column derivatization	EPA 531.2

SOP No.	Analytes	Method
HPLC 06	Determination of Phenylurea Compounds in Drinking water by Solid Phase Extraction and HPLC with UV Detection	EPA 532
HPLC 07	Determination of Perchlorate in Drinking Water by Liquid Chromatography Electrospray Ionization Mass/Mass Spectrometry	EPA 331
HPLC 08	The analysis of MCPA, MCPB and MCPP in Drinking Water by HPLC	EPA 555
HPLC 09	Measurement of Chloroacetanilide and other Acetamide Herbicide Degradates in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS)	EPA 535
HPLC 10	Determination of Acrylamide in Drinking Water by Liquid Chromatography Electrospray Ionization/Mass Spectrometry	Acrylamide
HPLC 11	Determination of Emerging Organic Pollutants in Environmental Matrices by Liquid Chromatography Mass Spec in Tandem Analysis	EDC 2
HPLC 12	Determination of Perfluorinated Pollutants in Environmental Matrices by Online SPE coupled with HPLC/MS in Tandem	PFC
GC 03	EDB, DBCP and 1,2,3-TCP	EPA 504.1
GC 08	Chlorination Disinfection Byproducts and Chlorinated Organic Solvents	EPA 551.1
GC 09	Haloacetic Acids	SM 6251 B
GC 16	1,2,-Dibromoethane & 1,2-Dibromo-3-Chloropropane by Microextraction & Gas Chromatography	EPA 8011
GC 27	Free and Total Chlorine Analysis	SM 4500-Cl-G
GC 29	Formation of Trihalomethanes and other disinfection by-products. Modified Standard Method 5710 B	SM 5710 B
GC 30	Aldehydes	SM 6252
GC 33	Chlorine Dioxide Analysis	SM 4500-CLO2-D
GC 34	Chlorinated Pesticides and PCBs	EPA 505
GC 35	Chlorinated Acids in Drinking Water	EPA 515.4
GC 36	Chlorine Demand	SM 2350B
Extract 3	Liquid - Solid Extraction	EPA 525.2
Extract 4	Liquid-Solid Extraction Method for Endothall Analysis	EPA 548.1
Extract 5	Liquid-Solid Extraction of Diquat and Paraquat	EPA 549.2
Extract 10	NDMA Continuous Liquid - Liquid Extraction	Modified EPA 625/ 1625, 3520/ 8270 C

SOP No.	Analytes	Method
Extract 11	Extraction BNA Continuous Liquid-Liquid Extraction	SM 8270 C
Extract 16	Solid Phase Extraction of Phenols in Drinking Water	EPA 528
Extract 17	Solid Phase Extraction of Explosives in Drinking Water	EPA 529
Extract 18	Solid Phase Extraction of Selected Pesticides and Flame Retardants in Drinking Water	EPA 527
Extract 19	Determination of Nitrosamines in Drinking Water by SPE	EPA 521
Extract 20	Measurement of Chloroacetanilide and Other Acetamide Herbicide Degradates in Drinking Water by Solid Phase Extraction	EPA 535
Extract 21	Determination of MCPA, MCPB and MCPP in Drinking Water by SPE	EPA 555
Extract 22	Liquid-Solid Extraction	EPA 526
Extract 23	Determination of Phenylurea Compounds in Drinking Water by SPE	EPA 532
Extract 24	EDC4 by Continuous Liquid-Liquid Extraction	EDC4
Extract 25	Determination of Nitrosamines in Drinking Water by Liquid-Liquid Extraction	EPA 521
GCMS 01	Volatile Organic Compounds in Drinking Water by GC/MS	EPA 524.2 (Modified)
GCMS 01a	Determination of 1,2,3 Trichloropropane (TCP) in Drinking Water by Purge and Trap GC/MS in SIM Mode	EPA 524.2 (Modified)
GCMS 01b	Determination of tert-Butanol, Epichlorohydrin, 1,2-Dichloropropane, 1,2,3-TCP and Cyanogen Chloride in DW by purge and trap GC/MS in SIM mode	EPA 524.2 (Modified)
GCMS 02	Determination of Semivolatile Organic Compounds in Drinking Water by Gas Chromatography/Mass Spectrometry	EPA 525.2
GCMS 03	Endothall Analysis by Liquid-Solid Extraction and GCMS	EPA 548.1
GCMS 04	Volatile Organic Compounds in Aqueous Matrix by GC/MS	EPA 624 (Modified)
GCMS 05	Analysis of Semivolatile Organic Compounds by GCMS	EPA 625
GCMS 07	Volatile Organic Compounds in Water by GC/MS	EPA 8260 B
GCMS 08	Analysis of Semivolatile Organic Compounds by GCMS	EPA 8270 C
GCMS 14	NDMA by GCMS	EPA 1625
GCMS 15	Determination of Selected Semivolatile Organic Compounds in Drinking Water by Solid Phase Extractions and Capillary Column GCMS	EPA 526
GCMS 16	Determination of Phenols in Drinking Water by Solid Phase Extraction and Capillary Column GCMS	EPA 528
GCMS 17	Solid Phase Micro-Extraction and GCMS	SM 6040D
GCMS 20	Determination of Nitrosamines in Drinking Water by Capillary Column GC with Large Volume Injection and Chemical Ionization Tandem Mass Spectrometry	EPA 521
GCMS 21	Determination of Explosives and Related Compounds in Drinking Water by Solid Phase Extractions and Capillary Column GCMS	EPA 529

SOP No.	Analytes	Method
GCMS 22	Determination of Endocrine Disruptor Chemicals in Wastewater by GCMS Method 4	EDC 4
GCMS 23	Determination of Selected Pesticides and Flame Retardants in Drinking Water by Solid Phase Extraction and Capillary Column Gas Chromatography/Mass Spectrometry (GC/MS)	EPA 527
Wet Chem 01	Cyanide Analysis by Ion Selective Electrode (ISE)	SM 4500-CN F
Wet Chem 02	Fluoride by Ion Selective Electrode	SM 4500-F C
Wet Chem 03	Alkalinity	SM 2320B
Wet Chem 04	Total Dissolved Solids (TDS) in water	SM 2540 C
Wet Chem 05	Total Suspended Solids (TSS) in water	SM 2540D
Wet Chem 06	Turbidity – Nephelometric	EPA 180.1
Wet Chem 07	Total Solids (TS) in Aqueous Sample	SM 2540B
Wet Chem 09	Settleable Solids	SM 2540 F
Wet Chem 11	Color	SM 2120 B
Wet Chem 12	Conductivity (EC)	SM 2510B/ EPA 120.1
Wet Chem 13	Cyanide (Reflux-Distillation) Midi Distillation	EPA 335.4
Wet Chem 14	Orthophosphate, Total, Suspended and Dissolved	SM 4500-P F/Hach 8048
Wet Chem 15	Odor	SM 2150
Wet Chem 16	Determination of Perchlorate in Drinking water using Ion Chromatography	EPA 314.0/ CADHS 300.0 Modified
Wet Chem 17	Biochemical Oxygen Demand	SM 5210B / EPA 405.1
Wet Chem 19	Phenolics	EPA 420.1 / 420.4
Wet Chem 21	Determination of Nitrate / Nitrite by Flow Injection Analysis	EPA 353.2
Wet Chem 22	Nitrogen, Kjeldahl, Total (Colorimetric, Semi-Automated Digester)	EPA 351.2
Wet Chem 25	Determination of Anions by Ion Chromatography	EPA 300.0 A, B 300.1 B
Wet Chem 26	Total Volatile Solids/Volatile Suspended Solids in Liquid	EPA 160.4
Wet Chem 27	Ammonia as Nitrogen by Rapid Flow Analyzer (RFA)	EPA 350.1/ SM 4500-NH3 G

SOP No.	Analytes	Method
Wet Chem 28	pH Value	SM 4500-H/ EPA 9040
Wet Chem 31	Surfactants, Anionic (MBAS)	SM 5540 C
Wet Chem 32	Total Organic Carbon and Dissolved Organic Carbon by UV/ Persulfate Oxidation	SM 5310 C
Wet Chem 34	Analytical method for Ultraviolet Absorption of Organic constituents at 254 nm	SM 5910B
Wet Chem 35	Sulfide Determination (Methylene Blue)	SM 4500-S2-
Wet Chem 36	Chemical Oxygen Demand (COD)	EPA 410.4 SM 5220 D
Wet Chem 37	Determination of Total Cyanide by Semi-Automated Colorimetry	EPA 335.4
Wet Chem 38	Determination of Total Phosphate by Flow Injection Analysis Colorimetry	EPA 365.1/SM 4500 PF
Wet Chem 39	Langelier Index by Calculation	SM 2330 B
Wet Chem 40	Determination of Inorganic Oxyhalide Disinfection By-Products in drinking water using Ion Chromatography with the addition of a post column reagent for Trace Bromate Analysis.	EPA 300.0B/300.1B/EPA 317.1 PCR
Wet Chem 42	Dissolved Organic Halogen: Adsorption-Pyrolysis-Titrimetric Method	SM 5320 B
Wet Chem 43	Dissolved Oxygen, Membrane Electrode	SM 4500 OG
Wet Chem 48	Determination of Low Level Perchlorate in Drinking Water using Ion Chromatography	EPA 314.0
Wet Chem 49	Determination of Dissolved Hexavalent Chromium in Drinking Water, Ground Water, and Industrial Wastewater effluents by IC	EPA 218.6
Wet Chem 50	Orthophosphate, Total, Suspended and Dissolved	EPA 365.1
Wet Chem 51	Orthophosphate, Total, Suspended and Dissolved	EPA 365.1
Wet Chem 52	Cyanide (Reflux – Distillation) Micro Distillation	EPA 335.4
Wet Chem 53	A Simplified and Rapid Method for Biodegradable Dissolved Organic Carbon Measurement (BDOC)	N/A
Non Method 01	Sample Receiving and Log In	N/A
Non Method 02	Chain of Custody	N/A
Non Method 03	Preparation and Shipment of Sample Kits	N/A
Non Method 04	Hazardous Waste Management and Sample Disposal Procedures	N/A

SOP No.	Analytes	Method
Non Method 05	Laboratory Ethics/Data Integrity	N/A
Non Method 06	Environmental Monitoring for Microbiological Contaminants	N/A
Non Method 07	Standards and Reagent Preparation, Documentation, and Labeling	N/A
Non Method 08	Compositing and Subsampling in the Laboratory	N/A
Non Method 10	Implementation of Good Automated Laboratory Practices (GALP)	N/A
Non Method 11	Balance Maintenance	N/A
Non Method 12	Manual Integration	N/A
Non Method 13	Retention of Significant figures	N/A
Non Method 14	Instrument Maintenance	N/A
Non Method 15	Use of Class A glassware	N/A
Non Method 16	Glassware Cleaning	N/A
Non Method 18	Data Entry & Data Transfer	N/A
Non Method 19	Temperature Monitoring and Thermometer Calibration	N/A
Non Method 20	Handling and Disposal of Foreign Soil Samples	N/A
Non Method 21	Electronic Quality Investigation Report	N/A
Non Method 22	States Certification & Performance Tests Requirements	N/A

Table 4-2 Other Certifications

#	AGENCY	LAB ID	EXPIRATION DATE
1	LACSD	10249	-------
2	Radioactive Material License	3069-19	March 15, 2009
3	Soil Permit	S-65114	March 31, 2009
4	CUPA Consolidate Permit/License to Operate	AR0036980	June 30, 2009
5	Drug Enforcement Administration (DEA)	RM0322696	January 31, 2010

The most current licenses are available in the QA Department for review.

Figure 4-3 State of California Certification

NELAP - RECOGNIZED

CALIFORNIA STATE

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM BRANCH

CERTIFICATE OF NELAP ACCREDITATION

Is hereby granted to

MWH LABORATORIES, a division of MWH Americas, Inc.

750 ROYAL OAKS DRIVE, SUITE 100

MONROVIA, CA 91016

Scope of the Certificate is limited to the
"NELAP Fields of Accreditation"
which accompany this Certificate.

Continued accredited status depends on successful
ongoing participation in the program.

This Certificate is granted in accordance with provisions of
Section 100825, et seq. of the Health and Safety Code.

Certificate No.: **01114CA**

Expiration Date: **01/31/2010**

Effective Date: **01/31/2009**

Richmond, California
subject to forfeiture or revocation

George C. Kulasingam, Ph.D., Chief
Environmental Laboratory Accreditation Program Branch

Figure 4-4 List of California Certified Analytes

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM - NELAP RECOGNIZED
NELAP Fields of Accreditation

MWH LABORATORIES, a division of MWH Americas, Inc. **Lab Phone** (626) 386-1100

750 ROYAL OAKS DRIVE, SUITE 100
MONROVIA, CA 91016

Certificate No: 01114CA Renew Date: 1/31/2010

101 - Microbiology of Drinking Water

101.010	001	SM9215B	Heterotrophic Bacteria
101.020	001	SM9221A,B	Total Coliform
101.021	001	SM9221E (MTF/EC)	Fecal Coliform
101.022	001	CFR 141.21(f)(6)(i) (MTF/EC+MUG)	E. coli
101.060	002	SM9223	Total Coliform
101.060	003	SM9223	E. coli
101.070	002	Colisure	Total Coliform
101.070	003	Colisure	E. coli
101.120	001	SM9221A,B,C	Total Coliform (Enumeration)
101.130	001	SM9221E (MTF/EC)	Fecal Coliform (Enumeration)

102 - Inorganic Chemistry of Drinking Water

102.020	001	EPA 180.1	Turbidity
102.030	001	EPA 300.0	Bromide
102.030	002	EPA 300.0	Chlorate
102.030	003	EPA 300.0	Chloride
102.030	004	EPA 300.0	Chlorite
102.030	006	EPA 300.0	Nitrate
102.030	007	EPA 300.0	Nitrite
102.030	010	EPA 300.0	Sulfate
102.040	001	EPA 300.1	Bromide
102.040	002	EPA 300.1	Chlorite
102.040	003	EPA 300.1	Chlorate
102.040	004	EPA 300.1	Bromate
102.045	001	EPA 314.0	Perchlorate
102.047	001	EPA 331.0	Perchlorate
102.050	001	EPA 335.4	Cyanide
102.060	001	EPA 353.2	Nitrate calc.
102.061	001	EPA 353.2	Nitrite
102.070	001	EPA 365.1	Phosphate, Ortho
102.100	001	SM2320B	Alkalinity
102.110	001	SM2330B	Corrosivity (Langlier Index)
102.120	001	SM2340B	Hardness
102.130	001	SM2510B	Conductivity

As of 1/20/2009 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 01114CA
Renew Date: 1/31/2010

102.140	001	SM2540C	Total Dissolved Solids
102.163	001	SM4500-Cl G	Chlorine, Free and Total
102.180	001	SM4500-ClO2 D	Chlorine Dioxide
102.191	001	SM4500-CN F	Cyanide, Total
102.192	001	SM4500-CN G	Cyanide, amenable
102.200	001	SM4500-F C	Fluoride
102.210	001	SM4500-H+ B	pH
102.212	001	EPA 150.1	pH
102.240	001	SM4500-P E	Phosphate, Ortho
102.262	001	SM5310C	Total Organic Carbon
102.263	001	SM5310C	DOC
102.263	002	SM5310C	TOC/DOC
102.267	001	SM5310C-OO	TOC/DOC
102.270	001	SM5540C	Surfactants
102.280	001	SM5910B	UV254
102.520	001	EPA 200.7	Calcium
102.520	002	EPA 200.7	Magnesium
102.520	003	EPA 200.7	Potassium
102.520	004	EPA 200.7	Silica
102.520	005	EPA 200.7	Sodium
102.520	006	EPA 200.7	Hardness (calc.)
102.542	001	SM4500-SiO2 C (20th)	Silica
102.545	001	EPA 317.0	Bromate
102.545	003	EPA 317.0	Chlorite
102.551	001	SM4500-Cl G (20th)	Chlorine, Free, Combined, Total
102.558	001	SM4500-Cl G-OO	Chlorine, Free, Combined, Total

103 - Toxic Chemical Elements of Drinking Water

103.130	001	EPA 200.7	Aluminum
103.130	003	EPA 200.7	Barium
103.130	004	EPA 200.7	Beryllium
103.130	005	EPA 200.7	Cadmium
103.130	007	EPA 200.7	Chromium
103.130	008	EPA 200.7	Copper
103.130	009	EPA 200.7	Iron
103.130	011	EPA 200.7	Manganese
103.130	012	EPA 200.7	Nickel
103.130	015	EPA 200.7	Silver
103.130	017	EPA 200.7	Zinc
103.140	001	EPA 200.8	Aluminum
103.140	002	EPA 200.8	Antimony
103.140	003	EPA 200.8	Arsenic

As of 1/20/2009 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 01114CA
Renew Date: 1/31/2010

103.140	004	EPA 200.8	Barium
103.140	005	EPA 200.8	Beryllium
103.140	006	EPA 200.8	Cadmium
103.140	007	EPA 200.8	Chromium
103.140	008	EPA 200.8	Copper
103.140	009	EPA 200.8	Lead
103.140	010	EPA 200.8	Manganese
103.140	012	EPA 200.8	Nickel
103.140	013	EPA 200.8	Selenium
103.140	014	EPA 200.8	Silver
103.140	015	EPA 200.8	Thallium
103.140	016	EPA 200.8	Zinc
103.160	001	EPA 245.1	Mercury
103.301	001	EPA 100.2	Asbestos

104 - Volatile Organic Chemistry of Drinking Water

104.030	001	EPA 504.1	1,2-Dibromoethane
104.030	002	EPA 504.1	1,2-Dibromo-3-chloropropane
104.030	003	EPA 504.1	1,2,3-Trichloropropane
104.040	001	EPA 524.2	Benzene
104.040	002	EPA 524.2	Bromobenzene
104.040	003	EPA 524.2	Bromochloromethane
104.040	006	EPA 524.2	Bromomethane
104.040	007	EPA 524.2	n-Butylbenzene
104.040	008	EPA 524.2	sec-Butylbenzene
104.040	009	EPA 524.2	tert-Butylbenzene
104.040	010	EPA 524.2	Carbon Tetrachloride
104.040	011	EPA 524.2	Chlorobenzene
104.040	012	EPA 524.2	Chloroethane
104.040	014	EPA 524.2	Chloromethane
104.040	015	EPA 524.2	2-Chlorotoluene
104.040	016	EPA 524.2	4-Chlorotoluene
104.040	018	EPA 524.2	Dibromomethane
104.040	019	EPA 524.2	1,3-Dichlorobenzene
104.040	020	EPA 524.2	1,2-Dichlorobenzene
104.040	021	EPA 524.2	1,4-Dichlorobenzene
104.040	022	EPA 524.2	Dichlorodifluoromethane
104.040	023	EPA 524.2	1,1-Dichloroethane
104.040	024	EPA 524.2	1,2-Dichloroethane
104.040	025	EPA 524.2	1,1-Dichloroethene
104.040	026	EPA 524.2	cis-1,2-Dichloroethene
104.040	027	EPA 524.2	trans-1,2-Dichloroethene

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 01114CA
Renew Date: 1/31/2010

104.040	028	EPA 524.2	Dichloromethane
104.040	029	EPA 524.2	1,2-Dichloropropane
104.040	030	EPA 524.2	1,3-Dichloropropane
104.040	031	EPA 524.2	2,2-Dichloropropane
104.040	032	EPA 524.2	1,1-Dichloropropene
104.040	033	EPA 524.2	cis-1,3-Dichloropropene
104.040	034	EPA 524.2	trans-1,3-Dichloropropene
104.040	035	EPA 524.2	Ethylbenzene
104.040	036	EPA 524.2	Hexachlorobutadiene
104.040	037	EPA 524.2	Isopropylbenzene
104.040	038	EPA 524.2	4-Isopropyltoluene
104.040	039	EPA 524.2	Naphthalene
104.040	040	EPA 524.2	Nitrobenzene
104.040	041	EPA 524.2	N-propylbenzene
104.040	042	EPA 524.2	Styrene
104.040	043	EPA 524.2	1,1,1,2-Tetrachloroethane
104.040	044	EPA 524.2	1,1,2,2-Tetrachloroethane
104.040	045	EPA 524.2	Tetrachloroethene
104.040	046	EPA 524.2	Toluene
104.040	047	EPA 524.2	1,2,3-Trichlorobenzene
104.040	048	EPA 524.2	1,2,4-Trichlorobenzene
104.040	049	EPA 524.2	1,1,1-Trichloroethane
104.040	050	EPA 524.2	1,1,2-Trichloroethane
104.040	051	EPA 524.2	Trichloroethene
104.040	052	EPA 524.2	Trichlorofluoromethane
104.040	053	EPA 524.2	1,2,3-Trichloropropane
104.040	054	EPA 524.2	1,2,4-Trimethylbenzene
104.040	055	EPA 524.2	1,3,5-Trimethylbenzene
104.040	056	EPA 524.2	Vinyl Chloride
104.040	057	EPA 524.2	Xylenes, Total
104.040	058	EPA 524.2	Hexachloroethane
104.045	001	EPA 524.2	Bromodichloromethane
104.045	002	EPA 524.2	Bromoform
104.045	003	EPA 524.2	Chloroform
104.045	004	EPA 524.2	Dibromochloromethane
104.045	005	EPA 524.2	Trihalomethanes
104.050	002	EPA 524.2	Methyl tert-butyl Ether (MTBE)
104.050	004	EPA 524.2	tert-Amyl Methyl Ether (TAME)
104.050	005	EPA 524.2	Ethyl tert-butyl Ether (ETBE)
104.050	006	EPA 524.2	Trichlorotrifluoroethane
104.050	011	EPA 524.2	Oxygenates

As of 1/20/2009 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 01114CA
Renew Date: 1/31/2010

105 - Semi-volatile Organic Chemistry of Drinking Water

105.010	001	EPA 505	Aldrin
105.010	002	EPA 505	Alachlor
105.010	004	EPA 505	Chlordane
105.010	005	EPA 505	Dieldrin
105.010	006	EPA 505	Endrin
105.010	007	EPA 505	Heptachlor
105.010	008	EPA 505	Heptachlor Epoxide
105.010	009	EPA 505	Hexachlorobenzene
105.010	011	EPA 505	Lindane
105.010	012	EPA 505	Methoxychlor
105.010	014	EPA 505	Toxaphene
105.010	015	EPA 505	PCBs as Aroclors (screen)
105.010	016	EPA 505	PCB-1016
105.010	017	EPA 505	PCB-1221
105.010	018	EPA 505	PCB-1232
105.010	019	EPA 505	PCB-1242
105.010	020	EPA 505	PCB-1248
105.010	021	EPA 505	PCB-1254
105.010	022	EPA 505	PCB-1260
105.083	001	EPA 515.4	2,4-D
105.083	002	EPA 515.4	Dinoseb
105.083	003	EPA 515.4	Pentachlorophenol
105.083	004	EPA 515.4	Picloram
105.083	005	EPA 515.4	2,4,5-TP
105.083	006	EPA 515.4	Dalapon
105.083	007	EPA 515.4	Bentazon
105.083	008	EPA 515.4	Dicamba
105.090	001	EPA 525.2	Alachlor
105.090	002	EPA 525.2	Aldrin
105.090	003	EPA 525.2	Atrazine
105.090	004	EPA 525.2	Benzo(a)pyrene
105.090	005	EPA 525.2	Butachlor
105.090	006	EPA 525.2	Chlordane
105.090	007	EPA 525.2	Dieldrin
105.090	008	EPA 525.2	Di(2-ethylhexyl) Adipate
105.090	009	EPA 525.2	Di(2-ethylhexyl) Phthalate
105.090	010	EPA 525.2	4,4'-DDD
105.090	011	EPA 525.2	4,4'-DDE
105.090	012	EPA 525.2	4,4'-DDT
105.090	013	EPA 525.2	Endrin

As of 1/20/2009 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 01114CA
Renew Date: 1/31/2010

105.090	014	EPA 525.2	Heptachlor
105.090	015	EPA 525.2	Heptachlor Epoxide
105.090	016	EPA 525.2	Hexachlorobenzene
105.090	017	EPA 525.2	Hexachlorocyclopentadiene
105.090	018	EPA 525.2	Lindane
105.090	019	EPA 525.2	Methoxychlor
105.090	020	EPA 525.2	Metolachlor
105.090	021	EPA 525.2	Metribuzin
105.090	022	EPA 525.2	Molinate
105.090	023	EPA 525.2	Pentachlorophenol
105.090	024	EPA 525.2	Propachlor
105.090	025	EPA 525.2	Simazine
105.101	001	EPA 531.2	Carbofuran
105.101	002	EPA 531.2	Oxamyl
105.101	003	EPA 531.2	Aldicarb
105.101	004	EPA 531.2	Aldicarb Sulfone
105.101	005	EPA 531.2	Aldicarb Sulfoxide
105.101	006	EPA 531.2	Carbaryl
105.101	007	EPA 531.2	3-Hydroxycarbofuran
105.101	008	EPA 531.2	Methomyl
105.120	001	EPA 547	Glyphosate
105.140	001	EPA 548.1	Endothall
105.150	001	EPA 549.2	Diquat
105.170	001	EPA 551.1	Bromochloroacetonitrile
105.170	005	EPA 551.1	Chloral Hydrate
105.170	007	EPA 551.1	Chloropicrin
105.170	008	EPA 551.1	Dibromoacetonitrile
105.170	012	EPA 551.1	Dichloroacetonitrile
105.170	013	EPA 551.1	1,1-Dichloro-2-propanone
105.170	015	EPA 551.1	Trichloroacetonitrile
105.170	018	EPA 551.1	1,1,1-Trichloro-2-propanone
105.175	001	EPA 551.1	Bromodichloromethane
105.175	002	EPA 551.1	Bromoform
105.175	003	EPA 551.1	Chloroform
105.175	004	EPA 551.1	Dibromochloromethane
105.175	005	EPA 551.1	Trihalomethanes
105.190	001	SM6251B	Bromoacetic Acid
105.190	002	SM6251B	Bromochloroacetic Acid
105.190	003	SM6251B	Chloroacetic Acid
105.190	005	SM6251B	Dibromoacetic Acid
105.190	006	SM6251B	Dichloroacetic Acid

As of 1/20/2009 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 01114CA
Renew Date: 1/31/2010

105.190	007	SM6251B	Trichloroacetic Acid
105.190	008	SM6251B	Haloacetic Acids (HAA5)
106 - Radiochemistry of Drinking Water			
106.010	001	EPA 900.0	Gross Alpha
106.010	002	EPA 900.0	Gross Beta
106.060	001	EPA 904.0	Radium-228
106.092	001	EPA 200.8	Uranium
106.610	001	SM7500-Rn	Radon-222
107 - Microbiology of Wastewater			
107.010	001	SM9215B	Heterotrophic Bacteria
107.020	001	SM9221B	Total Coliform
107.030	001	SM9221B	Total Coliform with Chlorine Present
107.040	001	SM9221C,E (MTF/EC)	Fecal Coliform
107.050	001	SM9221E	Fecal Coliform with Chlorine Present
107.100	001	SM9230B	Fecal Streptococci
107.100	002	SM9230B	Enterococci
108 - Inorganic Chemistry of Wastewater			
108.020	001	EPA 120.1	Conductivity
108.090	001	EPA 160.4	Residue, Volatile
108.110	001	EPA 180.1	Turbidity
108.112	001	EPA 200.7	Boron
108.112	002	EPA 200.7	Calcium
108.112	003	EPA 200.7	Hardness (calc.)
108.112	004	EPA 200.7	Magnesium
108.112	005	EPA 200.7	Potassium
108.112	006	EPA 200.7	Silica
108.112	007	EPA 200.7	Sodium
108.120	001	EPA 300.0	Bromide
108.120	002	EPA 300.0	Chloride
108.120	004	EPA 300.0	Nitrate
108.120	005	EPA 300.0	Nitrite
108.120	006	EPA 300.0	Nitrate-nitrite
108.120	008	EPA 300.0	Sulfate
108.183	001	EPA 335.4	Cyanide, Total
108.200	001	EPA 350.1	Ammonia
108.211	001	EPA 351.2	Kjeldahl Nitrogen
108.232	001	EPA 353.2	Nitrate-nitrite
108.260	001	EPA 365.1	Phosphate, Ortho
108.261	001	EPA 365.1	Phosphorus, Total
108.323	001	EPA 410.4	Chemical Oxygen Demand
108.360	001	EPA 420.1	Phenols, Total

As of 1/20/2009 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 01114CA
Renew Date: 1/31/2010

108.362	001	EPA 420.4	Phenols, Total
108.385	001	SM2120B	Color
108.390	001	SM2130B	Turbidity
108.410	001	SM2320B	Alkalinity
108.420	001	SM2340B	Hardness (calc.)
108.430	001	SM2510B	Conductivity
108.440	001	SM2540B	Residue, Total
108.441	001	SM2540C	Residue, Filterable
108.442	001	SM2540D	Residue, Non-filterable
108.443	001	SM2540F	Residue, Settleable
108.465	001	SM4500-Cl G	Chlorine
108.473	001	SM4500-CN G	Cyanide, amenable
108.480	001	SM4500-F C	Fluoride
108.490	001	SM4500-H+ B	pH
108.493	001	SM4500-NH3 D or E (19th/20th)	Ammonia
108.498	001	SM4500-NH3 H (18th)	Ammonia
108.531	001	SM4500-O G	Dissolved Oxygen
108.540	001	SM4500-P E	Phosphate, Ortho
108.541	001	SM4500-P E	Phosphorus, Total
108.551	001	SM4500-SiO2 C (20th)	Silica
108.580	001	SM4500-S= D	Sulfide
108.590	001	SM5210B	Biochemical Oxygen Demand
108.591	001	SM5210B	Carbonaceous BOD
108.602	001	SM5220D	Chemical Oxygen Demand
108.611	001	SM5310C	Total Organic Carbon
108.620	001	SM5320B	Total Organic Halides
108.640	001	SM5540C	Surfactants

109 - Toxic Chemical Elements of Wastewater

109.002	001	EPA 100.2	Asbestos
109.010	001	EPA 200.7	Aluminum
109.010	002	EPA 200.7	Antimony
109.010	004	EPA 200.7	Barium
109.010	005	EPA 200.7	Beryllium
109.010	007	EPA 200.7	Cadmium
109.010	009	EPA 200.7	Chromium
109.010	010	EPA 200.7	Cobalt
109.010	011	EPA 200.7	Copper
109.010	012	EPA 200.7	Iron
109.010	013	EPA 200.7	Lead
109.010	015	EPA 200.7	Manganese
109.010	016	EPA 200.7	Molybdenum

As of 1/20/2009 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 01114CA
Renew Date: 1/31/2010

109.010	017	EPA 200.7	Nickel
109.010	021	EPA 200.7	Silver
109.010	024	EPA 200.7	Tin
109.010	026	EPA 200.7	Vanadium
109.010	027	EPA 200.7	Zinc
109.020	001	EPA 200.8	Aluminum
109.020	002	EPA 200.8	Antimony
109.020	003	EPA 200.8	Arsenic
109.020	004	EPA 200.8	Barium
109.020	005	EPA 200.8	Beryllium
109.020	006	EPA 200.8	Cadmium
109.020	007	EPA 200.8	Chromium
109.020	008	EPA 200.8	Cobalt
109.020	009	EPA 200.8	Copper
109.020	010	EPA 200.8	Lead
109.020	011	EPA 200.8	Manganese
109.020	012	EPA 200.8	Molybdenum
109.020	013	EPA 200.8	Nickel
109.020	014	EPA 200.8	Selenium
109.020	015	EPA 200.8	Silver
109.020	016	EPA 200.8	Thallium
109.020	017	EPA 200.8	Vanadium
109.020	018	EPA 200.8	Zinc
109.104	001	EPA 218.6	Chromium (VI)
109.190	001	EPA 245.1	Mercury
109.809	002	SM3500-Cr B (20th)	Chromium (VI)

110 - Volatile Organic Chemistry of Wastewater

110.040	001	EPA 624	Benzene
110.040	002	EPA 624	Bromodichloromethane
110.040	003	EPA 624	Bromoform
110.040	004	EPA 624	Bromomethane
110.040	005	EPA 624	Carbon Tetrachloride
110.040	006	EPA 624	Chlorobenzene
110.040	007	EPA 624	Chloroethane
110.040	008	EPA 624	2-Chloroethyl Vinyl Ether
110.040	009	EPA 624	Chloroform
110.040	010	EPA 624	Chloromethane
110.040	011	EPA 624	Dibromochloromethane
110.040	012	EPA 624	1,2-Dichlorobenzene
110.040	013	EPA 624	1,3-Dichlorobenzene
110.040	014	EPA 624	1,4-Dichlorobenzene

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 01114CA
Renew Date: 01/31/2008

110.040	010	EPA 624	Chloromethane
110.040	011	EPA 624	Dibromochloromethane
110.040	012	EPA 624	1,2-Dichlorobenzene
110.040	013	EPA 624	1,3-Dichlorobenzene
110.040	014	EPA 624	1,4-Dichlorobenzene
110.040	015	EPA 624	1,1-Dichloroethane
110.040	016	EPA 624	1,2-Dichloroethane
110.040	017	EPA 624	1,1-Dichloroethene
110.040	018	EPA 624	trans-1,2-Dichloroethene
110.040	019	EPA 624	1,2-Dichloropropane
110.040	020	EPA 624	cis-1,3-Dichloropropene
110.040	021	EPA 624	trans-1,3-Dichloropropene
110.040	022	EPA 624	Ethylbenzene
110.040	023	EPA 624	Methylene Chloride
110.040	024	EPA 624	1,1,2,2-Tetrachloroethane
110.040	025	EPA 624	Tetrachloroethene
110.040	026	EPA 624	Toluene
110.040	027	EPA 624	1,1,1-Trichloroethane
110.040	028	EPA 624	1,1,2-Trichloroethane
110.040	029	EPA 624	Trichloroethene
110.040	030	EPA 624	Trichlorofluoromethane
110.040	031	EPA 624	Vinyl Chloride

111 - Semi-volatile Organic Chemistry of Wastewater

111.100	001	EPA 625	Acenaphthene
111.100	002	EPA 625	Acenaphthylene
111.100	003	EPA 625	Anthracene
111.100	004	EPA 625	Benzidine
111.100	005	EPA 625	Benz(a)anthracene
111.100	006	EPA 625	Benzo(b)fluoranthene
111.100	007	EPA 625	Benzo(k)fluoranthene
111.100	008	EPA 625	Benzo(g,h,i)perylene
111.100	009	EPA 625	Benzo(a)pyrene
111.100	010	EPA 625	Benzyl Butyl Phthalate
111.100	011	EPA 625	Bis(2-chloroethoxy)methane
111.100	012	EPA 625	Bis(2 chloroethyl) Ether
111.100	013	EPA 625	Bis(2-chloroisopropyl) Ether
111.100	014	EPA 625	Di(2-ethylhexyl) Phthalate
111.100	015	EPA 625	4-Bromophenyl Phenyl Ether
111.100	016	EPA 625	4-Chloro-3-methylphenol
111.100	017	EPA 625	2-Chloronaphthalene
111.100	018	EPA 625	2-Chlorophenol

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 01114CA
Renew Date: 1/31/2010

110.040	015	EPA 624	1,1-Dichloroethane
110.040	016	EPA 624	1,2-Dichloroethane
110.040	017	EPA 624	1,1-Dichloroethene
110.040	018	EPA 624	trans-1,2-Dichloroethene
110.040	019	EPA 624	1,2-Dichloropropane
110.040	020	EPA 624	cis-1,3-Dichloropropene
110.040	021	EPA 624	trans-1,3-Dichloropropene
110.040	022	EPA 624	Ethylbenzene
110.040	023	EPA 624	Methylene Chloride
110.040	024	EPA 624	1,1,2,2-Tetrachloroethane
110.040	025	EPA 624	Tetrachloroethene
110.040	026	EPA 624	Toluene
110.040	027	EPA 624	1,1,1-Trichloroethane
110.040	028	EPA 624	1,1,2-Trichloroethane
110.040	029	EPA 624	Trichloroethene
110.040	030	EPA 624	Trichlorofluoromethane
110.040	031	EPA 624	Vinyl Chloride

111 - Semi-volatile Organic Chemistry of Wastewater

111.100	001	EPA 625	Acenaphthene
111.100	002	EPA 625	Acenaphthylene
111.100	003	EPA 625	Anthracene
111.100	004	EPA 625	Benzidine
111.100	005	EPA 625	Benz(a)anthracene
111.100	006	EPA 625	Benzo(b)fluoranthene
111.100	007	EPA 625	Benzo(k)fluoranthene
111.100	008	EPA 625	Benzo(g,h,i)perylene
111.100	009	EPA 625	Benzo(a)pyrene
111.100	010	EPA 625	Benzyl Butyl Phthalate
111.100	011	EPA 625	Bis(2-chloroethoxy)methane
111.100	012	EPA 625	Bis(2-chloroethyl) Ether
111.100	013	EPA 625	Bis(2-chloroisopropyl) Ether
111.100	014	EPA 625	Di(2-ethylhexyl) Phthalate
111.100	015	EPA 625	4-Bromophenyl Phenyl Ether
111.100	016	EPA 625	4-Chloro-3-methylphenol
111.100	017	EPA 625	2-Chloronaphthalene
111.100	018	EPA 625	2-Chlorophenol
111.100	019	EPA 625	4-Chlorophenyl Phenyl Ether
111.100	020	EPA 625	Chrysene
111.100	021	EPA 625	Dibenz(a,h)anthracene
111.100	022	EPA 625	1,2-Dichlorobenzene
111.100	023	EPA 625	1,3-Dichlorobenzene

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 01114CA
Renew Date: 1/31/2010

111.100	024	EPA 625	1,4-Dichlorobenzene
111.100	025	EPA 625	3,3'-Dichlorobenzidine
111.100	026	EPA 625	2,4-Dichlorophenol
111.100	027	EPA 625	Diethyl Phthalate
111.100	028	EPA 625	2,4-Dimethylphenol
111.100	029	EPA 625	Dimethyl Phthalate
111.100	030	EPA 625	Di-n-butyl phthalate
111.100	031	EPA 625	Di-n-octyl phthalate
111.100	032	EPA 625	2,4-Dinitrophenol
111.100	033	EPA 625	2,4-Dinitrotoluene
111.100	034	EPA 625	2,6-Dinitrotoluene
111.100	035	EPA 625	Fluoranthene
111.100	036	EPA 625	Fluorene
111.100	037	EPA 625	Hexachlorobenzene
111.100	038	EPA 625	Hexachlorobutadiene
111.100	039	EPA 625	Hexachlorocyclopentadiene
111.100	040	EPA 625	Hexachloroethane
111.100	041	EPA 625	Indeno(1,2,3-c,d)pyrene
111.100	042	EPA 625	Isophorone
111.100	043	EPA 625	2-Methyl-4,6-dinitrophenol
111.100	044	EPA 625	Naphthalene
111.100	045	EPA 625	Nitrobenzene
111.100	046	EPA 625	2-Nitrophenol
111.100	047	EPA 625	4-Nitrophenol
111.100	048	EPA 625	N-nitrosodimethylamine
111.100	049	EPA 625	N-nitrosodi-n-propylamine
111.100	050	EPA 625	N-nitrosodiphenylamine
111.100	051	EPA 625	Pentachlorophenol
111.100	052	EPA 625	Phenanthrene
111.100	053	EPA 625	Phenol
111.100	054	EPA 625	Pyrene
111.100	055	EPA 625	1,2,4-Trichlorobenzene
111.100	056	EPA 625	2,4,6 Trichlorophenol
111.120	048	EPA 1625	N-nitrosodimethylamine

112 - Radiochemistry of Wastewater

112.010	001	EPA 900.0	Gross Alpha
112.010	002	EPA 900.0	Gross Beta

As of 1/20/2009 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

Figure 4-5 Laboratory Certificate - State of California (ELAP)

CDPH
California Department of Public Health

CALIFORNIA STATE

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM BRANCH

CERTIFICATE OF ENVIRONMENTAL ACCREDITATION

Is hereby granted to

MWH LABORATORIES, a division of MWH Americas, Inc.

750 ROYAL OAKS DRIVE, SUITE 100

MONROVIA, CA 91016

Scope of the certificate is limited to the
"Fields of Testing"
which accompany this Certificate.

Continued accredited status depends on successful completion of on-site, proficiency testing studies, and payment of applicable fees.

This Certificate is granted in accordance with provisions of Section 100825, et seq. of the Health and Safety Code.

Certificate No.: **1422**

Expiration Date: **01/31/2011**

Effective Date: **01/01/2009**

George C. Kulasingam

George C. Kulasingam, Ph.D., Chief
Environmental Laboratory Accreditation Program Branch

Richmond, California
subject to forfeiture or revocation

Figure 4-6 California (ELAP) Field of Testing

State of California—Health and Human Services Agency
California Department of Public Health

MARK B HORTON, MD, MSPH
Director

ARNOLD SCHWARZENEGGER
Governor

January 7, 2009

ANDREW D. EATON, Ph.D.
MWH LABORATORIES, a division of MWH Americas, Inc.
750 ROYAL OAKS DRIVE, SUITE 100
MONROVIA, CA 91016

Dear ANDREW D. EATON, Ph.D.: Certificate No. 1422

This is to advise you that the laboratory named above continues to be certified as an environmental testing laboratory pursuant to the provisions of the Health and Safety Code (HSC), Division 101, Part 1, Chapter 4, Section 100825, et seq. Certification for all currently certified Fields of Testing that the laboratory has applied for renewal shall remain in effect until **01/31/2011** unless it is revoked.

Please note that the renewal application for certification is subject to an on-site process, and the continued use of this certificate is contingent upon:

* **successful completion of the on-site process;**
* **acceptable performance in the required proficiency testing (PT) studies;**
* **timely payment of all fees, including an annual fee due before January 31, 2010;**
* **compliance with Environmental Laboratory Accreditation Program Branch (ELAP) statutes (HSC, Section 100825, et seq.) and Regulations (California Code of Regulations (CCR),Title 22, Division 4, Chapter 19).**

An updated certificate of the "Fields of Testing" will be issued to the laboratory upon successful completion of the on-site process.

ORIGINAL

The application for the renewal of this certificate must be received before the expiration date to remain in force according to the HSC100845(a).

Please note that the laboratory is required to notify ELAP of any major changes in the laboratory such as the transfer of ownership, change of laboratory director, change in location, or structural alterations which may affect adversely the quality of analyses (HSC, Section 100845(b)(d)). Please include the above certificate number in all your correspondence with ELAP.

If you have any questions, please contact Wanda Porter at (510) 620-3155.

Sincerely,

George C. Kulasingam, Ph.D., Chief
Environmental Laboratory Accreditation Program Branch

Environmental Laboratory Accreditation Program Branch
850 Marina Bay Parkway, Building P, 1st Floor, MS 0511, Richmond, CA 94804
Phone (510) 620-3155, Fax (510) 620-3165
www.cdph.ca.gov/certlic/labs/Pages/ELAP.aspx

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM
Accredited Fields of Testing

MWH LABORATORIES, a division of MWH Americas, Inc. **Lab Phone** (626) 386-1100

750 ROYAL OAKS DRIVE, SUITE 100
MONROVIA, CA 91016-3629

Certificate No: 1422 **Renew Date: 01/31/2009**

Field of Testing: 101 - Microbiology of Drinking Water				
101.060	002	Total Coliform	SM9223	
101.060	003	E. coli	SM9223	
101.070	002	Total Coliform	Colisure	
101.070	003	E. coli	Colisure	
101.160	001	Total Coliform (Enumeration)	SM9223	
Field of Testing: 103 - Toxic Chemical Elements of Drinking Water				
103.130	018	Boron	EPA 200.7	
103.140	018	Vanadium	EPA 200.8	
103.310	001	Chromium (VI)	EPA 218.6	
Field of Testing: 104 - Volatile Organic Chemistry of Drinking Water				
104.035	001	1,2,3-Trichloropropane	SRL 524M-TCP	
104.050	007	tert-Butyl Alcohol (TBA)	EPA 524.2	
104.050	008	Carbon Disulfide	EPA 524.2	
104.050	009	Methyl Isobutyl Ketone	EPA 524.2	
Field of Testing: 105 - Semi-volatile Organic Chemistry of Drinking Water				
105.090	028	Thiobencarb	EPA 525.2	
Field of Testing: 109 - Toxic Chemical Elements of Wastewater				
109.104	001	Chromium (VI)	EPA 218.6	
Field of Testing: 114 - Inorganic Chemistry of Hazardous Waste				
114.010	001	Antimony	EPA 6010B	Aqueous only
114.010	003	Barium	EPA 6010B	Aqueous only
114.010	004	Beryllium	EPA 6010B	Aqueous only
114.010	005	Cadmium	EPA 6010B	Aqueous only
114.010	006	Chromium	EPA 6010B	Aqueous only
114.010	007	Cobalt	EPA 6010B	Aqueous only
114.010	008	Copper	EPA 6010B	Aqueous only
114.010	009	Lead	EPA 6010B	Aqueous only
114.010	010	Molybdenum	EPA 6010B	Aqueous only
114.010	011	Nickel	EPA 6010B	Aqueous only
114.010	013	Silver	EPA 6010B	Aqueous only
114.010	015	Vanadium	EPA 6010B	Aqueous only
114.010	016	Zinc	EPA 6010B	Aqueous only
114.020	001	Antimony	EPA 6020	Aqueous only
114.020	002	Arsenic	EPA 6020	Aqueous only
114.020	003	Barium	EPA 6020	Aqueous only
114.020	004	Beryllium	EPA 6020	Aqueous only

As of 02/06/2008 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

MWH LABORATORIES, a division of MWH Americas, Inc.

Certificate No: 1422
Renew Date: 01/31/2009

114.020	005	Cadmium	EPA 6020	Aqueous only
114.020	006	Chromium	EPA 6020	Aqueous only
114.020	007	Cobalt	EPA 6020	Aqueous only
114.020	008	Copper	EPA 6020	Aqueous only
114.020	009	Lead	EPA 6020	Aqueous only
114.020	010	Molybdenum	EPA 6020	Aqueous only
114.020	011	Nickel	EPA 6020	Aqueous only
114.020	012	Selenium	EPA 6020	Aqueous only
114.020	013	Silver	EPA 6020	Aqueous only
114.020	014	Thallium	EPA 6020	Aqueous only
114.020	015	Vanadium	EPA 6020	Aqueous only
114.020	016	Zinc	EPA 6020	Aqueous only
114.103	001	Chromium (VI)	EPA 7196A	Aqueous only
114.106	001	Chromium (VI)	EPA 7199	Aqueous only
114.140	001	Mercury	EPA 7470A	Aqueous only
Field of Testing: 116 - Volatile Organic Chemistry of Hazardous Waste				
116.010	000	EDB and DBCP	EPA 8011	Aqueous only
116.080	000	Volatile Organic Compounds	EPA 8260B	Aqueous only
116.080	120	Oxygenates	EPA 8260B	Aqueous only
Field of Testing: 117 - Semi-volatile Organic Chemistry of Hazardous Waste				
117.110	000	Extractable Organics	EPA 8270C	Aqueous only

Figure 4-7 LA County Fire Department License to Operate

LOS ANGELES COUNTY CERTIFIED UNIFIED PROGRAM AGENCY
ADMINISTERED BY LOS ANGELES COUNTY FIRE DEPARTMENT

UNIFIED PROGRAM FACILITY PERMIT

FISCAL YEAR: July 1, 2008 - June 30, 2009

ISSUED TO: FA0034152
MWH LABORATORIES DIV OF AMERIC
750 ROYAL OAKS DR
MONROVIA, CA 91016

LA Co. CUPA NO. AR: AR0036980

FACILITY OWNER: MWH GLOBAL INC

THIS PERMIT IS ISSUED FOR THE FOLLOWING PROGRAMS:

Administering Agency:	Program Description:
CITY OF MONROVIA	HAZARDOUS MATERIALS DISCLOSURE PROGRAM
LA COUNTY FIRE DEPARTMENT	HAZARDOUS WASTE GENERATOR PROGRAM
LA COUNTY FIRE DEPARTMENT	TIERED PERMIT - CONDITIONALLY EXEMPT (CE)

THIS PERMIT MUST BE CONSPICUOUSLY DISPLAYED AT THE FACILITY AT ALL TIMES.

ISSUED BY: P. Michael Freeman
County of Los Angeles Fire Chief

ISSUED ON: Jun 12, 2009

This permit is valid only for the above location and is subject to ALL REQUIRMENTS of State and Local Laws. The permit is non-transferrable and is void upon change in ownership or location.

Figure 4-8 Drug Enforcement Administration Certificate

MWH LABORATORIES
750 ROYAL OAKS DRIVE
SUITE 100
MONROVIA, CA 91016-3629-000

DEA REGISTRATION NUMBER	THIS REGISTRATION EXPIRES	FEE PAID
RM0322696	01-31-2010	FEE PAID

SCHEDULES	BUSINESS ACTIVITY	ISSUE DATE
3N,4,	ANALYTICAL LAB	01-06-2009

MWH LABORATORIES
750 ROYAL OAKS DRIVE
SUITE 100
MONROVIA, CA 91016-3629

CONTROLLED SUBSTANCE REGISTRATION CERTIFICATE
UNITED STATES DEPARTMENT OF JUSTICE
DRUG ENFORCEMENT ADMINISTRATION
WASHINGTON D.C. 20537

Sections 304 and 1008 (21 USC 824 and 958) of the Controlled Substances Act of 1970, as amended, provide that the Attorney General may revoke or suspend a registration to manufacture, distribute, dispense, import or export a controlled substance.

THIS CERTIFICATE IS NOT TRANSFERABLE ON CHANGE OF OWNERSHIP, CONTROL, LOCATION, OR BUSINESS ACTIVITY, AND IT IS NOT VALID AFTER THE EXPIRATION DATE.

CONTROLLED SUBSTANCE REGISTRATION CERTIFICATE
UNITED STATES DEPARTMENT OF JUSTICE
DRUG ENFORCEMENT ADMINISTRATION
WASHINGTON D.C. 20537

DEA REGISTRATION NUMBER	THIS REGISTRATION EXPIRES	FEE PAID
RM0322696	01-31-2010	FEE PAID

SCHEDULES	BUSINESS ACTIVITY	ISSUE DATE
3N,4,	ANALYTICAL LAB	01-06-2009

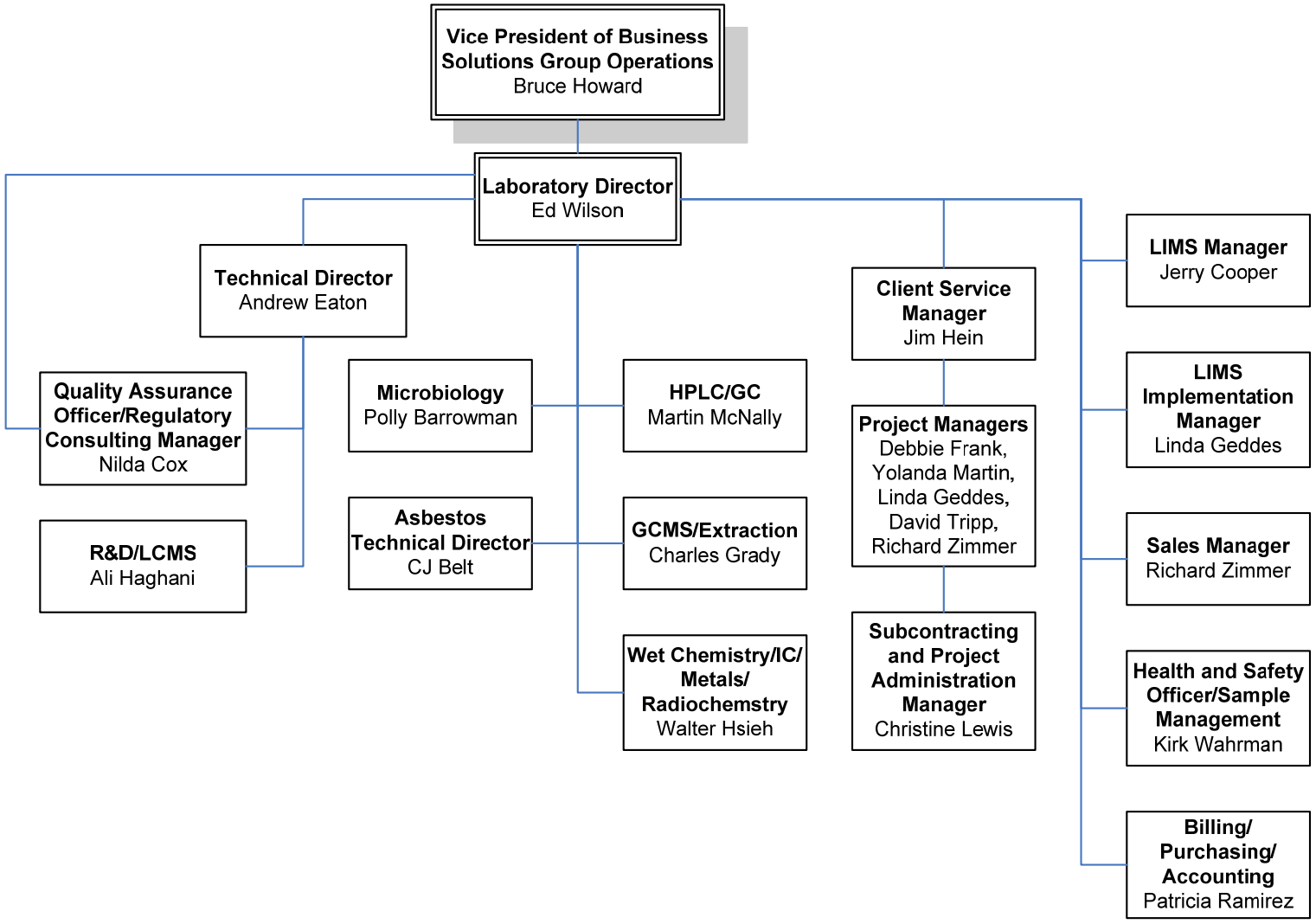
MWH LABORATORIES
750 ROYAL OAKS DRIVE
SUITE 100
MONROVIA, CA 91016-3629

Sections 304 and 1008 (21 USC 824 and 958) of the Controlled Substances Act of 1970, as amended, provide that the Attorney General may revoke or suspend a registration to manufacture, distribute, dispense, import or export a controlled substance.

THIS CERTIFICATE IS NOT TRANSFERABLE ON CHANGE OF OWNERSHIP, CONTROL, LOCATION, OR BUSINESS ACTIVITY, AND IT IS NOT VALID AFTER THE EXPIRATION DATE.

Form DEA-223 (4/07)

Figure 4-9 MWH Organizational Chart



5.0 QUALITY ASSURANCE OBJECTIVES

Before analytical data can be used, the quality of data produced by MWH Laboratories is measured by the following characteristics: precision, accuracy, completeness, representativeness, comparability, timeliness, and documentation, used in the determination of the suitability of the data for a given purpose. MWH Laboratories has set specific objectives for each of these characteristics as a means of meeting the data quality objectives of the client. A definition of each of the characteristics follows, along with the specific objectives for each of the characteristics.

Table 5-1 lists specific limit objectives for precision and accuracy for drinking water analyses.

Table 5-2 lists specific limit objectives for precision and accuracy for wastewater analyses.

Table 5-3 lists specific limit objectives for precision and accuracy for hazardous waste analyses.

Criteria for precision and accuracy included are only for representative reference methods. Criteria for the other methods and specific analytes can be found in relevant SOPs.

5.1. PRECISION

Analytical precision is an important component of overall data quality since it is a measure of how far an individual determination may be from the mean of replicate measurements (how well replicate analyses agree). If the precision of an analysis is poor, there is a good probability that the reported result will differ substantially from the true value even if there are no systematic errors leading to bias in the result. Precision is often directly related to concentration.

5.1.1. MWH Laboratories uses Relative Percent Difference (RPD) to measure agreement between duplicate analyses. RPD is calculated as follows:

$$\textbf{RPD} = \frac{(S-D)}{(S+D)/2} \times 100$$

where;

RPD	=	Relative Percent Difference
S	=	First Sample Value (original)
D	=	Second Sample Value (duplicate)

5.1.2. The precision of a method is expressed as the Relative Standard Deviation (RSD) of the percent recoveries. Percent RSD (%RSD) is calculated as follows:

$$\textbf{\%RSD} = \frac{S}{X_{avg}} \text{ X } 100$$

where:

X_{avg} = the arithmetic mean of the recovery values, and

$$S = \sqrt{\sum \frac{(X_i - X)^2}{n-1}}$$

where:

S	=	Standard Deviation
X_i	=	the individual recovery values
X	=	the arithmetic mean of the recovery values
n	=	the number of determinations

5.1.3. To assess precision in the laboratory, MWH Laboratories uses the following:

- Duplicate Samples
- Duplicate Matrix Spikes
- Duplicate Laboratory Control Samples
- Control Charts

5.2. ACCURACY

Accuracy is the agreement between an experimentally determined value and the accepted reference value (deviation of the analytical value from the "true or known value). Analytical accuracy is a measure of analytical bias due to systematic errors. A measure of this bias along with a measure of the precision will provide the overall accuracy of the results.

The true value for field samples are never known, so accuracy measurements are made on the analysis of QC samples analyzed with field samples. The primary QC tools for assessing accuracy are control standards (LCSs), matrix spikes and spike duplicates (MS/MSD), and surrogate spikes.

5.2.1. Spike recoveries are calculated as follows:

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

Where;

%R	=	percent spike recovery
SSR	=	spiked sample result
SR	=	sample result
SA	=	spike amount added

5.2.2. For Laboratory Control Samples, percent recovery (%R) is calculated as follows:

$$\%R = \frac{\text{found concentration}}{\text{true concentration}} \times 100$$

5.2.3. Accuracy is monitored for nearly all methods by percent recoveries of the LCSs and plotted on control charts. The mean recovery ± 2 standard deviations are the warning limits, and the mean recovery ± 3 standard deviations are the control limits. In the event that the method has no acceptance criteria, control charts are reviewed and evaluated to establish internal limits or guidelines [NELAC 5.Appendix D.1.1.2.1d)]

To assess accuracy, MWH Laboratories uses the following:

- MRL Checks
- Laboratory Control Samples
- Matrix Spikes
- Certified Reference Materials
- Blind Audit Samples
- Control Charts

5.3. REPRESENTATIVENESS/SAMPLING OF SUB-ALIQUOT

All sample aliquots, which are analyzed, must be representative of the bulk sample from which they are taken (NELAC 5.5.7). Representativeness is easily achieved for aqueous samples free of suspended material. Obtaining a representative sample is a more difficult task for soils and sludge.

Unless a sample is known to be non-randomly heterogeneous in its composition, the most appropriate manner of obtaining a representative aliquot for analysis is by simple random sampling after the material has been mixed as thoroughly as possible. Thorough mixing is acceptable for inorganic analyses, but any samples requiring volatile or semi-volatile organic analyses must be handled in a manner which minimizes loss of these volatile compounds from the sample.

Representativeness is also impacted by conditions of sample receipt. MWH documents all samples that do not meet acceptance criteria (NELAC 5.5.8.3).

The laboratory documents the sampling techniques of aliquots from a submitted sample in the method SOPs to ensure that representativeness of samples are obtained. (NELAC 5.5.7.1).

5.4. COMPARABILITY

The characteristic of comparability determines whether analytical conditions are uniform for each analytical run to insure that all of the reported data will be consistent. This requires temporal stability of analytical conditions within the laboratory.

To insure temporal stability, uniform analytical and quality control protocols will be closely adhered to for each analytical run. In addition, traceable standards are used as part of every analytical run. Every analyst is required to demonstrate his precision and accuracy for a particular analysis by analyzing four replicate matrix spiked samples. All newly trained or backup analysts must demonstrate comparable precision and accuracy.

5.5. COMPLETENESS

The characteristic of completeness is a measure of the percentage of specified data which are valid. Valid data are obtained when samples are analyzed in accordance with the quality control procedures outlined in this manual and none of the quality control criteria is exceeded.

Sample data which does not meet the specified quality control criteria will automatically be reanalyzed if sufficient quantity of sample is available and analytical holding times have not been exceeded. The laboratory strives for a completeness percentage of 100%.

5.6. TIMELINESS

EPA guidelines require that samples be analyzed for constituents within specified holding times. These holding times represent a compromise between allowance of a realistic time to perform the analysis and minimization of elapsed time to insure sample integrity.

MWH Laboratories has adopted a computerized sample tracking system and supervisory review process to insure that samples are scheduled for extraction and analysis within the EPA holding times. In the unforeseen circumstance of instrument performance problems, MWH Laboratories will do everything possible to meet EPA holding times without compromising the quality of the reported data. The client is notified if a holding time is exceeded.

5.7. DOCUMENTATION

Proper documentation is a vital component in supporting the integrity of analytical results. All of the proceeding quality control components will not support reported data unless they have been fully documented for subsequent review. MWH Laboratories maintains documentation of sample handling, chain of custody (if applicable), analytical procedures, raw and calculated data, supporting chromatograms, quality control data, and final reports. Please see section 14 for data reduction, validation, and reporting procedures.

NOTE: For several analytes, MS-LFM recovery limits are based on Control Charts. The Limits stated in the table below, may not reflect the current range.

Table 5-1 Precision and Accuracy for Drinking Water for Mid or High Level Spikes

(A) Inorganics - Wet Chemistry

Parameter Method Name	Method Number	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
Alkalinity	SM 2320B	Bicarbonate	90 - 110	80 - 120	10
		Carbonate	90 - 110	80 - 120	10
		Hydroxide	90 - 110	80 - 120	10
Bromate, BrO3	EPA 317	Bromate	90 - 110	75 - 125	20
Bromate, BrO3	EPA 300.1	Bromate	90 - 110	75 - 125	20
Bromide, Br	EPA 300.0	Bromide	90 - 110	80 - 120	20
Bromide, Br	EPA 300.1	Bromide	90 - 110	85 - 115	20
Chloride, Cl	EPA 300.0	Chloride	90 - 110	90 - 110	20
Chlorine Dioxide	SM 4500-ClO2 D	Chlorine Dioxide	85 - 115	85 - 115	15
Chlorite, ClO2	EPA 300.0	Chlorite	90 - 110	75 - 125	20
Chlorite, ClO2	EPA 300.1	Chlorite	90 - 110	85 - 115	20
Chlorite, ClO2	EPA 317.0	Chlorite	90 - 110	85 - 115	20
Chlorate, ClO3	EPA 300.0	Chlorate	90 - 110	75 - 125	20
Chlorate, ClO3	EPA 300.1	Chlorate	90 - 110	85 - 115	20
Color	SM 2120B	Color	-	-	+1 unit (0-10)
					+5 units (10-110)
					+10 units (>110)
Conductivity	SM2510B	Conductivity	95 - 105	-	20
Corrosivity (Langlier Index)	SM 2330B	Corrosivity	85 - 115	85 - 115	15
Cyanide	SM4500CN-F, G	Cyanide	80 - 120	80 - 120	20
	EPA335.4	Cyanide	90 - 110	90 - 110	20
Fluoride	SM 4500 F-C	Fluoride	81 - 116	73 - 124	20
Free & Total Chlorine	SM 4500 Cl G	Free & Total Chlorine	85 - 115	85 - 115	15
Hardness	EPA 200.7/SM 2340B	Calcium Hardness	-	-	-
Nitrate	EPA300.0/353.2	Nitrate	90 - 110	90 - 110	20
Nitrate & Nitrite	EPA 353.2	Nitrate & Nitrite	90 - 110	90 - 110	20
Nitrite	EPA300.0	Nitrite	90 - 110	90 - 110	20
	EPA353.2	Nitrite	90 - 110	90 - 110	20
Odor	SM 2150B	Odor	-	-	20
o-Phosphate	365.1	o-Phosphate	90 - 110	90 - 110	90
	SM4500 P-E, PF	o-Phosphate	90 - 110	90 - 110	20

Parameter Method Name	Method Number	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
Perchlorate	EPA 314.0	Perchlorate	85 - 115	80 - 120	20
pH	SM4500-HB	pH	-	-	+ 0.1 pH unit
Phenols	EPA 420.1/420.4	Phenols	70 - 130	70 - 130	10
Residual Disinfectant (Total/ Free Residual Chlorine)	SM4500 Cl-G	Residual Disinfectant	85 - 115	-	25
Silica	EPA200.7	Silica	85 - 115	70 - 130	-
	SM 4500 SiO2C	Dissolved /Reactive Silica	90 - 110	80 - 120	20
Total Dissolved Solids (TDS)	SM 2540C	Total Dissolved Solids (TDS)	85 - 115	-	10
Total Suspended Solids (TSS)	SM 2540D	Total Suspended Solids (TSS)	80 - 120	-	10
Sulfate	EPA 300.0	Sulfate	90 - 110	90 - 110	20
Total Organic Carbon / Dissolved Organic Carbon	SM 5310C/EPA 415.3	TOC/DOC	90 - 110	90 - 110	20
Turbidity	EPA180.1	Turbidity	N/A	N/A	20
UV 254	SM 5910 B/EPA 415.3	UV/SUVA	85 - 115	N/A	10 (6.0 mg/L/DOC)

(B) Inorganics – Metals

Parameter Method Name	EPA Method Number	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec	% Rec	
Chromium VI	EPA 218.6	Chromium VI (Dissolved)	90 - 110	90 - 110	10
Mercury	EPA 245.1	Mercury, Hg	85 - 115	70 - 130	20
Metals	EPA200.7	Aluminum, Al	85 - 115	70 - 130	20
		Barium, Ba	85 - 115	70 - 130	20
		Beryllium, Be	85 - 115	70 - 130	20
		Boron, B	85 - 115	70 - 130	20
		Calcium, Ca	85 - 115	70 - 130	20
		Cadmium, Cd	85 - 115	70 - 130	20
		Chromium, Cr	85 - 115	70 - 130	20
		Copper, Cu	85 - 115	70 - 130	20
		Iron, Fe	85 - 115	70 - 130	20
		Magnesium, Mg	85 - 115	70 - 130	20
		Manganese, Mn	85 - 115	70 - 130	20
		Nickel, Ni	85 - 115	70 - 130	20

Parameter Method Name	EPA Method Number	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec	% Rec	
		Potassium, K	85 - 115	70 - 130	20
		Silica, SiO2	85 - 115	70 - 130	20
		Silver, Ag	85 - 115	70 - 130	20
		Sodium, Na	85 - 115	70 - 130	20
		Thallium, Ti	85 - 115	70 - 130	20
		Tin, Sn	85 - 115	70 - 130	20
		Zinc, Zn	85 - 115	70 - 130	20
Metals	EPA200.8	Aluminum, Al	85 - 115	70 - 130	20
		Antimony, Sb	85 - 115	70 - 130	20
		Arsenic, As	85 - 115	70 - 130	20
		Barium, Ba	85 - 115	70 - 130	20
		Beryllium, Be	85 - 115	70 - 130	20
		Cadmium, Cd	85 - 115	70 - 130	20
		Chromium, Cr	85 - 115	70 - 130	20
		Copper, Cu	85 - 115	70 - 130	20
		Lead, Pb	85 - 115	70 - 130	20
		Manganese, Mn	85 - 115	70 - 130	20

(C) Microbiology/Microscopy Tests

Parameter Method Name	Method Number	Analyte Parameter	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
Asbestos	EPA 100.2	Asbestos	-	-	-
Fecal Coliforms--EC Medium, MTF	SM9221E	Fecal Coliforms EC Medium (Enumeration)	-	-	-
Heterotrophic Plate Count (Standard Plate Count)	SM9215B	Heterotrophic Plate Count	-	-	10
Total Coliform by Multiple Tube Fermentation (MF)	SM9221AB	Total Coliform/Enumeration	-	-	-
Total Coliform/ E-Coli (Colilert)	SM 9223B	Total Coliforms (Present or Absent)	-	-	-
Total Coliform/Colilert (Enumeration)	SM 9223B	Total Coliform (Enumeration)	-	-	-
Total Coliform (MF)	SM9222A, B, C	Total Coliform	-	-	-
Total Coliforms (MTF) Enumeration	SM9221A, B	Total Coliforms	-	-	-
Total Coliform and E-Coli	SM 9223B- Colisure	Total Coliform and E-Coli	-	-	-

Parameter Method Name	Method Number	Analyte Parameter	Accuracy		Precision RPD
Coliphage	1602	Coliphage	-	-	-

(D) Organics

Parameter Method Name	EPA Method Number	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
DBCP/EDB	EPA504.1	1,2-Dibromo-3-chloropropane	70 - 130	65 - 135	20
		1,2-Dibromoethane (EDB)	70 - 130	65 - 135	20
		1,2,3-Trichloropropane (1,2,3-TCP)	70 - 130	65 - 135	20
Organohalide Pesticides and Commercial Polychlorinated Biphenyl (PCB)	EPA 505	Alachlor	70 - 130	65 - 135	20
		Aldrin	70 - 130	65 - 135	20
		Chlordane	70 - 130	65 - 135	20
		Dieldrin	70 - 130	65 - 135	20
		Endrin	70 - 130	65 - 135	20
		Heptachlor	70 - 130	65 - 135	20
		Heptachlor Epoxide	70 - 130	65 - 135	20
		Lindane	70 - 130	65 - 135	20
		Methoxychlor	70 - 130	65 - 135	20
		Cis-Nonachlor	70 - 130	65 - 135	20
		Trans-Nonachlor	70 - 130	65 - 135	20
		Toxaphene	70 - 130	65 - 135	20
		Aroclor 1016	58 - 145	65 - 135	20
		Aroclor 1221	65 - 132	65 - 135	20
		Aroclor 1232	56 - 152	65 - 135	20
		Aroclor 1242	70 - 130	65 - 135	20
		Aroclor 1248	63 - 130	65 - 135	20
		Aroclor 1254	78 - 136	65 - 135	20
		Aroclor 1260	52 - 152	65 - 135	20
Chlorinated Acids	EPA 515.4	2,4,5-TP (Silvex)	70 - 130	70 - 130	30
		2,4,5-T	70 - 130	70 - 130	30
		2,4-D	70 - 130	70 - 130	30
		2,4-DB	70 - 130	70 - 130	30
		Acifluorfen	70 - 130	70 - 130	30
		DCPA	70 - 130	70 - 130	30
		Dichloroprop	70 - 130	70 - 130	30
		Dinoseb	70 - 130	70 - 130	30
		4-Nitrophenol	-	-	30
		Pentachlorophenol	70 - 130	70 - 130	30
		Picloram	70 - 130	70 - 130	30
		2,4-Dichlorophenylacetic Acid	70 - 130	70 - 130	30
		3,5-Dichlorobenzoic Acid	70 - 130	70 - 130	30

Parameter Method Name	EPA Method Number	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB % Rec.	MS/LFM % Rec.	
		Bentazon	70 - 130	70 - 130	30
		Dalapon	70 - 130	70 - 130	30
		Dicamba	70 - 130	70 - 130	30
Purgeable Organic Compounds/ Halogenated & Aromatic Volatiles/ Trihalomethanes, Di-Isopropyl Ether (DIPE), Tertiary Amyl methyl Ether (TAME) Tert-Butyl ethyl ether (ETBE)	EPA524.2	1,1,1-Trichloroethane	70 - 130	70 - 130	20
		1,1,2,2-Tetrachloroethane	70 - 130	70 - 130	20
		1,1,1,2-Tetrachloroethane	70 - 130	70 - 130	20
		1,1,2-Trichloroethane	70 - 130	70 - 130	20
		1,1-Dichloroethane	70 - 130	70 - 130	20
		1,1-Dichloroethylene	70 - 130	70 - 130	20
		1,2,3-Trichlorobenzene	70 - 130	70 - 130	20
		1,2,4 Trichlorobenzene	70 - 130	70 - 130	20
		1,2,3- Trichloropropane	70 - 130	70 - 130	20
		1,2,4- Trimethylbenzene	70 - 130	70 - 130	20
		1,3,5 Trimethyl benzene	70 - 130	70 - 130	20
		1,1-Dichloropropene	70 - 130	70 - 130	20
		1,2-Dichloropropane	70 - 130	70 - 130	20
		1,3-Dichloropropane	70 - 130	70 - 130	20
		2,2-Dichloropropane	70 - 130	70 - 130	20
		Benzene	70 - 130	70 - 130	20
		Bromobenzene	70 - 130	70 - 130	20
		Bromochloromethane	70 - 130	70 - 130	20
		Bromodichloromethane	70 - 130	70 - 130	20
		Bromoform	70 - 130	70 - 130	20
		Bromomethane	70 - 130	70 - 130	20
		Carbon Tetrachloride	70 - 130	70 - 130	20
		Chlorobenzene	70 - 130	70 - 130	20
		Chlorodibromomethane	70 - 130	70 - 130	20
		Chloroform (Trichloromethane)	70 - 130	70 - 130	20
		Chloroethane	70 - 130	70 - 130	20
		Chloromethane (Methyl Chloride)	70 - 130	70 - 130	20
		Dichloromethane	70 - 130	70 - 130	20
		Dibromomethane	70 - 130	70 - 130	20
		Dichlorodifluoromethane	70 - 130	70 - 130	20
		Ethylbenzene	70 - 130	70 - 130	20
		Fluorotrichloromethane (Freon	70 - 130	70 - 130	20
		Hexachlorobutadiene	70 - 130	70 - 130	20
		Isopropylbenzene	70 - 130	70 - 130	20
Purgeable Organic	EPA524.2	Methyl Tert-Butyl Ether (MTBE)	70 -130	70 - 130	20

Parameter Method Name	EPA Method Number	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
Compounds/ Halogenated & Aromatic Volatiles/ Trihalomethanes, Di-Isopropyl Ether (DIPE), Tertiary Amyl methyl Ether (TAME) Tert-Butyl ethyl ether (ETBE)		m-Dichlorobenzene (1,3-DCB)	70 - 130	70 - 130	20
		Naphthalene	70 - 130	70 - 130	20
		n-Butylbenzene	70 - 130	70 - 130	20
		n-Propylbenzene	70 - 130	70 - 130	20
		Styrene	70 - 130	70 - 130	20
		Tetrachloroethylene (PCE)	70 - 130	70 - 130	20
		Tert-Butyl Alcohol (TBA)	70 - 130	70 - 130	20
		Carbon Disulfide	70 - 130	70 - 130	20
		Methyl Isobutyl Ketone (MIBK)	70 - 130	70 - 130	20
		Toluene	70 - 130	70 - 130	20
		Trichloroethylene	70 - 130	70 - 130	20
		1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	70 - 130	70 - 130	20
		Vinyl Chloride	70 - 130	70 - 130	20
		cis-1,2-Dichloroethylene	70 - 130	70 - 130	20
		cis-1,3-Dichloropropene	70 - 130	70 - 130	20
		sec-Butylbenzene	70 - 130	70 - 130	20
		m,p-Xylenes	70 - 130	70 - 130	20
		1,2-Dichlorobenzene	70 - 130	70 - 130	20
		o-Chlorotoluene	70 - 130	70 - 130	20
		o-Xylene	70 - 130	70 - 130	20
		p-Chlorotoluene	70 - 130	70 130	20
		p-Isopropyltoluene	70 - 130	70 - 130	20
		1,4-Dichlorobenzene	70 - 130	70 - 130	20
		2-Butanone (MEK)	70 - 130	56 - 85	20
		4-Methyl-2-Pentanone	70 - 130	70 - 130	20
		trans-1,2-Dichloroethylene	70 - 130	85 - 129	20
		trans-1,3-Dichloropropene	70 - 130	80 - 131	20
		tert-Butylbenzene	70 - 130	70 - 130	20
		Di-Isopropyl Ether (DIPE)	70 - 130	70 - 130	20
		Tertiary Amyl methyl ether	70 - 130	70 130	20
		Tertiarry Butyl ethyl Ether	70 - 130	70 130	20
		Nitrobenzene	80 - 120	70 - 130	20
		Hexachloroethane	80 - 120	70 - 130	20
		1,2-Dichlorobenzene	80 - 120	70 - 130	20
		1,2-Dichloroethane	80 - 120	70 - 130	20
TCP-Low (5ppt)	CA DHS SRLPT/ GCMS	1,2,3-Trichloropropane	80 - 120	70 - 130	20
Semi-Volatile Organics	EPA 525.2	Acenaphthylene	70 - 130	70 - 130	20*

Parameter Method Name	EPA Method Number	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
Acid/Base Neutrals		Alachlor	70 - 130	70 - 130	20*
		Aldrin	70 - 130	70 - 130	20*
		Anthracene	70 - 130	70 130	20*
		Atrazine	70 - 130	70 130	20*
		Benzo(a)anthracene	70 - 130	70 - 130	20*
		Benzo(a)pyrene	70 - 130	70 - 130	20*
		Benzo(b)fluoranthene	70 - 130	70 - 130	20*
		Benzo(g,h,i)perylene	70 - 130	70 130	20*
		Benzo(k)fluoranthene	70 - 130	70 130	20*
		Butylbenzylphthalate	70 - 130	80 - 131	20*
		Caffeine	70 - 130	70 - 130	-
		a-Chlordane	70 - 130	70 - 130	-
		g-Chlordane	70 - 130	70 130	20*
		Chrysene	70 - 130	70 130	20*
		Di-(2-Ethylhexyl)phthalate	70 - 130	70 - 130	20*
		Di-(2-Ethylhexyl)adipate	70 - 130	70 - 130	20*
		Di-n-Butylphthalate	70 - 130	70 - 130	20*
		Dibenzo(a,h)anthracene	70 - 130	70 - 130	20*
		Diethylphthalate	70 - 130	70 - 130	20*
		Dimethylphthalate	70 - 130	70 - 130	20*
		Endrin	70 - 130	70 - 130	20*
		Fluorene	70 - 130	70 - 130	20*
		Butachlor	70 - 130	70 - 130	20*
		4,4-DDD	70 - 130	70 - 130	20*
		4,4-DDE	70 - 130	70 - 130	20*
		4,4-DDT	70 - 130	70 - 130	20*
		Metolachlor	70 - 130	70 - 130	20*
		Metribuzin	70 - 130	70 - 130	20*
		Propachlor	70 - 130	70 - 130	20*
		Heptachlor	70 - 130	70 - 130	20*
		Heptachlor Expoxide	70 - 130	70 - 130	20*
Semi-Volatile Organics Acid/Base Neutrals	EPA 525.2	Hexachlorobenzene	70 - 130	70 - 130	20*
		Hexachlorocyclopentadiene	70 - 130	70 - 130	20*
		Indeno(1,2,3,c,d)pyrene	70 - 130	70 - 130	20*
		Lindane	70 - 130	70 - 130	20*
		Methoxychlor	70 - 130	70 - 130	20*
		Molinate	70 - 130	70 - 130	20*
		Pentachlorophenol	70 - 130	70 - 130	20*

Parameter Method Name	EPA Method Number	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
		Phenanthrene	70 - 130	70 - 130	20*
		Pyrene	70 - 130	70 - 130	20*
		Simazine	70 - 130	70 - 130	20*
		Thiobencarb	70 - 130	70 - 130	20*
		trans-Nonachlor	70 - 130	70 - 130	20*
		Perylene-d12 (surr)	70 - 130	70 - 130	-
N-methylcarbamoyloximes and N-Methylcarbamates	EPA531.2	3-Hydroxycarbofuran	70 - 130	70 - 130	-
		Aldicarb (Temik)	70 - 130	70 - 130	-
		Aldicarb Sulfone	70 - 130	70 - 130	-
		Aldicarb Sulfoxide	70 - 130	70 - 130	-
		Baygon	70 - 130	70 - 130	-
		Carbaryl	70 - 130	70 - 130	-
		Carbofuran (Furadan)	70 - 130	70 - 130	-
		Methiocarb	70 - 130	70 - 130	-
		Methomyl	70 - 130	70 - 130	-
		Oxamyl (Vydate)	70 - 130	70 - 130	-
		4-Bromo-3,5-Dimethylphenyl-N-Methylcarbamate (BDMC)	70 - 130	70 - 130	-
Glyphosate	EPA547	Glyphosate	70 - 130	70 - 130	-
Endothall	EPA548.1	Endothall	63 - 144	38 - 157	-
Diquat & Paraquat	EPA549.2	Diquat	70 - 130	70 - 130	-
		Paraquat	70 - 130	70 - 130	-
Trihalomethanes, Chloral Hydrate, and Haloacetonitrile	551.1	Bromodichloromethane	80 - 120	80 - 120	20
		Bromoform	80 - 120	80 - 120	20
		Chloral Hydrate	80 - 120	80 - 120	20
		Chloroform	80 - 120	80 - 120	20
		Dibromochloromethane	80 - 120	80 - 120	20
		Dibromoacetonitrile	80 - 120	80 - 120	20
		Dichloroacetonitrile	80 - 120	80 - 120	20
		1,1-Dichloro-2-propanone	80 - 120	80 - 120	20
		Trichloroacetonitrile	80 - 120	80 - 120	20
		1,1-Trichloro-2-propanone	80 - 120	80 - 120	20
Haloacetic Acids **	SM6251B	Bromochloroacetic Acid	85 - 115	85 - 117	20
		Chlorodibromoacetic Acid	85 - 115	70 - 130	-
		Dibromoacetic Acid	85 - 115	85 - 116	20
		Dichloroacetic Acid	85 - 115	81 - 119	20
		Monobromoacetic Acid	85 - 115	82 - 117	20
		Monochloroacetic Acid	85 - 115	68 - 126	20
		Tribromoacetic Acid	85 - 115	70 - 130	

Parameter Method Name	EPA Method Number	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB % Rec.	MS/LFM % Rec.	
		Trichloroacetic Acid	85 -115	76 - 125	20

* RPD-LCS
** Low Level LFB/LCS 50-150 % Recovery

(E) Radiochemistry

Parameter Method Name	EPA Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB % Rec.	MS/LFM % Rec.	
Uranium	EPA 200.8 (Screen)	Uranium	80 - 120	80 - 120	20
Gross Alpha	EPA 900.0	Gross Alpha	80 - 120	80 - 120	20
Gross Beta	EPA 900.0	Gross Beta	80 - 120	80 - 120	20
Radium 228	EPA 904	Radium 228	80 - 120	-	20
Radon 222, Liquid Scintillation	SM7500-Rn	Radon 222	80 - 120	-	20

Table 5-2 Precision and Accuracy for Wastewater for Mid or High Level Spikes

(A) Inorganics – Wet Chemistry

Parameter Method Name	Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB % Rec.	MS/LFM % Rec.	
Alkalinity	SM2320B	Bicarbonate	90 - 110	80 - 120	20
		Carbonate	90 - 110	80 - 120	20
		Hydroxide	90 - 110	80 - 120	20
Ammonia	EPA350.1 / SM4500NH3H/G	Ammonia	90 - 110	90 - 110	20
Biochemical Oxygen Demand (BOD)	EPA 405.1 / SM5210B	Biochemical Oxygen Demand	85 - 115	-	-
Carbon Biochemical Oxygen Demand (CBOD)	SM5210B	Carbon Biochemical Oxygen Demand	85 - 115	-	-
Chemical Oxygen Demand (COD)	EPA410.4 / 5220 D	Chemical Oxygen Demand (COD)	90 - 110	90 - 110	20
Chloride	EPA300.0	Chloride	90 - 110	90 - 110	20
Chlorine, Total Residual	SM4500 Cl G	Chlorine, Total Residual	85 - 115	-	-
Chromium VI	EPA 218.6/ SM3500 Cr-B, Colorimetric	Chromium VI	85 - 115	70 - 130	20
Specific Conductance	SM2510B / EPA 120.1	Specific Conductance	95 - 105	-	5
Cyanide, Total	EPA 335.4	Cyanide, Total	90 - 110	90 - 110	20
Cyanide, Amenable to Chlorination	SM 4500CN-G	Cyanide, Amenable to Chlorination	80 - 120	80 - 120	20
Fluoride	SM4500 F-C	Fluoride	81 - 116	73 - 124	20

Parameter Method Name	Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB % Rec.	MS/LFM % Rec.	
Hardness	SM2340B/EPA 200.7	Hardness	90 - 110	80 - 120	20
Total Kjeldahl Nitrogen	EPA351.2	Kjeldahl Nitrogen	90 - 110	90 - 110	20
Nitrate	EPA353.2	Nitrate + Nitrite	90 - 110	90 - 110	20
	EPA300.0	Nitrate	90 - 110	90 - 110	20
Nitrite	EPA300.0	Nitrite	90 - 110	90 - 110	20
	EPA 353.2	Nitrite	90 - 110	90 - 110	20
Orthophosphate	EPA365.1/ SM4500 P-E/PF	Orthophosphate	90 - 110	80 - 120	20
Perchlorate	EPA 314	Perchlorate	85 - 115	80 - 120	20
pH	SM4500-HB	pH	-	-	+ 0.1 pH
Phenols	EPA 420.1 / 420.4	Phenols	90 - 110	90 - 110	20
Phosphorus, Total	EPA365.1/ SM4500 P-F	Phosphorus, Total	90 - 110	90 - 110	10
Dissolved Silica	SM 4500 SiO2C	Dissolved Silica	85 - 115	70 - 130	-
Residue, Filterable (Total Dissolved Solids--TDS)	SM2540C	TDS	85 - 115	-	20
Residue, Non-filterable (Total Suspended Solids--TSS)	SM2540D	TSS	80 - 120	-	10
Residue, Settleable (Settleable Solids)	SM2540F	Residue, Settleable (Settleable Solids)	-	-	-
Sulfate	EPA300.0	Sulfate	90 - 110	90 - 110	20
Sulfide (Total & Soluble)	SM 4500S-2D	Sulfide	90 - 110	80 - 120	20
Total Residue	SM 2540 B	Total Solids	80 - 120	-	10
Total Organic Carbon (TOC)	SM5310C	Total Organic Carbon (TOC)	90 - 110	90 - 110	20
Total Organic Halide (TOX)	SM 5320B	Total Organic Halide (TOX)	85 - 115	90 - 110	-
Dissolved Oxygen	SM 4500-O G	Dissolved Oxygen	85 - 115	70 - 130	-
Color	SM 2120B	Color	-	-	-
Surfactants	SM 5540C	Surfactants	90 - 110	80 - 120	20
Turbidity	SM 2130B/ EPA 180.1	Turbidity	90 - 110	-	-

(B) Inorganics – Metals

Parameter Method Name	Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB % Rec.	MS/LFM % Rec.	
Asbestos	EPA 100.2	Asbestos	-	-	-
Metals	EPA200.7	Aluminum, Al	85 - 115	70 - 130	20
		Antimony, Sb	85 115	70 130	20
		Barium, Ba	85 - 115	70 - 130	20
		Beryllium, Be	85 - 115	70 - 130	20

Parameter Method Name	Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
		Boron, B	85 - 115	70 - 130	20
		Cadmium, Cd	85 - 115	70 - 130	20
		Calcium, Ca	85 - 115	70 - 130	20
		Chromium, Cr	85 - 115	70 - 130	20
		Cobalt, Co	85 - 115	70 - 130	20
		Copper, Cu	85 - 115	70 - 130	20
		Iron, Fe	85 - 115	70 - 130	20
		Magnesium, Mg	85 - 115	70 - 130	20
		Manganese, Mn	85 - 115	70 - 130	20
		Molybdenum, Mo	85 115	70 130	20
		Nickel, Ni	85 - 115	70 - 130	20
		Potassium, K	85 - 115	70 - 130	20
		Silica, SiO2	85 - 115	70 - 130	20
		Silver, Ag	85 - 115	70 - 130	20
		Sodium, Na	85 - 115	70 - 130	20
		Tin, Sn	85 - 115	70 - 130	20
		Vanadium, V	85 - 115	70 - 130	20
		Zinc, Zn	85 - 115	70 - 130	20
Metals	EPA 200.8	Aluminum, Al	85 - 115	70 - 130	20
		Antimony, Sb	85 - 115	70 - 130	20
		Arsenic, As	85 - 115	70 - 130	20
		Barium, Ba	85 - 115	70 - 130	20
		Beryllium, Be	85 - 115	70 - 130	20
		Cadmium, Cd	85 - 115	70 - 130	20
		Chromium, Cr	85 - 115	70 - 130	20
		Cobalt, Co	85 - 115	70 - 130	20
		Copper, Cu	85 - 115	70 - 130	20
		Lead, Pb	85 - 115	70 - 130	20
		Manganese, Mn	85 - 115	70 - 130	20
		Molybdenum, Mo	85 - 115	70 - 130	20
		Nickel, Ni	85 - 115	70 - 130	20
		Selenium, Se	85 - 115	70 - 130	20
		Silver, Ag	85 - 115	70 - 130	20
		Thallium, Tl	85 - 115	70 - 130	20
		Vanadium, V	85 - 115	70 - 130	20
		Zinc, Zn	85 - 115	70 - 130	20
Mercury	EPA 245.1/7470A	Mercury,Hg	85 - 115	70 - 130	20
Chromium VI	SM 3500Cr B (20th)	Chromium VI	85 - 115	70 - 130	20

Parameter Method Name	Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
Silica, Dissolved	SM 4500SiO2C	Silica, Dissolved	85 - 115	70 - 130	20

(C) Microbiology/Microbiology Tests

Parameter Method Name	Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
Fecal Coliforms By Multiple Tube Fermentation /EC Medium	SM9221C, E (MTF/EC)	Fecal Coliforms	-	-	-
Fecal Streptococci/ Enterococci by MTF	SM9230B	Fecal Streptococci/ E-Coli by MTF	-	-	-
Heterotrophic Plate Count	SM9215B	Heterotrophic Plate Count	-	-	-
Total Coliforms Multiple Tube Fermentation (MTF)	SM9221B	Total Coliforms	-	-	-

(D) Radiochemistry

Parameter Method Name	EPA Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
Gross Alpha/Proportional Counting	EPA900.0	Gross Alpha	80 - 120	80 - 120	20
Gross Beta	EPA900.0	Gross Beta	80 - 120	80 - 120	20

Table 5-3 Precision and Accuracy for Hazardous Waste for Mid or High Level Spikes

(A) Inorganics – Wet Chemistry

Parameter Method Name	EPA Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
Total Organic Halogen	EPA 9020B	Total Organic Halogen	85 - 115	70 - 130	20

(B) Inorganics – Metals

Parameter Method Name	EPA Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
Metals, Total	EPA6010B	Aluminum, Al	85 - 115	70 - 130	20
		Antimony, Sb	85 - 115	70 - 130	20

Parameter Method Name	EPA Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
		Barium, Ba	85 - 115	70 - 130	20
		Beryllium, Be	85 - 115	70 - 130	20
		Cadmium, Cd	85 - 115	70 - 130	20
		Chromium, Cr	85 - 115	70 - 130	20
		Cobalt, Co	85 - 115	70 - 130	20
		Copper, Cu	85 - 115	70 - 130	20
		Manganese, Mn	85 - 115	70 - 130	20
		Molybdenum, Mo	85 - 115	70 - 130	20
		Nickel, Ni	85 - 115	70 - 130	20
		Silver, Ag	85 - 115	70 - 130	20
		Strontium, Sr	70 - 130	70 - 130	20
		Tin, Sn	85 - 115	70 - 130	20
		Titanium, Ti	70 - 130	70 - 130	20
		Vanadium, V	85 - 115	70 - 130	20
		Zinc, Zn	85 - 115	70 - 130	20
Metals , Total	EPA6020	Antimony, Sb	85 - 115	70 - 130	20
		Arsenic, As	85 - 115	70 - 130	20
		Barium, Ba	85 - 115	70 - 130	20
		Beryllium, Be	85 - 115	70 - 130	20
		Cadmium, Cd	85 - 115	70 - 130	20
		Chromium, Cr	85 - 115	70 - 130	20
		Cobalt, Co	85 - 115	70 - 130	20
		Copper, Cu	85 - 115	70 - 130	20
		Lead, Pb	85 - 115	70 - 130	20
		Molybdenum, Mo	85 - 115	70 - 130	20
		Nickel, Ni	85 - 115	70 - 130	20
		Selenium, Se	85 - 115	70 - 130	20
		Silver, Ag	85 - 115	70 - 130	20
		Thallium, Tl	85 - 115	70 - 130	20
		Vanadium, V	85 - 115	70 - 130	20

Parameter Method Name	EPA Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
		Zinc, Zn	85 - 115	70 - 130	20
Chromium VI	EPA 7196A EPA 7199	Hexavalent Chromium	85 - 115	70 - 130	20
Mercury	EPA7470A	Mercury, Hg	85 - 115	70 - 130	20

(C) Organics

Parameter Method Name	EPA Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
Halogenated/ Aromatic Volatiles	EPA8260B	Acetone	70 - 130	70 - 130	30
		Acrolein (Propenal)	70 - 130	70 - 130	30
		Acrylonitrile	70 - 130	70 - 130	30
		Benzene	70 - 130	70 - 130	30
		Bromodichloromethane	70 - 130	70 - 130	30
		Bromoform	70 - 130	70 - 130	30
		Bromomethane	70 - 130	70 - 130	30
		2-Butanone (MEK)	70 - 130	70 - 130	30
		Carbon disulfide	70 - 130	70 - 130	30
		Carbon tetrachloride	70 - 130	70 - 130	30
		Chlorobenzene	70 - 130	70 - 130	30
		Chlorodibromomethane	70 - 130	70 - 130	30
		Chloroethane	70 - 130	70 - 130	30
		2-Chloroethyl vinyl ether	70 - 130	70 - 130	30
		Chloroform	70 - 130	70 - 130	30
		Chloromethane	70 - 130	70 - 130	30
		Acetone	70 - 130	70 - 130	30
		Dibromomethane	70 - 130	70 - 130	30
		1,2-Dichlorobenzene	70 - 130	70 - 130	30
		1,3-Dichlorobenzene	70 - 130	70 - 130	30
		1,4-Dichlorobenzene	70 - 130	70 - 130	30
		Dichlorodifluoromethane	70 - 130	70 - 130	30
		1,1-Dichloroethane	70 - 130	70 - 130	30
		1,2-Dichloroethane	70 - 130	70 - 130	30

Parameter Method Name	EPA Method Name	Parameters/ Analytes	Accuracy		Precision RPD Maximum
			LCS/LFB	MS/LFM	
			% Rec.	% Rec.	
		1,1-Dichloroethylene	70 - 130	70 - 130	30
		cis-1,2-Dichloroethene	70 - 130	70 - 130	30
		trans-1,2-Dichloroethene	70 - 130	70 - 130	30
		1,2-Dichloropropane	70 - 130	70 - 130	30
		cis-1,3-Dichloropropene	70 - 130	70 - 130	30
		trans-1,3-Dichloropropene	70 - 130	70 - 130	30
		Ethylbenzene	70 - 130	70 - 130	30
		2-Hexanone	70 - 130	70 - 130	30
		Methylene chloride	70 - 130	70 - 130	30
		4-Methyl-2-pentanone (MIBK)	70 - 130	70 - 130	30
		Naphthalene	70 - 130	70 - 130	30
		2-Pentanone	70 - 130	70 - 130	30
		Styrene	70 - 130	70 - 130	30
		1,1,2,2-Tetrachloroethane	70 - 130	70 - 130	30
		Tetrachloroethene	70 - 130	70 - 130	30
		Toluene	70 - 130	70 - 130	30
		1,2,4-Trichlorobenzene	70 - 130	70 - 130	30
		1,1,1-Trichloroethane	70 - 130	70 - 130	30
		1,1,2-Trichloroethane	70 - 130	70 - 130	30
		Trichloroethene	70 - 130	70 - 130	30
		Trichlorofluoromethane	70 - 130	70 - 130	30
		Vinyl acetate	70 - 130	70 - 130	30
		Vinyl chloride	70 - 130	70 - 130	30
		o-Xylene	70 - 130	70 - 130	30
		m-Xylene	70 - 130	70 - 130	30
		p-Xylene	70 - 130	70 - 130	30
		1,2-Dichloroethane-d4 (surr)	80 - 120	80 - 120	-
		Toluene-d8 (surr)	88 - 110	88 - 110	-
		4-Bromofluorobenzene (surr)	86 - 115	86 - 115	-

6.0 QUALITY OF TEST RESULTS

6.1. ESSENTIAL QUALITY CONTROL PROCEDURES

The laboratory has established a quality control program that is designed to provide two different types of information about a particular analysis. The ability to confidently evaluate laboratory performance in terms of analytical bias and precision is accomplished through the use of both laboratory control samples (LCS), in the absence of sample matrix effects, and the traditional approach of using matrix spikes and duplicate (MS/MSD) analyses.

The quality control program implemented at MWH Laboratories recognizes the problems associated with the use of matrix spikes and duplicates, and thus decisions regarding method data quality, when matrix effects are present, are made using data obtained from all control samples. The types and frequencies of control samples used at MWH Laboratories are summarized below. Control limits are calculated from historical data, whenever possible, for each method and matrix. Limits are updated at least once a year, or at least once every 6 months for Hazardous Waste, and the limits listed in this manual may not reflect what is actually in use at the time of sampling. (See relevant SOP for the current control limits).

6.1.1. NEGATIVE CONTROL

6.1.1.1. Method Blanks

A method blank consists of laboratory pure water containing all of the reagents utilized in the analytical procedure. The method blank is prepared in the same manner as a sample and is processed through all of the analytical steps. All reagents are dated upon receipt in the laboratory and each new lot of reagents is checked by performance of method blanks.

Method blanks are performed to determine whether there is reagent contamination or instrument contamination due to sample carryover. The method blanks must remain below the MRL for each analyte of interest. Some analyses (see specific SOPs) have a more stringent requirement (e.g. < ½ or < 1/3 MRL). If samples require a preparatory procedure such as a digestion or extraction prior to analysis, a method blank must be carried through the entire process and analyzed in addition to the instrumental calibration blanks.

When a blank is determined to be contaminated, the cause must be investigated and measures taken to minimize or eliminate the problem. Samples associated with a contaminated blank shall be evaluated as to the best corrective action for the samples (e.g. reprocessing or data qualifying codes). In all cases the corrective action must be documented. (NELAC D.1.1.1.d.3.)

Method blanks are analyzed as part of the initial or daily calibration process (calibration blanks) and after every 20 samples for each matrix type to monitor the overall procedural blank as well as the purity of the reagents. If analyte in method blanks is >MRL and is >1/10 of amount measured in sample and if blank contamination affects samples or individual data, quality, objectives, the problem is eliminated and reprocessed or affected samples appropriately qualified.

6.1.1.2. **Travel Blanks**

Both methods 504.1 and 524.2 for volatiles determination require a trip blank with each set of samples. The trip blank is required to be analyzed in the event of any detects in the associated field samples

When running method 525.2 for phthalates determination for compliance monitoring purposes, the laboratory runs a trip blank if any of the samples are found positive for phthalates. This is necessary to show that samples were not contaminated from bottle caps, the HCl used for preservation, or the latex gloves worn during sampling. If the samples show the presence of phthalates and there was no trip blank with the set of samples then subsequent resamples from the site must be accompanied by a trip blank. If the samples are not to be analyzed for phthalates, the laboratory does not need to run a trip blank.

If a client has submitted a trip blank and wishes it to be analyzed automatically, the sample is logged in with the appropriate tests and with the log-in ID "Trip Blank - Analyze" so that analysts will know to analyze and report them.

If a trip blank is submitted and is only to be analyzed in the event of hits, the sample is logged in with an ID of "Trip Blank-Hold."

For the analysis of ethylene dibromide and dibromochloropropane by Method 504.1 and phthalates by method 525.2, the analyst and supervisor ensure that if hits are detected in the associated samples, the trip blank is analyzed and reported within holding times.

Because of the relatively short holding times for VOAs by Method 524.2 and 504.1, the trip blanks are usually analyzed (unless specified by client) whether or not there are hits in the associated sample. In this way, Trip Blanks are always analyzed within holding times.

If there is adequate holding time remaining the analyst may elect to not analyze the trip blank. However in this case, the data should be reduced immediately and if there are hits, the sample should be analyzed on the next run, still within holding time.

In the event that no hits are present in the associated client samples the analyst and supervisor enter NA for the trip blank and preferably place a comment on the sample “not analyzed, no hits in field samples".

In the event that an analyte is detected in the trip blank, the analyst gets the associated stationary blank from shipping, if available, and runs that immediately to confirm that the hits are not due to lab contamination when the blank was prepared. The information to associate the proper trip blank to the sample(s) is be found on the sample bottle label, through the LIMS numbering system, and/or on the COC.

6.1.1.3. **Field Blanks**

Field blanks are used to identify contamination that may have occurred during the sample collection process. Empty containers are sent to the field and filled with analyte-free water at the sampling location at the time of sampling as provided by the client.

6.1.1.4. **Sample Blanks**

Sample blanks are used with spectrophotometric methods where sample characteristics such as color may give erroneous results. The absorbance of a sample is measured before and after the color development process. The absorbance before is subtracted from the absorbance after to give the true absorbance. Sample blanks are analyzed on an as-needed basis.

6.1.1.5. **Calibration Blanks**

For non-chromatographic analysis, calibration blanks are prepared along with the calibration standards and differ from the standards only in that the calibration blank does not contain any of the analyte(s) of interest. The calibration blank, by definition, provides the "zero point" in the calibration curve.

6.1.2. **Positive Control**

6.1.2.1. **Laboratory Control Sample (LCS)/Laboratory Fortified Blank (LFB)**

The LCS is used to evaluate the performance of the total analytical system, including all preparation and analysis steps. (NELAC Appendix D.1.1.2.1)

Laboratory control samples (LCSs) are defined as an interference free matrix spiked with a particular set of method-specific target compounds at a level 5-10 times above the minimum reporting limit. The matrix used to prepare aqueous LCS samples is laboratory reagent water (deionized water - carbon-filtered for organic analyses). In some cases LCS must be from a second or independent source, but other methods allow for the use of same sources.

The purpose of the LCS matrix is not to duplicate the sample matrix, but more importantly to provide a consistent matrix with which baseline performance data for an analysis can be generated. This feature of the LCS provides one of the most significant

advantages over the use of matrix spikes and spike duplicates. The variable matrix interferences inherent to matrix spikes and spike duplicates are manifested in the extremely wide control limits presented in the methods. This variability results in a large relative standard deviation in the data used to calculate the control limits which forces the control limits to become wider. The control of this variability significantly reduces the relative standard deviation of the data and results in control limits that are representative of laboratory precision alone.

6.1.2.2. Matrix Spike and Matrix Spike Duplicate Samples (MS/MSD)

MS/MSD samples are defined as a sample matrix spiked with a particular set of method-specific target compounds at a level 5-10 times above the minimum reporting limit. Samples are generally divided into two types of matrices, aqueous and non-aqueous.

Matrix spikes and spike duplicates are prepared using a sample matrix that is representative of the sample type being analyzed for a particular method.

6.1.2.3. LCS and MS/MSD Concentration Levels

The following criteria (in order of descending preference) are to be applied when determining the appropriate concentration of any particular analyte in the designated control sample:

6.1.2.3.1. If no MCL exists, or the MCL represents an impractical level relative to MDL or calibration range, the selected level should be set at the corresponding level used in the EPA's reference methods.

6.1.2.3.2. The level selected should be equal to any existing federal maximum contaminant level (MCL). This may not always be practical (as in the case of thallium [Tl]) when the MCL is too close to our actual MRL to yield consistent accuracy and precision.

6.1.2.3.3. If there is no EPA protocol for a particular method, or this level is inappropriate for the method, then the selected level should be near the midpoint of the calibration range. Optimally, this would be equivalent to the MCL, unless the calibration range spans more than 2 orders of magnitude.

6.1.2.3.4. If the calibration range spans 2 or more orders of magnitude, the selected level should be set at approximately 10 times the MRL for each analyte.

In some cases multiple levels (MRL, midpoint, high) are used to monitor control throughout the calibration range.

6.1.2.4. Selection of Spike Analytes

Any analyte reported must be included in the LCS and MS spiked sample. The selection of specific analytes to be spiked should be based on the following scheme:

6.1.2.4.1. If there are regulatory or method specific monitoring requirements for any of the target compounds, these compounds should be included.

6.1.2.4.2. If there are no regulatory or method specific monitoring requirements or additional analytes required to meet the absolute number to be included in the subset, follow NELAC 5.Appendix D.1.1.2c) requirements for LCS spiking composition and NELAC 5.Appendix D.1.1.3.1c) for MS spiking composition.

6.1.2.4.3. For those test methods that have extremely long lists of analytes, a representative number may be chosen. The analytes selected should be representative of all analytes reported. The following criteria shall be used for determining the minimum number of analytes to be spiked for LCS and MS. However, the laboratory shall ensure that all targeted components are included in the spike mixture over a 2-year period.

- For methods that include 1-10 targets, spike all components;
- For methods that include 11-20 targets, spike at least 10 or 80%, whichever is greater;
- For methods with more than 20 targets, spike at least 16 components.

6.1.2.4.4. If neither of the above criteria apply, then the analytes should be selected for the subset so that all the different classes of compounds in the list of target compounds for the method are represented.

6.1.2.4.5. Any unique, method-specific problem analyte or element (such as potential loss of a particular analyte during extraction, digestion, or cleanup step or an element subject to severe inter-element interference on the ICP) should be represented in the subset.

6.1.2.4.6. In the absence of specified spiking components, for those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike chosen represents the chemistries and elution patterns of the components to be reported.

6.1.2.5. **Sample Preparation of LCS/LFB and MS/MSD**

The intent of this program is to set our control sample analytes and concentration levels such that a single concentrated stock mix is (1) independently prepared (preferably from different neat materials) from calibration stock solutions, and (2) can be used to prepare LCS samples as well as MS/MSD samples for both aqueous and non-aqueous environmental samples.

The ratio of spiked concentrate to sample aliquot used to prepare MS/MSD samples must be 1 to 10%, depending on the method specifications. In the case of matrix spikes, this practice ensures that we are not diluting the environmental sample to such an extent that we are diluting out any matrix interferences. The purpose of the matrix spike is to provide information regarding the ability to recover an analyte from a particular matrix.

6.1.2.5.1. **Stock Source of LCS/LFB and MS/MSD**

In order to serve its purpose as an external verification (reference) of the calibration, it is essential that the stock solutions used to prepare LCS and matrix spike samples be prepared independently of calibration stocks unless a method specifies a contrary approach. In the organics area, there is a lack of independent sources from which reference materials are obtained but the stock solutions should be prepared independently although they may share a common source.

The source of control sample reference materials should be selected in the following order of preference:

6.1.2.5.1.1. The neat compound must be prepared from either a completely independent sources. For example, a 1000-mg/L stock As solution obtained from Fisher is used to prepare As calibration standards, while a 1000 mg/L stock As solution obtained from Spex is used to prepare the control sample concentrate.

6.1.2.5.1.2. If a completely independent source cannot be obtained, the same vendor may be used, but the solution shall be from a completely different lot (second lot).

6.1.2.5.1.3. If it is impossible to obtain the reference material from two independent sources, or from two different lots, then the material from a single source can be used provided that a different analyst than the one who prepared the calibration stock is responsible for preparing the control sample solution.

6.1.2.6. **Frequency of MS/MSD**

MS/MSD samples are run at a frequency of one pair for every sample batch of 20 or less of a similar matrix. In cases where there is insufficient sample to run a MS/MSD as well as the original, a pair of LCS samples may be substituted to fulfill this requirement. There is often insufficient sample for aqueous samples to have a MS/MSD set up due to the large volumes of sample required for analysis. MWH Laboratories encourages clients who require precision and accuracy information based on a particular matrix to make arrangements to submit adequate sample volumes for this purpose. By supplying these samples, the client is able to obtain not only specific information regarding laboratory performance (from LCS sample data), but also a measure of the applicability of the sample matrix to the analytical method used (from the matrix spike and duplicate data). If the matrix spike is used in place of the LCS, the acceptance criteria must be as stringent as the LCS (NELAC D.1.1.2.1.c.).

6.1.2.7. **Frequency of LCS/LFB**

Laboratory control samples are analyzed throughout a run at a frequency of 5%-10% for environmental samples of a similar matrix. Bias information is provided based on recovery data for the LCS and precision information is available by comparing LCS sample results using a RPD calculation. The frequencies are consistent with the requirements of most methods referenced in Standard Methods, EPA Manual for Chemical Analysis of Water and Waste, 40 CFR 136 for the wastewater methods, and EPA Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Edition. Additional measures of precision and bias are obtained from other control samples, as specified in the SOP's.

In order to ensure that some measure of analytical control is provided with each batch of samples going through a pre-analysis preparation step, an LCS is prepared with each set of 20 samples extracted or digested for these analyses. In each case, an LCS will be associated with each set of samples prepared, to allow documentation of control of the analytical procedures. Some methods require varying concentrations of LCS throughout a run.

6.1.2.7.1. Analyses with a preliminary treatment step (i.e. extraction or digestion):

6.1.2.7.1.1. LCS frequency is one for every 10 to 20 samples (see individual method SOPs) or at least one for every preparation batch.

6.1.2.7.1.2. MS/MSD or LCS pair (in cases where there is insufficient sample volume for a MS/MSD) is prepared for every sample batch of 20 samples or as per method specifications.

6.1.2.7.2. Analyses not requiring pretreatment:

6.1.2.7.2.1. A LCS must be run with each analytical run at a frequency of no less than one for every 10 or 20 samples (see individual method SOPs).

6.1.2.7.2.2. A MS/MSD or LCS pair must be run for every batch of 20 samples as defined in method specifications or NELAC standards.

6.1.2.7.2.3. Any exceptions to this frequency on a given run must be documented on a corrective action form.

6.1.2.8. **Evaluation Criteria of MS/MSD**

MS acceptance criteria are compared to the acceptance criteria as published in the mandated test method if not specified in the method. Advisory limits for each method are established initially based on method validation data. Initial control limits are defined

as the mean recovery (accuracy) ± 3 times the standard deviation obtained from the analysis of 4 (or more) replicates spiked at approximately 10x MRL during the method validation process. Warning limits are set as the mean recovery (accuracy) ±2 times the standard deviation.

Firm acceptance criteria, based upon actual laboratory data, are established once a minimum of 20 data points has been generated. These historical control limits are compared to any method specified or recommended limits to assess their feasibility. Control limits are re-calculated at least yearly to verify that there has been no significant change in performance.

Precision is determined as the relative percent difference (RPD) between LCS pairs or MS/MSD samples. By linking a LCS or MS/MSD pair to each batch of 20 environmental samples, it is possible to link a measure of analytical precision (and two measures of analytical accuracy) to each environmental sample analyzed.

Precision control limits for some analytes have been adopted from the EPA CLP program where they exist, otherwise, control limits are set after the analysis of 20 MS/MSD or LCS pairs of samples (40 control samples). Control limits are set as the mean ± 3 standard deviations of the RPD from the 20-30 "pairs", with warning limits set at the mean ± 2 standard deviations. Until such time as 20-30 data points have been accumulated, interim acceptance criteria should be set as 3 times the standard deviations of the RPD obtained during the method validation process.

Whenever MS/MSD or LCS pairs do not meet these limits, an analysis may have a potential problem. Samples with failing LCS shall be reprocessed and reanalyzed or data reported with data qualifying codes. The source of any problems must be investigated and documented by preparing a corrective action or procedural variance report.

For drinking water method, when there is no method specification, the spike level should not be less than the concentration of the sample selected for fortification unless specified by the method. If the sample concentration is unknown or less than detectable, the analyst should choose an appropriate concentration. If the spike level is less than the concentration of the sample selected, the spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level.

6.1.2.9. **Evaluation Criteria of LCS/LFB – Marginal Exceedances**

If a large number of analytes are in the LCS, it becomes statistically likely that a few will be outside control limits. This may not indicate that the system is out of control, therefore corrective action may not be necessary. Upper and lower marginal exceedance (ME) limits can be established to determine when corrective action is necessary. A ME is defined as being beyond the LCS control limit (3 standard deviations), but within the ME limits. ME limits are between 3 and 4 standard deviations around the mean.

The number of allowable marginal exceedances is based on the number of analytes in the LCS. If more analytes exceed the LCS control limits than is allowed, or if any one analyte exceeds the ME limits, the LCS fails and corrective action is necessary. This marginal exceedance approach is relevant for methods with long lists of analytes. If will not apply to target analyte lists with fewer than 11 analytes.

The number of allowable marginal exceedances is as follows:

- 90 analytes in LCS, 5 analytes allowed in ME of the LCS control limit;
- 71 – 90 analytes in LCS, 4 analytes allowed in ME of the LCS control limit;
- 51 – 70 analytes in LCS, 3 analytes allowed in ME of the LCS control limit;
- 31 – 50 analytes in LCS, 2 analytes allowed in ME of the LCS control limit;
- 11 – 30 analytes in LCS, 1 analytes allowed in ME of the LCS control limit;
- < 11 analytes in LCS, no analytes allowed in ME of the LCS control limit.

Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. Laboratories must have a written procedure to monitor the application of marginal exceedance allowance to the LCS to ensure random behavior.

6.2. Sample Specific Controls

6.2.1. Internal and Surrogate Standards

Internal standards are run with GC/MS analyses to monitor the efficiency of the analytical procedure for each sample matrix encountered. They are useful in GC analyses to monitor retention time shifts and the efficiency of the auto-sampler injection. Surrogate standards are run with GC/MS and GC analyses to monitor the efficiency of the extraction for each sample matrix encountered. When there are no established criteria for surrogates from the method, the lab determines internal limits through control charts.

Control limits are re-established annually for surrogates based on historical laboratory data from environmental sample matrices. Internal and surrogate standards are added to each sample analyzed by EPA Methods as recommended and run in accordance with the method procedures. For references to specific compounds used for internal and surrogate standards please reference the SOP.

Current surrogate acceptance limits may be found in Table 6-1 and Tables 5-1, 5-2, and 5-3.

6.2.2. Spikes – Recoveries, RPDs

Spiked sample analyses (MS/MSD) are performed to evaluate the effect of the sample matrix on the analytical methodology. A known amount of the analyte(s) of interest is added to an aliquot of sample, which is then analyzed along with the unspiked sample. Spiked samples are prepared and subjected to the same process as the original sample. Spike recoveries are calculated, and used to determine whether the sample matrix interferes with the method.

Spike recoveries are calculated as follows:

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

Where;

%R	=	percent spike recovery
SSR	=	spiked sample result
SR	=	sample result
SA	=	spike amount added.

The Laboratory documents the percent (%) recoveries and %RPD for MS/MSD samples [NELAC 5.Appendix D.1.1.3.1d)].

6.2.3. **Duplicates, Duplicate Spikes**

Duplicate analysis of a sample has traditionally been used to obtain a measure of analytical precision in the form of a relative percent difference (RPD) calculation between the two values. MWH Laboratories routinely will analyze duplicate spiked control samples, MS/MSD to meet specific client's QC requirements such as Arizona.

Since no precision information is obtained when either or both of the duplicates have analyte concentrations below the method detection limit, duplicate analysis of the spiked samples makes the most sense. While still subject to interference problems the advantage of duplicate matrix spikes is clearly the ability to obtain calculated RPD values specific for a particular sample matrix. Clients are encouraged to submit sufficient sample for the analysis of MS/MSD samples by specific request when a RPD value for their particular matrix is desirable.

Ongoing analytical precision is evaluated by tracking the difference between the MS/MSD (or LCS pairs) analyzed with each batch of 20 samples. These differences are compared to control limits established for each analysis from historical monitoring. In the event that the method does not specify the criteria, control charts are reviewed to set laboratory internal/default QC criteria [NELAC 5.Appendix D.1.1.3.1d)].

For those analyses for which MS/MSD or LCS samples are not prepared, sample duplicates are analyzed to monitor performance.

The relative percent difference between duplicates or duplicate spikes is calculated as follows:

$$\textbf{RPD} = \frac{(S-D)}{(S+D)/2} \times 100$$

where;

RPD	=	Relative Percent Difference
S	=	First Sample Value (original)
D	=	Second Sample Value (duplicate)

6.2.4. External Reference Samples

Reference samples such as those available from NIST and EPA are analyzed to verify the accuracy of calibration standards. Reference standards with matrices comparable to the samples being analyzed are also included in the run whenever available.

External reference samples are analyzed immediately following the calibration standards for all inorganic and organic analyses. Appropriate reference samples for organics analyses by GC and GC/MS are less readily available and are only run when a new stock standard is prepared to verify its accuracy

6.2.5. Confirmation

Confirmation is performed to verify the compound identification when positive results are detected on a sample from a location that has not been previously tested by the laboratory. Confirmations are performed on GC organic tests such as pesticides or herbicides. GC confirmation is done following method requirements or recommendations. See method SOPs for detailed discussion of the confirmation methods. Confirmation is not required when a sample is analyzed by mass spectrometer methods. All confirmation is documented in appropriate log books/work books.

6.2.6. Retention Time Windows

Absolute retention time and relative retention time aid in the identification of components in chromatographic analyses and to evaluate the effectiveness of a column to separate constituents. The laboratory ensures that it meets the method acceptance criteria for retention time windows. If the method does not specify acceptance criteria for retention time windows, the laboratory gathers a minimum of 30 data points and calculates the acceptance criteria range using 3 times the standard deviation of the average ($\bar{x} \pm 3sd$).

6.3. DEMONSTRATION OF CAPABILITY (DOC)

6.3.1. **Method Detection Limits (MDL) / Limit of Detection (LOD)**

6.3.1.1. The laboratory shall utilize MDL determination by 40 CFR Part 136 as one option to provide an LOD for each analyte that is appropriate and relevant for the intended use of the data. An LOD is not required for a test method when test results are not reported outside the calibration range. LOD shall be determined by the protocol in the mandated test method or applicable regulation. If the protocol for determining LOD is not specified, the selection of the procedure must reflect instrument limitations and the intended application of the test method. (NELAC Appendix D.1.2.1)

6.3.1.2. The MDL shall be initially determined for the compounds of interest in each test method in a quality system matrix in which there are not target analytes nor interferences at a concentration that would impact the results of the MDL must be determined in the quality system matrix of interest. (NELAC Appendix D.1.2.1.a.)

6.3.1.3. Method Detection Limits (MDLs) will be determined as per 40CFR, part 136, Appendix B. Essentially, this requires that an estimate of the detection limit be determined for each target analyte based on analytical experience or published references. Seven replicates of DI water must then be spiked at this estimated MDL for each method analyte carried through the entire procedure over a minimum of 3 separate analysis/extraction days. The MDL is then calculated as the standard deviation of the 7 replicates multiplied by the statistical "t-value" associated with the actual number of replicates analyzed assuming N-1 degrees of freedom (for exactly 7 replicates, the t-value is 3.143; 40 CFR, Part 136).

6.3.1.4. LOD/MDL must be verified annually as per the EPA Manual at a minimum (or more frequently if stated in the Method such as EPA 300.0 and 353.2 where the MDL study has to be repeated every 6 months). A copy of all associated data must be submitted to the QA group for filing.

6.3.1.5. An MDL study must be repeated for each new analyst trained in a particular method, or if there is a change in the instrumentation or the test method that is used for the analysis in question. This is a necessary requirement to ensure that each new analyst has received sufficient training such that the data generated will be comparable to that of former analysts. It is necessary to repeat the MDL process with a change in instrumentation to ensure that the new instrumentation is capable of achieving equivalent sensitivity. An MDL study must also be repeated when there is any significant change in background or instrument response.

6.3.1.6. A minimum of a three-point calibration will be performed prior to the MDL study. One of the points must be at the MDL spike level. The calibration must meet all criteria outlined in the Calibration Policy.

6.3.1.7. The spiked level must be within 10 times the calculated MDL or the process must be repeated at a lower spike concentration. The spike level should be greater than the calculated level.

6.3.1.8. If there is a significant blank level, the spike level for the MDL determination must be at least three times greater than the blank concentration.

6.3.2. **Minimum Reporting Limits (MRL) / Limits of Quantification (LOQ)**

6.3.2.1. The Minimum Reporting Limit (MRL) is the lowest concentration normally reported to the client. It represents the reporting value linked to a specific analyte for aqueous matrix in the LIMS system. The MRL represents a conservative, nominal reporting limit designed to be representative of the minimum quantifiable concentration level for a particular analyte in a real environmental matrix as opposed to the statistically derived MDL calculation.

6.3.2.2. The MRL will generally be established by multiplying the statistically derived MDL by a factor of 2 or 3. The rationale for this approach is that the resultant value becomes approximately 10 times the standard deviation obtained during the MDL study; the EPA frequently refers to this concentration as the "Limit of Quantification (LOQ)", and defines it as the level above which accurate quantitation can be achieved. This level is also more similar to the SW-846 and SDWA concept of "Practical Quantitation Limits" (PQL). At a minimum, the MRL needs to be greater than or equal to the MDL. The MRL must be verified annually for each quality system matrix, method and analyte according to the procedure specified in NELAC C.3.

6.3.2.3. Perform an MRL check and the acceptance criteria for recovery of spiked analyte at MRL is 50-150 % or ± 3 standard deviations, whichever is greater. MRL Check is run daily as per EPA Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Edition.

6.3.2.4. Final MRLs should only be established after receiving input from the Group Supervisor, Client Services Manager, Lab Director and QA Officer. This ensures that all relevant issues regarding the selection of MRLs have been considered. These issues include specific minimum reporting limits required by a particular state or regulatory body, contractually required reporting limits for a specific client, the need to provide consistent reporting limits for our clients that have historically submitted samples associated with long-term monitoring efforts, as well as to remain competitive in the market. Thus a specific client may require that we use an MDL on our reports rather than an MRL. This deviation must be documented on client reports. A “J” flag is used to qualify results greater than MDL, but less than MRL (>MDL, <MRL).

6.3.3. **Demonstration of Capability**

6.3.3.1. An IDC is performed for each analyst and instrument. The IDC for each analyst includes a demonstration of the ability to achieve a low background, the precision and accuracy required by the method, the method detection limit (MDL) in accordance with procedure in 40 CFR 136, Appendix B and satisfactory performance on an unknown sample as on-going proficiency test result are also filed.

6.3.3.2. The IDC is repeated when there is a change in analyst, test method or instrument.

6.3.3.3. All initial demonstrations of capability and method certification shall be documented through the use of the certification statement found in Appendix C of NELAC Quality Systems Standards. A copy of the certification should be retained in the personnel records of each affected employee. (NELAC C.2)

6.3.3.4. Initial demonstration of method performance is completed each time there is a significant change in instrument type, personnel, or test method.

6.3.3.5. Continuing demonstration of method performance (such as laboratory control and matrix spike samples) is monitored by use of control charts.

6.3.3.6. The QC sample used for the IDC analysis is obtained from an outside source. If an external vendor is not available, the laboratory prepares the QC sample independent of the instrument calibration standard.

6.3.3.7. The QC sample concentration prepared for the IDC is approximately 1-4 times the MRL for spike concentration if not specified by the method or regulations. Four aliquots of the sample are analyzed concurrently (same day) or over a period of days. Average recovery and standard deviation for each parameter of interest are calculated in the units used for reporting to clients. The resulting average recovery and standard deviation must meet the acceptance criteria for the method.

6.3.3.8. When it is not possible to determine mean and standard deviations, such as for presence/absence and logarithmic values, the laboratory assesses performance against established and documented criteria. If there is no mandatory criteria in the method, either reference or laboratory generated limits are used.

6.3.3.9. If standards cannot be prepared, as for Microbiology, QC samples or PE samples obtained from NIST or other approved PT providers are used for the IDC. The laboratory retains all associated supporting data necessary to reproduce analytical results summarized in the IDC certification statement.

6.3.3.10. Analysis of actual samples is not done until all parameters of interest for the IDC meet acceptance criteria. If one or more of the test parameters do not meet the acceptance criteria, the problem is corrected, followed by repeated analysis of the four aliquots for those that failed to meet criteria. If the repeat analyses fail

acceptance criteria the laboratory investigates, corrects the problem and repeats the test for all parameters.

6.4. METHOD SPECIFIC QUALITY CONTROL

6.4.1. Gravimetry

6.4.1.1. All laboratory analytical balances and thermometers of ovens are calibrated annually with Class S weights and a certified thermometer. Records of this balance calibration are maintained by the balances and periodically turned in to the QA Officer for filing as records are completed. Balances are verified on each day of use.

6.4.1.2. A sufficient number of dessicators are maintained to insure that samples are not crowded to the point where they cannot cool to room temperature at the end of the specified drying period. Desiccant replacement is based on color changes.

6.4.1.3. LCS samples are analyzed at a frequency of 5 or 10% and are specified in each method SOP. At least one LCS is analyzed for each analytical run.

6.4.1.4. MS/MSD samples (or LCS pairs) are analyzed at the rate of once every batch of 20 samples of a similar matrix, or at other frequency, depending on the method requirements.

6.4.2. Titration

6.4.2.1. Use of an automated titrator set to proper delivery speed insures that every sample is titrated to the same endpoint. For manual titration, selection of the proper endpoint is achieved by comparing the color of the sample currently being titrated with the color of the previously titrated sample. The analyst must be particularly careful when performing a titration with a fading endpoint. In such instances, it is important to complete the titration as rapidly as possible.

6.4.2.2. An external reference sample is analyzed with each new set of standards or titrant to verify the accuracy of the titrant standardization and the endpoint determination. In addition, the endpoint pH is checked for each sample.

6.4.2.3. LCS samples are analyzed at a frequency of 5 or 10% and are specified in each method SOP. At least one LCS is analyzed for each analytical run.

6.4.2.4. MS/MSD samples (or LCS pairs) are analyzed at the rate of once every batch of 20 samples of a similar matrix, or at other frequency, depending on the method requirements.

6.4.3. Colorimetric Spectrophotometry

6.4.3.1. The alignment of the cell holder and light source is checked when absorbancy indicates a problem.

6.4.3.2. A minimum of three standards plus a blank, equally spaced over the concentration range, are used to calibrate the spectrophotometer in the absorbance mode, except where methods specify the use of one standard only.

6.4.3.3. The analyst records the absorbance reading for the top standard and notes on the form if a gradual increase or decrease in the absorbance of this standard is occurring. A gradual decrease in absorbance values from week to week is usually indicative of a deteriorating standard or the initial stage of lamp failure.

6.4.3.4. The rate of color development and color stability of spectrophotometric procedures varies considerably. The allowable time interval for reading the absorbance of the sample is specified in the method and must be rigidly adhered to in order to obtain accurate results.

6.4.3.5. Measuring a blank and a calibration standard after every twenty samples checks the stability of the spectrophotometer. If the baseline absorbance or the standard absorbance value has changed by more than 0.005 absorbance units or 10% from the initial calibration standard, whichever is greater, the instrument must be recalibrated and all samples analyzed since the last acceptable calibration check must be reanalyzed.

6.4.3.6. Some water samples have a natural color or turbidity which absorbs appreciably at the wavelength used in the analysis. If the sensitivity of a procedure is sufficiently high, it is usually possible to minimize this interference by diluting the sample. If the sensitivity is not adequate to permit sample dilution, the turbidity or color interference is corrected for, by reading the absorbance of the sample carried through the procedure without addition of the indicator reagent when instrumentation permits it. This absorbance reading is then subtracted as a blank from the absorbance reading of the sample.

6.4.3.7. LCS samples are analyzed at a frequency of 5 or 10% and are specified in each method SOP. At least one LCS is analyzed for each analytical run.

6.4.3.8. MS/MSD samples (or LCS pairs) are analyzed at the rate of once every batch of 20 samples of a similar matrix, or at other frequency, depending on the method requirements.

6.4.4. ICP Emission Spectroscopy & ICPMS

6.4.4.1. The sensitivity of each element is recorded in order to detect deficiencies in the instrument or operating conditions.

6.4.4.2. Reagent blanks followed by a calibration check standard are run for each metal determined with a frequency of 10%. If there is a difference of >10% from the initial standard reading, the instrument must be recalibrated and all samples that were analyzed after the last acceptable calibration check must be reanalyzed.

6.4.4.3. For ICP analysis using the simultaneous system, inter-element correction factors must be available for each wavelength used. Background correction must be used for each element.

6.4.4.4. LCS samples are analyzed at a frequency of 5 or 10% as specified in each method SOP. At least one LCS is analyzed for each analytical run.

6.4.4.5. MS/MSD samples (or LCS pairs) are analyzed at the rate of once every batch of 20 samples of a similar matrix, or at other frequency, depending on the method requirements.

6.4.5. Radiochemistry

6.4.5.1. The laboratory participates in performance studies for gross alpha and beta, Uranium and radium. Results must be within the control limits established by the vendor for each analysis.

6.4.5.2. The laboratory monitors monthly radiation measurement of laboratory instrumentation for radioactive contamination. The procedure is discussed in the CHP Manual including criteria and corrective action procedure. [NELAC Appendix D.4.4.d)]

6.4.5.3. Efficiency curves are run at least annually and the data recorded in the radiation notebook.

6.4.5.4. A background is run (monthly for gamma and alpha spectroscopy, weekly for gas proportional counter, and each day of use for scintillation counter) and a known reference sample is run with each batch of radiation samples analyzed. Background check measurements shall be performed each day of use for gamma and alpha spectroscopy and gas proportional counter [NELAC 5.Appendix D 4.8b)]. Method blank shall be performed at a frequency of at least one per preparation batch. If the acceptance criteria specified in the SOP are not met, the specified corrective action and contingencies shall be followed and the result reported with appropriate data qualifying codes [NELAC 5.Appendix D 4.1 a)].

6.4.5.5. LCS samples are analyzed at a frequency of 5 or 10% and are specified in each method SOP. At least one LCS is analyzed for each analytical run. The activity of LCS shall be 2 – 10 times the detection limit or at a level comparable to that of the routine samples if the sample activities are expected to exceed 10 times the detection limit [NELAC 5.Appendix D 4.1 b) 3)].

6.4.5.6. Gross alpha and gross beta require MS for aqueous samples. When there is not sufficient sample aliquot size to perform a matrix spike, it shall be noted on the lab report [NELAC D 4.1 b).2]. MS activity shall be greater than 10 times the detection limit [NELAC 5.Appendix D 4.1 b) 4)].

6.4.5.7. The laboratory standards used to prepare LCS and MS shall be from a source independent of the laboratory standards used for instrument calibration [NELAC 5.Appendix D.4.1 b) 5)]. The MS shall be prepared by adding a known activity of target analyte.

6.4.5.8. Replicate shall be performed at a frequency of one per preparation batch where there is sufficient sample to do so. The replicate result shall be assessed against the specific acceptance criteria specified in the laboratory SOP. For low level samples (less than approximately three times the detection limit) the laboratory may analyze duplicate laboratory control samples or a replicate matrix spike (matrix spike and a matrix spike duplicate) to determine reproducibility within a preparation batch [NELAC 5.Appendix D 4.2].

6.4.5.9. Consistent test conditions for RAD testing are maintained through a radiological control program that addresses analytical radiological control (See MWH Radiation Safety Program Manual). The program shall address the procedures for segregating samples with potentially widely varying levels of radioactivity. The radiological control program shall explicitly define how low level and high level samples will be identified, segregated and processed in order to prevent sample cross-contamination. The radiological control program shall include the measures taken to monitor and evaluate background activity or contamination on an ongoing basis (NELAC D.4.8).

6.4.6. Gas Chromatography

6.4.6.1. A laboratory water blank is analyzed for all analyses to check for artifacts from the GC system and for the presence of impurities in the water blank making it unsuitable for LCS preparation.

6.4.6.2. A field or travel blank should be analyzed for each set of field samples taken. With each set of travel blanks sent out, a stationary travel blank is kept in the laboratory for analysis to demonstrate that the water sent out was free of contamination.

6.4.6.3. A series of continuing calibration standards are run with the analysis each day for all GC analyses. The acceptance criteria for the initial 5 point curve and the calibration standards is given in Table 9-1 of section 9.

6.4.6.4. LCS and/or MS/MSD samples for assessing precision and accuracy are determined by carrying the control samples or spike and spike duplicates through the extraction procedure as well as the instrumental analysis.

6.4.6.5. LCS samples are analyzed at a frequency of 5 or 10% and are specified in each method SOP. At least one LCS is analyzed for each analytical run.

6.4.6.6. MS/MSD samples (or LCS pairs) are analyzed at the rate of once every batch of 20 samples of a similar matrix.

6.4.7. Gas Chromatography/Mass Spectrometry

6.4.7.1. GC/MS Tuning Specifications

The mass spectrometer must be shown to be properly tuned during each daily 12 hour shift. This insures that the masses and abundance's, which the data system determines, are accurate. The EPA has suggested criteria for tuning the GC/MS with two standard compounds, decafluorotriphenylphosphine (DFTPP) and 1-bromo-4-fluorobenzene (BFB). Tuning criteria are shown in Table 11-5.

The following settings are maintained:

- Emission Current: 0.5 ma
- Electron Energy: 70 ev
- Electron Multiplier: 1000-2000 volts as required for sensitivity
- Dynodes: 3000 V

6.4.7.2. Quantitation of Identified Compounds/Quantitation from Initial Instrument Calibration

The calibration procedure for GCMS is based on the EPA Methods Reference, for example 524.2, 525.2, 624, and 625. A minimum five point standard curve is run for all analytes. For each calibration compound a response factor (Rf) and the %RSD are calculated.

The procedure to be employed for evaluation of the acceptability of the initial calibration curve based on the EPA Methods Reference, see individual SOPs for specific examples.

All quantitation are done from initial instrument calibration and not from continuing calibration unless required by the method, regulation or program [NELAC 5.5.5.2.2.1c)].

6.4.7.3. Internal and Surrogate Standards (IS and SS)

The internal standard area counts are recorded for all volatile and semi-volatile samples.

If any sample is found to have an IS beyond ± 50% (for ICAL, ± 30% for CCV) of the IS counts for the daily continuing calibration standard, the sample is re- analyzed unless an obvious matrix problem can be documented.

Surrogate standards are utilized in both the volatile and semi-volatile analysis.

Any volatile sample surrogate recovery that falls outside of the lab limits is immediately re-analyzed. If surrogate recoveries are still outside of the limits, a QIR is written and the report is annotated. If the second result is within the control limits, this result is reported.

For semi-volatile samples with unacceptable surrogate recoveries, the extraction run logs are examined for matrix related or other documented problems. In addition, the LCS recoveries are reviewed for the sample extraction set. If none of these indicate a matrix problem, the sample is re-extracted if still within holding times. If the analysis of the re-extract shows unacceptable surrogate recoveries, a QIR form is generated, then the sample report is annotated and the data reported.

6.4.7.4. Criteria for Tentatively Identified Compounds (TIC's)

A primary advantage of GC/MS is the ability to identify compounds for which the retention time and mass spectra are not well known to the operator. This is accomplished by performing a library search using the EPA/NIST library of mass spectra and comparing unknown to these spectra. The library search program gives five or ten of the "best fits". The best fits are determined by comparing the top eight mass fragments in the unknown to the spectra in the library. The program matches the mass numbers and the abundances at each mass number to those in the library. The program lists the possible identifications along with the numbers, which can be used by the MS operator to determine the quality of the identification. The fit is the degree to which the peaks and intensities in the unknown match those of a particular compound in the library. A perfect match would be 1000 or 1.000, depending on the software. MWH Labs utilizes CLP criteria and method specifications for determining identification of unknowns. This includes the presence of all major ions greater than 10% relative intensity, agreement of ± 20% for major ions in the sample and reference spectra, and the review of all ions present in the sample spectrum for possible background contamination or interference.

In general a computer fit of 850 or 0.850 should be the minimum used for identification. It should be noted that even with computer library searches, there is no substitute for the judgment of a trained analyst.

6.4.7.5. Control Samples

LCS samples are analyzed at a frequency of 5%. At least one LCS is analyzed for each analytical run.

MS/MSD samples (or Duplicate) are analyzed at the rate of once every batch of 20 samples of a similar matrix, as required by NELAC. Duplicates are usable only when target analytes are positives [NELAC 5.Appendix D.1.1.3.2a)].

6.4.7.6. Blanks

Laboratory reagent water blank is normally the first sample analyzed at the beginning of each working day to demonstrate that the system is free from contamination. If the blank result indicates contamination, the system is cleaned by running additional water blanks or if necessary, finding an alternate source of contaminant free water.

6.4.8. Total Organic Carbon (TOC)

6.4.8.1. Samples are diluted to fall within the linear range of the standards.

6.4.8.2. Every tenth sample is an LCS and %recoveries must fall within acceptable control limits. MS/MSD samples (or LCS pairs) are analyzed at the rate of once every batch of 20 samples of a similar matrix as per method requirements.

6.4.9. Total Organic Halogen (TOX)

6.4.9.1. Three carbon blanks (carbon packed adsorption columns washed with nitrate-wash solution only) are analyzed at the beginning of each workday. All values must be within 20% of the average blank value obtained before standards can be run.

6.4.9.2. Each day, a set of three calibration standards is analyzed prior to analysis of samples. Calculated values for the standards must fall within 5% of the nominal value except for the 1.0 standard, which is allowed a 10% range.

6.4.9.3. Every eighth sample is, alternately, a continuing calibration standard or a carbon blank.

6.4.9.4. All samples are analyzed in duplicate. If the net values of the duplicates are not within acceptance criteria of 20%, a third and possibly a fourth replicate is analyzed. Results are compared to the first and second replicate and the average of the two closest samples is reported.

6.4.9.5. The titration cell is revitalized by rinsing with fresh cell solution after every twenty analyses or sooner if necessary.

6.4.9.6. Samples are diluted to fall within the linear range of the standards.

6.4.9.7. Two or three serial adsorption columns from each sample adsorption are analyzed separately to determine if any organic halogen breakthrough is occurring. In the event

of breakthrough, an additional diluted sample is analyzed. Every tenth sample is an LCS and %recoveries must fall within acceptable control limits.

6.4.9.8. MS/MSD samples (or LCS pairs) are analyzed at the rate of once every batch of 20 samples of a similar matrix.

6.4.9.9. The purity and adsorption capacity of each new batch of carbon purchased is assessed by duplicate analysis of an adsorption efficiency standard. This adsorption efficiency standard (standards injected into reagent water then filtered) must be within 5% of the standard value. In addition, duplicate carbon blank results must be less than 1 µg Cl-.

6.4.10. General Microbiology - Use of Commercial Dehydrated Powder for Coliform Testing

6.4.10.1. The individual collecting samples should be aware of the sampling precautions outlined in Standard Methods.

6.4.10.2. Specific sampling instructions are available from the MWH Laboratories Microbiology Department. They list required precautions to follow to maintain the integrity of the samples and prevent contamination.

6.4.10.3. The maximum holding time for microbiological samples is 30 hours for drinking water and 6 hours for water/wastewater.

6.4.10.4. The bottles should be shipped sealed in strong plastic zip lock or bubble bags. This keeps the melting ice from contaminating the samples. Ice cubes or their equivalent must be placed around the samples but care must be taken that the samples do not freeze.

6.4.10.5. Sterility check on sample containers shall be performed on at least one container for each lot of purchased pre-sterilized sample containers. For containers prepared and sterilized in the lab, a sterility check shall be performed on one container per sterilized batch with non-selective growth media [NELAC 5.Appendix D 3.1a)4)]. Microbiology sample containers are disposable high clarity polystyrene vessels with sodium thiosulfate sufficient to neutralize 10-90 mg/L of chlorine (IDEXX Cat No. WS216PS). Containers from each lot of "ready to use" are tested to ensure efficacy of Na2S2O3 to 5 mg/L Cl2 for drinking water and 15 mg/L Cl2 for wastewater. Thus, samples received in the lab are not tested for additional residual Cl2 testing [NELAC-5.5.8.3.1a)3)].

6.4.10.6. A sterilization indicator is used during each autoclave cycle. If problems exist as indicated by a failure of the sterilization indicator, none of the items from that autoclave load is used and the group leader is notified. Demonstration of effective sterilization is provided by the use of biological indicators at least once per month of use [NELAC 5.Appendix D.3.8.b)2).ii)].

6.4.10.7. Culture media are prepared from commercial dehydrated powders or ready to use media such as colilert medium. The laboratory does not prepare media or its culture media from basic ingredients. [NELAC 5.Appendix D.3.6. and D.3.6a)]

6.4.10.8. Only nanopure water is used for the preparation of media. Once opened, the powdered media is tightly recapped to prevent hydration.

6.4.10.9. Prepared liquid medium is stored in the dark at refrigeration of 4°C and used within 3 months. The media is labeled with the type of medium, date prepared and the initials of the analyst who weighed out the dehydrated powder.

6.4.10.10. Prepared agar plates are stored in plastic bags, agar up, in the refrigerator. The bag is labeled to identify the type of medium, date prepared and the initials of the analyst who prepared it.

6.4.10.11. When bacteriological samples are incubated in a water bath or incubator, the temperature is recorded each morning and afternoon on the appropriate temperature sheet.

6.4.10.12. A thermometer calibrated at 44.5˚C is used for the water bath when fecal coliforms are incubated.

6.4.10.13. A positive control culture obtained from the American Type Culture Collection is inoculated for each batch of media including chromofluorogenic medium, incubated and read to indicate the acceptability of a media to a particular bacteria type. A negative control consisting of an inoculation of sterile phosphate buffer or an un-inoculated portion of media is also incubated to demonstrate the absence of contamination prior to first use of the medium. For filtration technique with each batch of samples, at least one beginning and ending control shall be prepared, with additional controls inserted after every 10 samples when the same equipment set is used to prepare multiple samples [NELAC 5.Appendix D 3.1 a) 2)]. When an interruption of more than 30 minutes occurs, the filtration funnels shall be resterilized.

6.4.10.14. When membrane filtration methods are used to analyze samples, a control blank of sterile dilution water is analyzed at the beginning of each set of samples. For membrane filter or plate media, duplicate counts shall be performed monthly on one positive sample for each month that the test is performed. If more than one analyst, each analyst shall count typical colonies on the same plate and count must be within 10%. If only one analyst, sample plate shall be counted twice by the analyst, with <5% difference between counts.

6.4.10.15. The laboratory analyzes a bacteriological proficiency test sample from ERA, either annually or semi-annually for NELAP accreditation. A coliform test, through the confirmation step and standard plate count, is conducted on this reference sample.

6.4.10.16. A completed test is conducted on 10% of all positive coliform samples. If no positives are found, at least one positive source water or control sample is completed quarterly.

6.4.10.17. Environmental monitoring is conducted weekly using PCA plates to measure background contamination occurring from bacteria, yeast and mold carried in the air. The number of colonies on the air density plate should not exceed 15 colonies/plate/15 minutes of exposure.

6.4.11. Asbestos

6.4.11.1. The sampling technique follows the methods outlined by EPA in Method 100.2-Analytical Method for Determining Asbestos Fibers in Water EPA-600/R-94/134, June 1994. All samples are to be stored at 4°C until filtration and completion of analysis.

6.4.11.2. Specific sampling instructions are available from the Microbiology Department. They list precautions to follow in order to maintain the integrity of the samples and prevent contamination.

6.4.11.3. The procedure is outlined in the Method 100.2. All modifications of procedures including reasons for modifications are recorded in the SOP.

6.4.11.4. All counts for calculations and report generation are entered into LIMS to eliminate inconsistency in the final report.

6.4.11.5. The manufacturers' manuals for proper operation of all equipment used in asbestos analyses are properly filed and accessible. Records of periodic inspection, calibration and service of equipment are maintained in appropriate logbooks. Phone numbers for instrument service are posted by each instrument.

6.4.11.6. Blank using fiber-free water is processed each day that samples are filtered as stated in Method 100.2. The criterion for acceptability of bottle and process blanks is ≤ 0.01 MFL > 10 microns in length. If this limit is exceeded, the samples filtered on the same day as the blank must be re-filtered.

6.4.11.7. All samples are filtered within 48 hours of sample collection. Samples received past 48 hours of collection are treated with O3 –UV.

6.4.11.8. The absolute (HEPA) filtration system is monitored daily and filters are changed when needed.

6.4.11.9. Asbestos glassware is prepared using sonication as stated in the method.

Table 6-1 Example of Surrogate Acceptance Limits

Method	Compound	Acceptance Limits, %
504.1/8011	1,2-Dibromopropane	60-140
524.2	4-Bromofluorobenzene	70-130
	1,2-Dichloroethane-d4	70-130
	Toluene-d8	70-130
525.2	perylene-d12	70-130
	1,3-dimethyl-2-nitrobenzene	70-130
	triphenylphosphate	70-130
531.2	BDMC	70-130
551.1	1,2-Dibromopropane	80-120
624	4-Bromofluorobenzene	82-117
	1,2-Dichloroethane-d4	77-121
	Toluene-d8	91-107
625/8270	Nitrobenzene-d5	52-108
	2-Fluorobiphenyl	44-110
	Terphenyl-d14	24-143
	2-Fluorophenyl	21-100
	Phenol-d6	19-109
	2,4,6-Tribromophenol	43-117
6251 B	3,5-Dichlorobenzoic Acid	70-130
8260B	4-Bromofluorobenzene	74-121
	1,2-Dichloroethane-d4	70-121
	Toluene-d8	81-117

7.0 SAMPLE COLLECTION, PRESERVATION, IDENTIFICATION, HANDLING, AND STORAGE

Sample collection and sample handling techniques are important aspects of the overall sample analysis process and have a major impact on the validity of the results. Specific containers and preservatives are used to ensure that the analytes originally present in the sample are not lost through degradation or do not become more concentrated. In addition, contaminants that would interfere with the analysis or give erroneously high results must be mitigated. Sampling services are not normally available from the laboratory, but detailed written procedures to ensure sampling consistency and compliance with method requirements are available to our clients.

7.1. SAMPLE COLLECTION AND BOTTLE PREPARATION

Production of quality analytical data requires that the collected sample is representative of the sampled area. Sampling procedures should adhere to the guidelines established by EPA and other regulatory agencies and be appropriate for the sample matrix and types of analytical parameters to be determined. If a client chooses to collect their own samples, experienced lab staff can brief clients by telephone or in writing on the proper methods of sample collection. The laboratory provides sampling instructions to clients to guide clients on the appropriate sample collection procedures.

Sample bottles for all analyses except bacteriological are purchased pre-cleaned according to EPA Protocol specifications from various vendors. Certification statements for each lot of bottles are kept on file in the shipping department and each bottle is marked with its lot number. Each new lot of bottles used for volatiles analyses are checked for volatiles and trace metals contamination. All files regarding Bottle Testing are kept in the QA Files. Bottles are wrapped in bubble bags to prevent breakage and normally shipped to the sampling site in coolers with gel packs for chilling samples. A copy of the original bottle work order is included with each shipment and should be returned with properly cooled samples to the laboratory along with a properly completed chain of custody form (COC). The work order specifies the numbers of bottles sent for each analysis and is used during the log in procedure in the laboratory.

7.2. CONTAINERS, PRESERVATIVES, HOLDING TIMES AND SAMPLE KITS

MWH Laboratories supplies the appropriate sample containers, preservatives, chain-of-custody forms, coolers, and packing materials to a client upon request. The container types, bottle sizes, preservatives, container closures, and recommended holding times are shown in Table 6-1 for Drinking Water, Table 6-2 for Wastewater, and Table 6-3 for Hazardous Waste. These specifications follow CFR 136-149, Required Containers, Preservation Technique and Holding times July 1, 2003 edition and updates. Also followed is the Manual for the Certification of Laboratories Analyzing Drinking Water, Fifth Edition. Arrangements for sample kits may be made through the Client Services department. Preservatives are shipped to clients only in the specified container; bulk

preservatives are not normally shipped. Only reagent grade (or better) preservatives are used. The chemicals used as preservatives are as follows:

Ascorbic Acid	Nitric acid	Sodium sulfite
Ammonium chloride	Potassium Citrate	Trizma Buffers
Copper Sulfate	Sodium hydroxide	Zinc acetate
Ethylenediamine	Sodium thiosulfate	
Hydrochloric acid	Sulfuric acid	

Containers are delivered to the client by the following methods:

(1) Client comes to laboratory to take delivery,
(2) Containers are sent to client by courier,
(3) Containers are shipped (via UPS/FedEx/DHL) in coolers meeting all DOT regulations.

To ensure that samples meet the temperature requirements, the laboratory checks and records the sample temperature upon receipt on the COC. The temperature check documents that the samples are kept cold (>1°C, ≤6°C) during transport (NELAC 5.5.8). Same day receipt, as day of collection are required to have "ice on arrival" to be acceptable if >6°C.

7.3. SAMPLE STORAGE

7.3.1. Under normal circumstances storage is maintained in a refrigerator kept at 4 ± 2°C for one month from receipt (NELAC 5.5.8). All samples are normally retained for at least 2 months after sample receipt or until holding times have expired, whichever is shorter. A different storage period can be arranged at the request of the client. All samples are kept in the proper storage environment for one month from receipt and then stored in the waste storage area until disposal.

7.3.2. Samples are kept in refrigerators or if storage at ambient temperature is permitted, on shelving in the designated area. Samples in the designated areas are available for the analyst to take as necessary. Documentation that these samples have been taken is available in the run log along with other pertinent information as shown in figure 7-7.

7.3.3. Samples designated for volatile analysis are not kept in the same refrigerators as samples designated for non-volatile analysis.

7.3.4. Temperature in the cold storage areas is monitored twice a day at least 4 hours apart to ensure all samples meet storage temperature requirements. Storage temperatures are recorded in appropriate logbooks (NELAC 5.5.8)

7.4. SAMPLE DISPOSAL

7.4.1. All laboratory wastes including excess samples, excess calibration standards, any excess test items, digestates, leachates, extracts or other sample preparation products are identified by their composition. Six waste streams are identified in the laboratory; extraction solvent, Methylene chloride wastewater, chloroform, Freon, rapid flow analyzer, corrosive acids and bases, HPLC, and flammable. Each type of waste is placed into a separate, clearly identified steel drum located in a secure area outside the laboratory. Each drum also has a characterization sheet (manifest) attached. This sheet is completed every time a waste is introduced into the drum. Drums are taken for disposal/recycling once the drum is 75 % full or every three months from the start date of accumulation.

7.4.2. A large majority of samples received by MWH Laboratories are raw or potable waters. Residual samples, if not extracted, are disposed of by neutralizing with sodium hydroxide (NaOH) or sulfuric acid (H2SO4) and flushing down the sink while running cold water. The type and amount of waste is recorded in a logbook.

7.4.3. A continuous strip chart recorder is attached to the effluent outfall into the city sewer to record pH of all outgoing fluids from the laboratory.

7.4.4. Hazardous waste is disposed of in 55 gallon drums. Characterization sheet is available for each type of waste or waste profile.

7.4.5. Sample disposal procedures details are available in the disposal area and available through our SOP titled, “Hazardous Waste Management and Sample Disposal Procedures”. The SOP describes the requirements for the safe and effective disposal of all sample, extract and digestate waste contained in the laboratory. Means of disposal include dispensing into manifested 55 gallon drums.

7.4.6. All samples that are considered to be potentially hazardous based upon analytical results or matrix will be disposed of through a hazardous waste disposal company or a client may request that the samples be returned to them for disposal. All disposal arrangements should be made with a project manager. All samples are disposed of in accordance to RCRA and county regulations (NELAC 5.5.8).

Table 7-1 Preservation and Holding Times for Drinking Water

(A) Inorganics – Wet Chemistry

No Extract Holding Time

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container
Alkalinity	SM2320B	Cool, ≤ 6°C	14 days	125 mL	Plastic
Bromate	EPA 300.1/ EPA 317.0	5mg Ethylene Diamine/ 125 mL	28 days	125 mL	Plastic
Bromide	EPA 300.0/ EPA 300.1	None	28 days	125 mL	Plastic
Chloride	EPA300.0	None	28 days	125 mL	Plastic
Chlorate	EPA 300.0/ EPA 300.1	5 mg Ethylene Diamine/125 mL	28 days	125 mL	Plastic
Chlorite	EPA 300.0/ EPA 300.1/ EPA 317.0	5 mg Ethylene Diamine/ 125 mL Cool, ≤ 6°C	14 days	125mL	Plastic
Color	SM2120B	Cool, ≤ 6°C	48 hours	500 mL	Glass
Conductivity	SM2510B	Cool, ≤ 6°C	28 days	125 mL	Plastic
Cyanide	SM4500CN-F/ EPA335.4	Cool, ≤ 6°C, 1 mL Ascorbic acid. (if chlorinated), 1 mL NaOH, pH>12	14 days	125 mL	Plastic
Fluoride	SM4500 F-C	None	28 days	125 mL	Plastic
Foaming Agents Surfactant (MBAS)	SM5540C	Cool, ≤ 6°C	48 hours	500 mL	Plastic
Nitrate (chlorinated)	EPA300.0/ EPA 353.2	Cool, ≤ 6°C	14 days	125 mL	Plastic
Nitrate (non-chlorinated)	EPA300.0/ EPA 353.2	Cool, ≤ 6°C	48 hours	125 mL	Plastic
Nitrate + Nitrite	EPA 353.2 EPA 300.0	Cool, ≤ 6°C, 0.5 mL H_2SO_4, pH<2	28 days	125 mL	Plastic
Nitrite	EPA300.0 EPA 353.2	Cool, ≤ 6°C	48 hours	125 mL	Plastic
Odor	SM2150B	Cool, ≤ 6°C	24 hours	500 mL	Glass
Perchlorate	EPA 314	None	28 days	125 mL	Plastic
Perchlorate	EPA 331	Sterile, Cool, ≤ 6°C	28 days	125 mL	Plastic
pH	SM4500-HB	Cool, ≤ 6°C	24 hours*	125 mL	Plastic

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container
o-Phosphate	SM4500 P-E	Filter immediately, Cool, ≤ 6°C	48 hours	125 mL	Polyglass Glass
Residual Disinfectant (Total/Free Residual Chlorine)	SM 4500 Cl-G	Cool, ≤ 6°C (Analyzed on the day of collection)	30 days*	125 mL	Amber Glass Bottle
Silica Dissolved/ Reactive Silica	EPA 200.7 SM 4500Si-D	Cool, ≤ 6°C	28 days	125 mL	Plastic
Solids (TDS)	SM 2540C	Cool, ≤ 6°C	7 days	125 mL	Plastic
Sulfate	EPA 300.0	Cool, ≤ 6°C	28 days	125 mL	Plastic
Turbidity	EPA 180.1	Cool, ≤ 6°C	48 hours	125 mL	Plastic
Total Organic Carbon/ Dissolved Organic Carbon (DOC)	SM 5310 C/ EPA 415.3	0.5 ml H_2SO_4 to pH<2 Cool, ≤ 6°C	28 days	125 mL	Amber Glass Bottle Teflon lined cap
UV 254/SUVA	SM 5910 B/ EPA 415.3	Cool, ≤ 6°C	48 hours	125 mL	Amber Glass Bottle Teflon lined cap

* Must be analyzed immediately in the field for compliance.

(B) Inorganics – Metals

No Extract Holding Time

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container
Metals (except Hg)	EPA200.7/ EPA200.8	0.5 mL HNO_3, pH<2	6 months	500 mL	Plastic
Metals (Ca, Mg, K, Na)	EPA200.7	0.5 mL HNO_3, pH<2	6 months	500 mL	Plastic
Mercury	EPA245.1	2 mL HNO_3, pH<2	28 days	500 mL	Plastic
Chromium VI (Dissolved)	EPA218.6	Ammonium Sulfate/Ammonium Hydroxide Buffer ≤ 6°C, pH 9-9.5	24 hours	125 mL	Plastic
Hardness	EPA200.7/ SM 2340B	0.5 mL HNO_3, pH <2	28 days	500 mL	Plastic

(C) Microbiology/Microscopy Tests

No Extract Holding Time

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container
Asbestos	EPA 100.2	Cool, ≤ 6°C	48 hours	800 mL	1 L Plastic Bottle
Drinking Water Source Enumeration	SM9223 (Colilert) SM9221BE (MTF)	Cool, ≤ 6°C, 0.2 mL of 3% $Na_2S_2O_3$	8 hours	100 mL	Sterile Plastic Bottle
Fecal Coliforms--EC Medium	SM9221E (MTF)	Cool, ≤ 6°C, 0.2 mL 3% $Na_2S_2O_3$	30 hours	100 mL	Sterile Plastic Bottle
Heterotrophic Plate Count (Standard Plate Count)	SM9215B	Cool, ≤ 6°C, 0.2 mL 3% $Na_2S_2O_3$	8 hours	100 mL	Sterile Plastic Bottle
Total Coliforms; By Multiple Tube Fermentation (MTF)	SM9221AB	Cool, ≤ 6°C, 0.2 mL 3% $Na_2S_2O_3$	30 hours	100 mL	Sterile Plastic Bottle
Total Coliforms--E. Coli	SM9223	Cool, ≤ 6°C	30 hours	100 mL	Sterile Plastic Bottle
Total Coliforms--E. Coli	SM 9223B - Colisure	Cool, ≤ 6°C	30 hours	100 mL	Sterile Plastic Bottle
Coliphage	EPA 1602	Cool, ≤ 6°C	48 hours	1000 mL	Sterile Plastic Bottle

(D) Organics

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Extract Holding Time	Recommended Minimum Sample Size	Type of Container
DBCP/EDB	EPA504.1	3 mg Sodium Thiosulfate Cool, ≤ 6°C	14 days	4 °C, 24 hours	40 mL	Glass with Teflon Lined Septum

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Extract Holding Time	Recommended Minimum Sample Size	Type of Container
Organohalide Pesticides and PCB	EPA 505	3 mg Sodium Thiosulfate Cool, ≤ 6°C	14 days/ 7 days for heptachlor	4 °C, 24 hours	40 mL	Vial with PTFE-lined Screw caps
Chlorinated Herbicides (GC with Electron Capture	EPA515.4	10°C (first 48 hours, ≤ 6°C after 48 hours)	14 days	4°C dark, 28 days	1 L	Amber Glass with Teflon lined Cap
Nitrosamines	EPA 521	80 – 100 mg sodium thiosulfate; Cool, 10°C (first 48 hours, ≤ 6°C after 48 hours)	40 days	7 days	1 L	Amber glass with PTFE-lined Screw caps
Purgeable Organic Compounds/ Halogenated Aromatics, THMs, Di-Isopropyl Ether (DIPE), Tertiary Amyl methyl ether (TAME), Tert Butyl ethyl ether (ETBE) Low level TCP	EPA 524.2	25 mg Ascorbic Acid, then HCl pH < 2; Cool, ≤ 6°C	14 days	NA	2x40 ml	Teflon Lined Septum
Low Level TCP (GC/MS)	EPA 524.2/ CA DHS	Cool, ≤6°C or thiosulfate	14 days	NA	2x40 ml	Teflon Lined Septum
Semi-Volatile Organics Acid/Base Neutrals, including thiobencarb (GC/MS)	EPA525.2	40-50 mg Sodium Sulfite, Dark, Cool, ≤ 6°C, HCl, pH<2. HCL must be added after sample dechlorination	14 days	30 days from collection	1 L	Amber Glass with teflon lined Cap

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Extract Holding Time	Recommended Minimum Sample Size	Type of Container
Acetanilide Pesticide Parent Compounds	EPA 525.2	40-50 mg Sodium Sulfite, Dark, Cool, ≤ 6°C, HCl, pH<2. HCL must be added after sample dechlorination	14 days	14 days	1 L	Amber Glass with teflon lined Cap
Pesticides and Flame Retadrants	EPA 527	0.10 g/L of L-Asorbic Acid, 0.35 g/L of Trisodium EDTA, and 9.4 g/L of Potassium dihydrogen citrate; Cool, 10°C (first 48 hours, ≤ 6°C after 48 hours)	28 days	14 days	1 L	Amber glass with PTFE-lined Screw caps
Explosives and Flame Retardants	EPA 529	0.5 g/L of Copper Sulfate pentahydrate, 5.0 g of Trizma buffer; Cool, 10°C (first 48 hours, ≤ 6°C after 48 hours)	30 days	14 days	1 L	Amber glass with PTFE-lined Screw caps
Carbamates	EPA 531.2	0.38 g/40-mL vial Potassium dihydrogen citrate If residual chlorine is present, 6-mg of sodium thiosulfate/40-mL vial	Cool, <10°C first 48 hrs; <6°C thereafter; dark; 28-days; pH - 3.8	< 6°C; 28-days	40 mL	Vial with PTFE-lined Screw caps
Acetanilide Pesticide Degradation Products	EPA 535	25 – 30 mg ammonium chloride; Cool, 10°C (first 48 hours, ≤ 6°C after 48 hours)	28 days	14 days	250 mL	Amber glass with PTFE-lined Screw caps

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Extract Holding Time	Recommended Minimum Sample Size	Type of Container
Glyphosate (HPLC with Fluorescence Detector)	EPA547	6 mg Sodium Thiosulfate	14 days (18 mo. If frozen)	NA	60 mL	Amber Glass with teflon lined septum
Endothall (GC/MS)	EPA548.1	Sodium Thiosulfate (HCl, pH 1.5-2 if high bio activity) Cool, ≤ 6°C, Dark	7 days	14 days ≥ 4°C	250 mL	Amber Glass with teflon lined septum
Diquat & Paraquat (HPLC with Photoiode, Array Detector)	EPA549.2	100 mg Sodium Thiosulfate (H_2SO_4, pH<2 if bio active) Cool, ≤ 6°C, Dark	7 days	21 days	1 L	Amber Plastic
THMs	EPA 551.1	10-50 mg NH4Cl/40 mL + 400-mg phosphate buffer/ 40 ml	14 days	14 days	3x40 ml	Clean glass vial
Haloacetic Acids	SM6251B	65 mg NH4Cl / 40 ml Cool, ≤ 6°C,	14 days	7 days	2 x 40 mL	Amber Glass with teflon lined cap
Aldehyde	SM 6252	Cool, ≤ 6°C If residual chlorine is present, 10 – 50 mg of ammonium chloride/40-mL vial	14 days	7 days	2 x 40 mL	Amber glass containers with teflon-faced septa and open top screw caps

(E) Radiochemistry

No Extract Holding Time

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container
Uranium	EPA 200.8	0.5 mL HNO_3 to pH<2	6 months	125 mL	Plastic
Gross Alpha	EPA 900.0	2.0 mL HNO_3 to pH<2	6 months	1 L	Plastic
Gross Beta	EPA 900.0	2.0 mL HNO_3 to pH<2	6 months	1 L	Plastic
Radium 228	EPA 904.0	2-mL HNO_3 per liter; pH <2	6-months, if unpreserved; after 5-days, preserve and hold in the original container for minimum of 16-hrs.before analysis	1 L	Plastic
Radon 222	SM 7500 Rn	None, no headspace	4 days	250 ml	Glass

Table 7-2 Preservation and Holding Times for Wastewater

(A) Inorganics – Wet Chemistry

No Extract Holding Time

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container
Alkalinity, (Bicarbonate, Carbonate, & Total Hydroxide)	SM 2320B	Cool, ≤ 6°C	14 days	125 mL	Plastic
Ammonia	EPA350.1 SM4500NH3-H	Cool, ≤ 6C, 0.5 mL of H_2SO_4 to pH < 2	28 days	125 mL	Plastic
Biochemical Oxygen Demand (BOD)	SM5210B	Cool, ≤ 6°C	48 hours	500 mL	Plastic
Bromide	EPA300.0	None	28 days	125 mL	Plastic

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container
Carbon Biochemical Oxygen Demand (CBOD)	SM5210B	Cool, ≤ 6°C	48 hours	500 mL	Plastic
Chemical Oxygen Demand (COD)	EPA410.4/ SM 5220D	Cool, ≤ 6°C, 0.5 mL of H_2SO_4 to pH < 2	28 days	125 mL	Plastic
Chloride	EPA300.0	None	28 days	125 mL	Plastic
Chlorine, Total Residual	SM4500 Cl G	Cool, ≤ 6°C	24 hours (immediately)	250 mL	Amber Glass
Chromium VI	SM 3500Cr-D/ EPA 218.6	Cool, ≤ 6°C, Ammonia Sulfate buffer, pH 9.3-9.7	24 hours	125 mL	Plastic
Cyanide, Total	EPA 335.4	Cool, ≤ 6°C, 4 mL NAOH to pH>12, 0.6 g Ascorbic Acid (if chlorinated)	14 days	1 L	Plastic
Cyanide, Amenable to Chlorination	EPA 335.1/ SM 4500 CN-G	Cool, ≤ 6°C, 4 mL of NAOH to pH>12, 0.6 g Ascorbic Acid (if chlorinated)	14 days	1 L	Plastic
Fluoride	SM4500 F-C	None	28 days	125 mL	Plastic
Hardness	EPA 200.7/ SM 2340B	1.0 mL HNO_3 to pH< 2	6 months	250 mL	Plastic
Kjeldahl Nitrogen	EPA 351.2	Cool, ≤ 6°C, 0.5 mL of $H_2SO_4$to pH < 2	28 days	125 mL	Plastic
Nitrate	EPA 353.2/ EPA 300.0	Cool, ≤ 6°C	48 hours	125 mL	Plastic
Nitrite	EPA300.0/ EPA 354.1/ 353.2	Cool, ≤ 6°C	48 hours	125 mL	Plastic
Orthophosphate	EPA 365.1/ SM4500 P-F	Filter Immediately, Cool, ≤ 6°C	48 hours	125 mL	Plastic
Perchlorate	EPA 314.0	None	28 days	125 mL	Plastic
pH	SM4500-HB	None	24 hours *	125 mL	Plastic
Phenols	EPA 420.4/ EPA 420.1	Cool, ≤ 6°C, 2.0 mL H_2SO_4 to pH < 2	28 days	500 mL	Amber Glass
Phosphorus, Total	EPA 365.1/ SM4500 P-F	Cool, ≤ 6°C,0.5 mL H_2SO_4 to pH < 2	28 days	125 mL	Plastic

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container
Residue, Filterable (Total Dissolved Solids--TDS)	SM2540C	Cool, ≤ 6°C	7 days	500 mL	Plastic
Residue, Non-filterable (Total Suspended Solids,TSS)	SM 2540D	Cool, ≤ 6°C	7 days	500 mL	Plastic
Residue, Settleable (Settleable Solids)	EPA 160.5/ SM 2540F	Cool, ≤ 6°C	48 hours	500 mL	Plastic
Specific Conductance	SM 2510B	Cool, ≤ 6°C	28 days	125 mL	Plastic
Sulfate	EPA300.0	Cool, ≤ 6°C	28 days	125 mL	Plastic
Sulfide (Total & Soluble)	SM 4500 S-2D	Cool, ≤ 6°C, Zinc Acetate, plus NaOH to pH > 9	7 days	125 mL	Plastic
Total Organic Carbon (TOC)	SM 5310C	Cool, ≤ 6°C,0.5 mL H_2SO_4 to pH < 2	28 days	125 mL	Amber Glass
Total Organic Halide (TOX)	SM 5320B	Sulfite & H_2SO_4	14 days	250 mL	Amber Glass
Turbidity	EPA180.1	Cool, ≤ 6°C	48 hours	125 mL	Plastic

(B) Inorganics – Metals

No Extract Holding Time

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container
Metals (except Hg)	EPA200.7 EPA200.8	0.5 mL HNO_3 to pH< 2	6 months	125 mL	Plastic
Metals (Ca, Mg, K, Na)	EPA200.7	0.5 mL HNO_3 to pH< 2	6 months	125 mL	Plastic
Mercury, Hg	EPA245.1	2.0 mL HNO_3 to pH< 2	28 days	500 mL	Plastic

(C) Microbiology/Microscopy Tests

No Extract Holding Time

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container
Asbestos	EPA 100.2	Cool, ≤ 6°C	48 hours	800 mL	Plastic (1 L)
Fecal Coliforms By Multiple Tube	SM9221E	Cool, ≤ 6°C; 0.2 mL 3% $Na_2S_2O_3$ (if chlorinated)	6 hours	100 mL	Sterile Plastic
Fecal Streptococci/ Enterococci by MTF	SM9230B	Cool, ≤ 6°C; 0.2 mL 3% $Na_2S_2O_3$ (if chlorinated)	6 hours	100 mL	Sterile Plastic
Heterotrophic Plate Count	SM9215B	Cool, ≤ 6°C; 0.2 mL 3% $Na_2S_2O_3$ (if chlorinated)	6 hours	100 mL	Sterile Plastic
Total Coliforms By Multiple Tube Fermentation (MTF)	SM9221B	Cool, ≤ 6°C; 0.2 mL 3% $Na_2S_2O_3$ (if chlorinated)	6 hours	100 mL	Sterile Plastic

(D) Organics

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Extract Holding Time	Recommended Minimum Sample Size	Type of Container
Halogenated Volatiles/ Aromatic Volatiles	EPA 624	Cool, 6°C, 10 mg $Na_2S_2O_3$ for residual Cl_2,HCl** pH < 4-5	14 days	NA	40 mL	Amber Glass/ Teflon lined Septum
Semi-Volatiles, Acid and Base/ Neutral Compounds	EPA 625	Cool, 6°C, 80 mg $Na_2S_2O_3$ for residual Cl_2	7 days	40 days	1 L	Amber Glass/ Teflon lined Cap

**HCl must be added after sample dechlorination

(E) Radiochemistry

No Extract Holding Time

Parameter/ Method Name	EPA/SM Method Number	Preservative	Sample Holding Time	Recommended Minimum Sample Size	Type of Container
Uranium	EPA200.8	0.5 ml HNO_3 to pH <2	6 months	125 ml	Plastic
Gross Alpha	EPA900.0	4.0 mL HNO_3 (18%) to pH<2	6 months	1 L	Plastic
Gross Beta	EPA900.0	4.0 mL HNO_3 (18%) to pH<2	6 months	1 L	Plastic
Radon 222	SM 7500 Rn-B	None	4 days	250 ml	Glass

Table 7-3 Preservation and Holding Times for Hazardous Waste (Aqueous Matrix Only)

(A) Inorganics – Wet Chemistry

No Extract Holding Time

Parameter/ Method Name	Matrix	EPA/SM Method Number	Preservative	Sample Holding Time	Sample Size	Type of Container
Chromium VI	Aqueous	EPA 7196A	Cool, ≤ 6°C	24 hours	125 mL	Plastic
Conductivity	Aqueous	EPA 9050A	Cool, ≤ 6°C	28 days	125 mL	Plastic
Cyanide, Total	Aqueous	EPA 9012A	4 mL NaOH to pH > 12, Cool, ≤ 6°C	14 days	1 L	Plastic
Fluoride	Aqueous	EPA 9214	Cool, ≤ 6°C	28 days	125 mL	Plastic
Nitrate as N	Aqueous	EPA 9056	Cool, ≤ 6°C	48 hours	125 mL	Plastic
Perchlorate	Aqueous	EPA 314/ EPA 331	Sterile, ≤ 6°C	28 days	125 mL	Plastic
pH	Aqueous	EPA 9040B	None	7 days	125 mL	Plastic
Phenol	Aqueous	EPA 9066	Cool, ≤ 6°C, 2.0 mL H_2SO_4 to pH < 2	28 days	500 mL	Amber Glass
Sulfide, Total	Aqueous	EPA 9030B	Zinc Acetate, NaOH pH > 9, Cool, ≤ 6°C	7 days	125 mL	Plastic
Total Organic Halides (TOX)	Aqueous	EPA 9020B	Sulfite & H_2SO_4	14 days	250 mL	Amber Glass
Chloride, Chlorite, Sulfate, Nitrite	Aqueous	EPA 9056	Cool, ≤ 6°C	48 hours	125 ml	Plastic

(B) Inorganics – Metals

No Extract Holding Time

Parameter/ Method Name	Matrix	EPA/SM Method Number	Preservative	Sample Holding Time	Sample Size	Type of Container
Arsenic, As, Dissolved	Aqueous	EPA 6020	0.5 mL HNO_3 to pH < 2, Cool, ≤ 6°C	6 months	125 mL	Plastic
Arsenic, As, Total						
Mercury, Total	Aqueous	EPA 7470A	2.0 mL HNO_3 to pH < 2, Cool, ≤ 6°C	28 days	500 mL	Plastic
Mercury, Dissolved			Filtered on site, 2.0 mL HNO_3 to pH < 2, Cool, ≤ 6°C			
Metals, Total *	Aqueous	EPA 6010B	0.5 mL HNO_3 to pH < 2, Cool, ≤ 6°C	6 months	125 mL	Plastic
		EPA 6020				
Metals, Dissolved *	Aqueous	EPA6010B	Filtered on site, HNO_3 to pH < 2, Cool, ≤ 6°C	6 months	125 mL	Plastic
		EPA6020				

* Aluminum, Antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, vanadium and zinc.

(C) Organics

Parameter/ Method Name	Matrix	EPA/SM Method Number	Preservative	Sample Holding Time	Extract Holding Time	Recommended Minimum Sample Size	Type of Container
EDB/DBCP	Aqueous	EPA 8011	3 mg sodium thiosulfate, Cool, ≤ 6°C	14 days	< 6°C, 24 hours	40 mL	Glass/ Teflon lined septum
Halogenated Volatiles & Aromatic Volatiles	Aqueous	EPA8260B	10 mg $Na_2S_2O_3$ for residual chlorine, HCl, pH < 2 Cool, ≤ 6°C	14 days	NA	40 mL	Amber Glass/ Teflon lined Septum
Semi-Volatile Organic Compounds	Aqueous	EPA8270C	80 mg $Na_2S_2O_3$, Cool, ≤ 6°C	7 days	40 days	1 L	Amber Glass/ Teflon lined Cap

8.0 SAMPLE MANAGEMENT

8.1. SAMPLE RECEIPT AND LOG-IN/SAMPLE RECEIPT PROTOCOL

MWH Laboratories receives all samples through its sample control group. Upon receipt of samples, the sample control group inspects each sample for breakage or leakage, inverted septa, inappropriate caps or bottles, air bubbles in volatile organics samples, incomplete sample labels, incomplete paperwork, or discrepancies between the sample labels and the paperwork. The sample custodian checks the sample temperature to ensure that the required temperature is maintained during transport. EPA requires for most methods that a sample temperature of 4 ± 2°C shall be maintained during transport. The sample custodian records the sample temperature on the Chain of Custody. If the reading is above 6°C, the Project Manager (PM) is notified who then notifies the client regarding his sample condition. For samples that arrive at the laboratory > 6°C, the client will be notified that the effected samples are unacceptable for regulatory compliance purposes, and analysis is at the discretion of the client. (Acceptance criteria as per MUR, March 12, 2007 is ≤ 6°C).

The sample custodian also screens all hazardous waste and wastewater samples from a new client with the Geiger Counter meter for presence of radiation levels above background. For additional details refer to Sample Receiving and Log-In SOP. Any sample receipt problems are recorded either on the Chain of Custody (COC) Form (Figure 8-6) for Level I or on COC and Sample Cooler Receipt Form (Figure 8-1) for Level II samples. The Client Services Manager or designated Project Manager is notified about the problems. The client is informed of these problems, the appropriate course of action is determined and a decision is made immediately whether re-sampling is required.

Sample control employees are designated to receive all shipments and deliveries to the laboratory. The procedure for receiving samples is detailed in the Sample Receipt SOP kept on file in the log-in area and central QA files. A MWH Laboratories Work Request Form (WR) is filled out for each client's samples. An example of the WR is shown in Figure 8-2. A computer assigned laboratory number is placed on each sample bottle and the bottles are stored in refrigerators segregated by receipt date.

8.1.1. Sample Labeling System

Sample bottles must be clearly labeled so that the laboratory tracking system can function optimally. All sample bottles are shipped with labels containing the particular parameters to be tested from each bottle as well as any preservative information. The client must fill in the sampling date and sample site, and the client name/identification, on the label. The sample control group insures that all returned samples contain sample site identifications.

After log-in, the sample control group attaches a label with the laboratory sample tracking number to each sample bottle. All sample bottles collected for a particular sample site normally receive the same base laboratory sample tracking number and a

stamped label with this number is attached to each bottle. When analysts run a sample work schedule for their particular analysis, they receive a computer printout listing the laboratory sample numbers requiring that analysis. The analyst must then find the samples with these assigned numbers in their appropriate containers in refrigerated storage. The work schedule printout also gives the name of the client and sample ID that is compared with the information printed on the sample label to insure a proper identification.

The assigned laboratory numbers utilized for sample tracking are always a ten-digit number. The first six digits represent the year, month and day the sample was logged in. The remaining four digits are utilized to give each sample a unique identification number and these numbers are assigned consecutively from 1 to 9999 by the computer when the samples are logged in. These last four digits are reset back to one (1) at the beginning of each day. The laboratory also assigns a unique laboratory identification number to each sample and subsample container, and attaches a durable label to each sample container. The assignment of unique laboratory ID is done for each subsample except for samples that have short holding times. All laboratory ID codes assigned to each sample are documented in each appropriate logbooks/workbook for related laboratory activities such as sample preparation calibration and analysis.

8.1.2. Sample Receipt Acceptance Criteria:

8.1.2.1. The laboratory establishes and implements a sample acceptance/rejection policy per NELAC -5.5.8.3.2. The laboratory accepts a sample when the following criteria are met:

8.1.2.1.1. Proper, full, and complete documentation, which shall include sample identification, the location, date and time of collection, collector's name, preservation type, sample type and any special remarks concerning the sample;

8.1.2.1.2. Proper sample labeling to include unique identification and a labeling system for the samples with requirements concerning the durability of the labels (water resistant) and the use of indelible ink;

8.1.2.1.3. Use of appropriate sample containers;

8.1.2.1.4. Adherence to specified holding times;

8.1.2.1.5. Adequate sample volume. Sufficient sample volume must be available to perform the necessary tests.

8.1.2.1.6. Procedures to be used when sample shows signs of damage or contamination.

8.1.2.1.7. All samples, which require thermal preservation, shall be considered acceptable if the arrival temperature is $\leq 6°C$ or the method specified range. For samples with a

specified temperature of 4°C, samples with a temperature ranging from just above the freezing temperature of water to 6°C shall be acceptable. Samples that are hand delivered to the laboratory immediately after collection may not meet these criteria. In these cases, the samples shall be considered acceptable if there is evidence that the chilling process has begun such as arrival on ice.

8.1.2.1.8. The laboratory implements procedures for checking chemical preservation using readily available techniques, such as pH or free chlorine, prior to or during sample preparation or analysis [NELAC 5.5.8.3.1a) 2)]. Residual Free Chlorine and pH testing are done for Volatile samples (524.2). Also samples for semivolatiles by 525.2 analysis and THMs by 551.1 are verified for proper preservation by checking the pH of the sample at the sample preparation area.

8.1.2.2. Results of all checks are recorded in the appropriate logbooks. If the sample does not meet the laboratory sample receipt acceptance criteria, the laboratory either:

8.1.2.2.1. Retains correspondence and/or records of conversations concerning the final disposition of rejected samples; or

8.1.2.2.2. Fully documents any decision to proceed with the analysis of samples not meeting acceptance criteria.

8.1.2.2.2.1. The condition of these samples shall, at a minimum, be noted on the chain of custody or transmittal form and laboratory receipt documents.

8.1.2.2.2.2. The analysis data shall be appropriately "qualified" on the final report.

8.1.2.3. After LIMS entries have been completed for a group, a sample acknowledgment is printed out (see figure 8-9). The original acknowledgment is sent to the client, typically by the end of the following business day, and reviewed by the client's project manager. The sample acknowledgment report allows the clients to confirm if methods and tests assigned to the samples are correct.

8.2. CHAIN OF CUSTODY

Chain of custody procedures provides legal evidence that tampering with a sample has not occurred. This is achieved by documenting an accurate written record tracing possession of the sample from collection through its final analysis and disposal. The MWH Laboratories chain of custody form provided with sample bottle shipments is presented in Figure 8-6. The laboratory maintains two levels of custody. As a standard protocol, the laboratory utilizes Level I chain of custody. Level II chain of custody is available upon request at an additional charge.

8.2.1. Level I

This process relies on the fact that the laboratory is a secure building. The laboratory either has custody of the sample, or not. Evidence of laboratory custody is shown through the receipt signatures on the chain of custody form. Documentation is available in the laboratory for the tracking and disposition of a sample, however this information is not intended to withstand rigorous legal scrutiny. Level I chain of custody is consistent with EPA's definition of custody. Documentation associated with this level of custody includes:

8.2.1.1. A copy of the Chain of Custody is kept in the project file.

8.2.1.2. Run logs indicating when samples were handled/analyzed.

8.2.2. Level II

Also known as Legal Chain of Custody, this process requires that the disposition of each sample be defined in terms of time and possession for the life span of the sample; from sample bottle preparation to the disposal or complete depletion of the sample during analysis. Documentation associated with this level of custody includes:

8.2.2.1. Requirements for Level I followed

8.2.2.2. Chain of custody signed by sample control personnel upon receipt of sample(s)

8.2.2.3. Airbills and/or courier receipts filed in the project file by sample control

8.2.2.4. Internal custody logbook and key to secure and separate storage refrigerators maintained by sample control personnel; all sample/extract/digestate transfers, including those to secured storage, recorded herein

8.2.2.4.1. This storage area is locked and entry is permitted only upon signing for the custody of the sample(s)/extract(s)/digestate(s).

8.2.2.5. Internal custody logbook entries include client, client sample ID, date sampled, analyses, laboratory ID, internal dates and times transferred, initials (all samples are returned at the end of each shift) see Figure 8-4.

8.2.2.6. Upon disposal the technician will complete the custody notebook (all client identifying label(s) on the container defaced or removed)

8.2.2.7. Errors deleted by drawing a single line through the item, dating and initialing and reasons clearly indicated

8.2.2.8. Disposal of samples occur only with the concurrence of the affected legal authority, sample data user and/or submitter of the sample

8.2.2.9. Conditions of disposal and all correspondence between all parties concerning final disposition of the physical sample recorded and retained by the laboratory

8.2.2.10. Level II chain of custody sample disposal logbook (Figure 8-5) which indicates the date of disposal, nature of disposal (such as sample depleted, sample disposed in hazardous waste facility or sample returned to client, and the name of the individual who performed the task

8.2.3. Sub-contract Laboratories

When samples are sent to a sub-contract laboratory, a chain of custody is initiated by sample control or the subcontract administration group. The original chain of custody is filed in the project file with a reference to the second chain of custody. This sample is tracked internally and is identified as a subbed-out sample from an entry made into LIMs by sample control. All information from the original chain of custody is transferred to the second chain of custody in addition our internal Laboratory IDs are referenced. If samples were extracted at MWH Laboratories and the extracts sent out, then the QC set for that extraction batch is sent out to the sub-contract laboratory also.

8.2.4. The QA Officer or the Project Manager periodically inspects the chain of custody logbook to verify that analysts are signing samples back into custody the same day they are removed.

8.3. SAMPLE STORAGE AND DISPOSAL

Sample storage and disposal procedures are found in section 7.3 Sample Storage and 7.4 Sample Disposal.

8.4. SAMPLE TRACKING

When samples pass initial inspection, they are logged into the computer running the lab LIMS system. This system tracks samples from the time they arrive in the laboratory until final data are transmitted to the client. Multiple queries can be made of the database, and new routines can be written for retrieving certain information in a specified format. The following are example queries made from LIMS, printouts of these queries are available for personnel, on demand:

8.4.1. **Sample Disposition** - Shows which analyses have been performed on a given sample, which results have been validated by the manager/supervisor, and the results.

8.4.2. **Due Date/Hold time Date** - Allows analysts to schedule tests by accessing sample information according to priority date (hold time/turnaround time); query can be made per test, per group, per client, or per prompted date.

8.4.3. **QC Data** - Accessibility to QC information which can be tabulated and used to derive acceptability ranges, trend analyses, control charts etc.

8.4.4. **Formats** - Data is available for clients in various hard-copy layouts and/or electronic data format.

8.5. LABORATORY INFORMATION MANAGEMENT SYSTEM (LIMS)

8.5.1. The current LIMS system used by the lab is Multi-LIMS a Laboratory Information Management System (LIMS) software package developed by Nuovotech, Inc., located in Richland, WA, specifically for the needs of an environmental analytical laboratory. The UNIX based system consists of programs written in 4GL and C to access the SQL standard database. Audit trails are an integral part of the LIMS system. The lab is also introducing a new LIMS system – STARLIMS.

8.5.2. The StarLIMS system provides functions to access client accounts, tests/analyses, sample tracking, test backlog generation, data entry/verification, data validation, client data in a variety of formats, monthly financial and statistical reports, and archival storage of data.

8.5.3. The security of the information contained in the LIMS is kept through the restricted use of the database. A password is assigned to all personnel who use the LIMS. The type of information entered, or queried is dependent on the level of access associated with the password.

8.5.4. LIMS has several user types defined with specified access to key areas. Three levels of access are defined below:

8.5.4.1. **Analyt/Reviewer** – Original data is entered by an analyst. Once entered, the person who entered it may not change this data. A review, or secondary check, is performed by a supervisor or peer. Data may be changed by the supervisor or peer.

8.5.4.2. **Manager/Validation** – After the secondary check, the group manager validates the data. Upon validation, the data is available to the client.

8.5.4.3. **User** – Personnel who only query the database, rather than enter data, are assigned this third level of access.

8.5.5. Aside from sample queries, the only forms that are routinely printed out from LIMS are the final report and the corresponding invoice. Copies of these are kept electronically, while the originals are sent to the client. If electronic deliverables are provided, hardcopy reports are still sent.

8.5.5.1. **Hardcopy Storage -** Scanned reports are stored by client and then by work order number. This allows for timely access to a file for any given client. Working files

are kept for two years. All previous files may be boxed and stored at an off-site facility.

8.5.5.2. **Electronic Data Deliverables (EDDs)** - Electronic data or magnetic medium data are delivered to the client upon request. This data is formatted by prompting LIMS to download the required data into a temporary file. This file is copied onto disk or sent via electronic mail to the client destination. The working file is not maintained. It is, rather, erased, or written over. The original information will be available in LIMS to recreate as needed. Some EDDs are stored in project files.

8.5.5.3. **LIMS Maintenance** - LIMS maintenance is performed by Hewlett Packard and as a supplement, our manager of computer services. MWH Laboratories has not purchased the source code for the LIMS system and hence does very limited programming on the system. Instead, software "packs" are purchased from the vendor which add to the abilities of the system. Software validation is performed by the vendor prior to the sale of the "pack" to commercial laboratories. Hardware is installed, maintained, and guaranteed by Hewlett Packard. Our service contract with Hewlett Packard allows for the expedient attention to hardware breakdowns or servicing.

A hardware/software maintenance logbook is kept with the manager of computer services. In addition to this record, all servicing performed by Hewlett Packard or outside vendors is documented by their staff and available for our use.

8.5.6. Sample Status

Samples are logged into the system upon receipt in the laboratory. A laboratory number is assigned to each sample by the computer and the required tests are scheduled. Each sample then appears on the work schedule for the appropriate department. Turnaround time is automatically assigned to each sample test based on the sampling date and time and EPA holding times.

The work schedule is the primary means of checking the backlog for the analyst. The analyst can schedule the samples according to priority date, which is calculated according to the laboratory turnaround time and priority. An example of a computer generated work schedule is shown in figure 7-8.

Operations meetings are held weekly to discuss the status of data. An Operations Report (Figure 8-10) is used by the supervisors and Project Managers during operations meetings. The Operations Report includes the group No., Client ID, Total number of Tests, Tests ready to be validated and, incomplete tests by department. The Operations Reports allow the supervisor and the project manager to monitor sample status. Also during the Operations meeting, Project managers are informed of any issues that may have arisen so that they can proactively contact the client. A list of samples with short turnaround time, 72 hours or less, is kept at sample control. Sample control contacts the analyst when short holding time samples arrive. Bottle orders are completed when clients

request containers and supplies. This allows sample control to monitor the amount of samples due to arrive in the near future.

8.5.7. Data Entry and Report Generation

Data entry is accomplished through a variety of interactive sub-systems. Some situations require the entry of raw data and the system performs calculations, and reports final results and detection limits. In other cases, final data is entered either manually or via instrument interfaces. When the final scheduled test result goes into the system, the Group Supervisor passes on the reports to the validation section within the system for approval. In all cases, client reports are generated and printed automatically after the verification and approval by the supervisor of each analytical group.

Results are stored in LIMS in such a manner that immediate access is available to these reports. A list of all reports completed, indexed by client number, is maintained on the system. A few keystrokes can recall every report produced for a given client. Additionally, the system provides constant information on laboratory performance. This includes turnaround times reports for every analysis done by the laboratory, and productivity reports grouped into cost isolation accounts. A weekly laboratory Turnaround time report allows the tracking of turnaround time per department to ensure that the laboratory continuously improves its turnaround time and meets client needs. See example of weekly Lab Turnaround Time Report (Figure 8-11). Quarterly Productivity Workload Reports are generated by test and matrices that allow the laboratory to manage any changes in the volume and type of work undertaken. See example of workload report (Figure 8-12).

The system provides several levels of security. The first level is the entry of a password to initially log on to the computer, and then the person must be designated as a qualified user. Additionally, the department to which a person is assigned governs/accesses the various functions of the system. The system also provides for read-only access to results to further protect the data from unauthorized modification or deletion.

Figure 8-1 Cooler Receipt Form

MWH LABORATORIES COOLER RECEIPT FORM

PROJECT: _____ DATE RECEIVED: _____

Use back of form to note check-in problems and describe action(s) regarding the resolution(s) of problems.

A. PRELIMINARY EXAMINATION
Date Cooler opened: _____
By (print) _____ (sign)_____

1. Did cooler come with shipping slip (air bill, etc.)? Yes No
   If yes, attach and enter carrier and air bill number here: _____

2. Were custody seals on outside of cooler? Yes No
   If yes, how many and where: _____
   If yes, enter the following: seal date: _____ seal name: _____

3. Were custody seals unbroken and intact at delivery? Yes No

4. Were custody papers sealed in bag and taped to lid? Yes No

5. Were custody papers filled out properly (ink, etc.)? Yes No

6. Did you sign custody papers in appropriate place? Yes No

7. Was project identifiable from custody papers? Yes No

8. Have designated person(s) initial and acknowledge receipt: _____ date: _____

B. LOGIN PHASE
Date samples were logged in: _____
By (print) _____(sign)_____

9. Describe packing: _____

10. If required, was enough ice used? Yes No

11. Were all bottles sealed in separate plastic bags? Yes No

12. Did all bottles arrive unbroken and in good condition? Yes No

13. Were all bottle labels complete (ID, date, sign, preservative)?

14. Did all bottle labels agree with custody papers? If no, list on back. Yes No

15. Were correct containers used for the analytes? Yes No

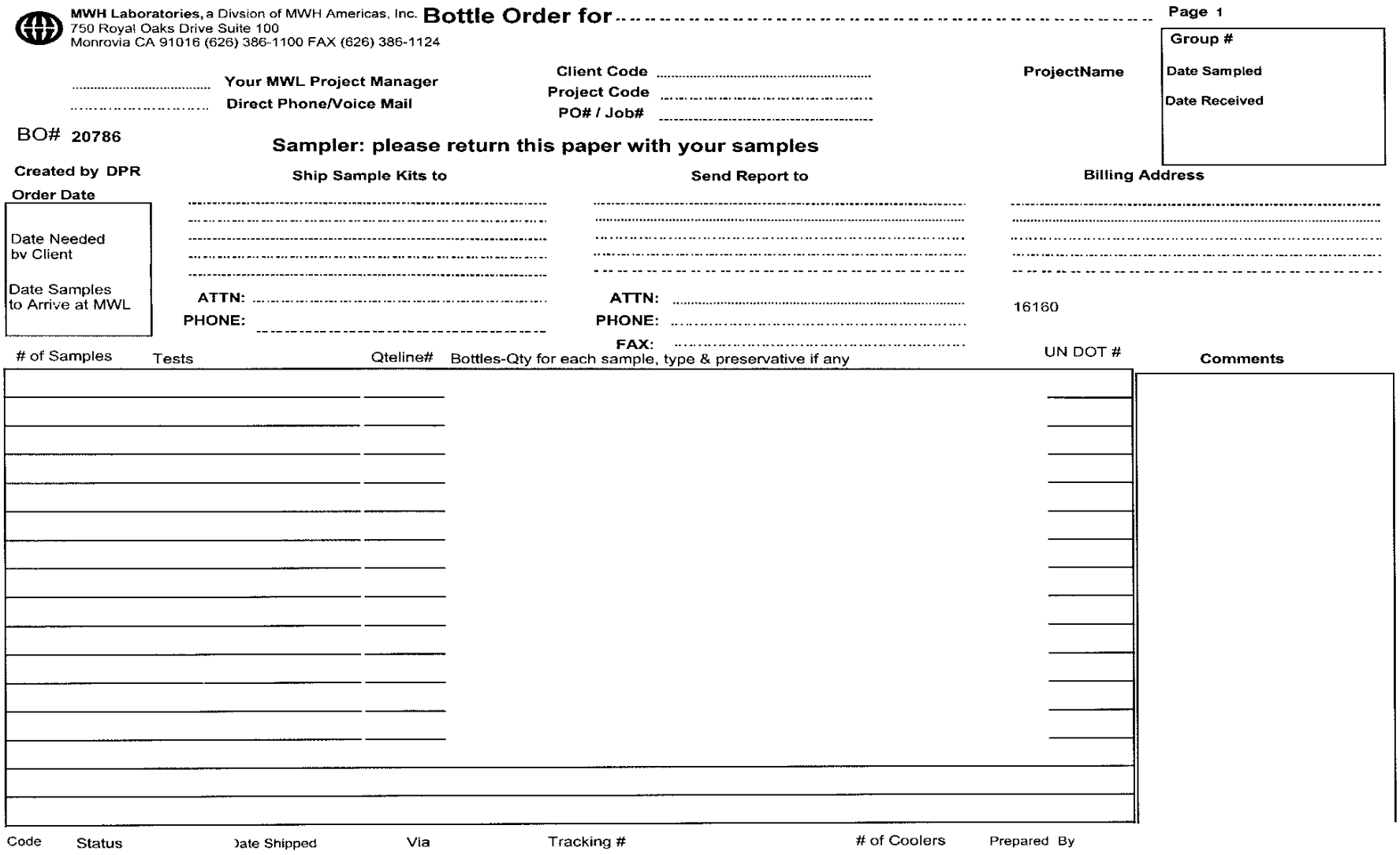
16. Were correct preservatives used when required? Yes No

17. Was sufficient amount of sample sent for tests? Yes No

18. Bubbles absent in VOA vials? If no, list by sample ID on back. Yes No

19. Was Client Services informed of problems? Yes No

Figure 8-2 Price Quotation/Work Order Form



MWH Laboratories, a Divsion of MWH Americas, Inc.
750 Royal Oaks Drive Suite 100
Monrovia CA 91016 (626) 386-1100 FAX (626) 386-1124

Bottle Order for .....

Page 1

Group #
Date Sampled
Date Received

..... Your MWL Project Manager
..... Direct Phone/Voice Mail

Client Code .....
Project Code .....
PO# / Job# .....

ProjectName

BO# 20786

Sampler: please return this paper with your samples

Created by DPR
Order Date

Date Needed by Client

Date Samples to Arrive at MWL

Ship Sample Kits to

ATTN: .....
PHONE: .....

Send Report to

ATTN: .....
PHONE: .....
FAX: .....

Billing Address

16160

# of Samples	Tests	Qteline#	Bottles-Qty for each sample, type & preservative if any	UN DOT #	Comments

Code Status Date Shipped Via Tracking # # of Coolers Prepared By

Figure 8-3 Example Sample Labels

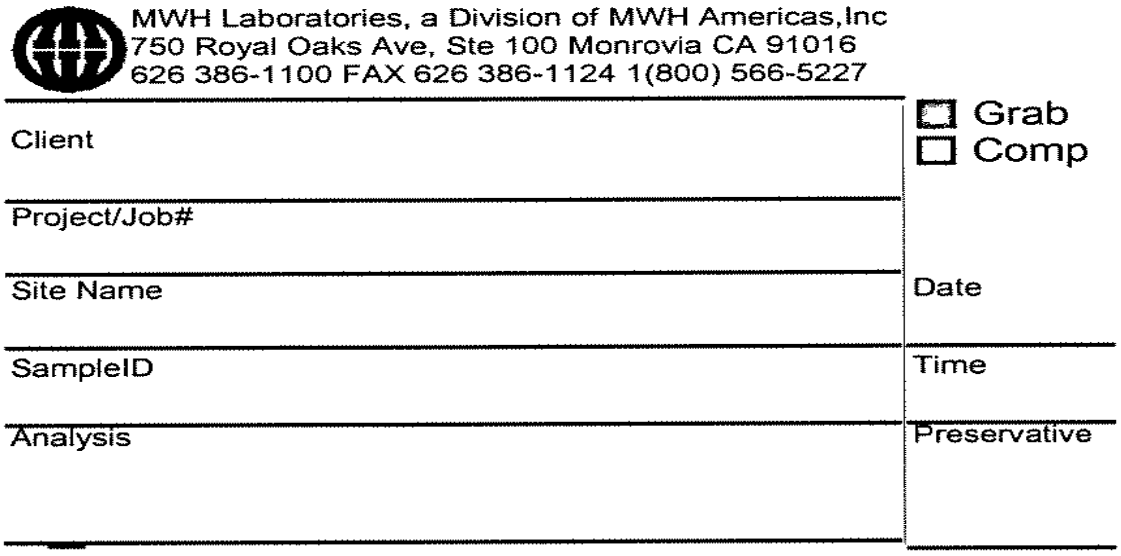


Figure 8-4 Internal Custody Logbook

Internal C.O.C

Log In Rcvd Date	Client	Client Sample ID	Sampling Date	Analysis (Tag #)	Laboratory Sample ID	Removal Code	Received			Returned		
							By	Date	Time	By	Date	Time

MWH Laboratories

Footnote: P Preparation; Extraction, Digestion, Incubation
A Analyze
D Disposal
R Relocate (state new location)

Figure 8-5 Internal Sample Disposal (Level II)

Level II Chain of Custody Sample Disposal Logbook

Log in Rec'd Date	Client	Lab Sample ID	Authorized to Dispose By:	Tag Label		Date of Disposal	Nature of Disposal				Initials	Signature
				Yes	No		Sample Depleted	Hazwaste Drum	Sewer	Returned to Client		

Figure 8-6 Chain-of-Custody Form

MWH Laboratories
MONTGOMERY WATSON HARZA

CHAIN OF CUSTODY RECORD

750 Royal Oaks, Suite 100
Monrovia, California 91016
Phone: (626) 386-1100
(800) 566-5227
Fax: (626) 386-1101

MWH LABS USE ONLY: PAGE 2 OF 2

LOGIN COMMENTS: _____

SAMPLES CHECKED AGAINST COC BY: _____

SAMPLES LOGGED IN BY: _____

SAMPLE TEMP WHEN REC'D AT LAB: _____ (Compliance: 4 +/- 2°C)

SAMPLES REC'D DAY OF COLLECTION? ☐ (check for yes)

CONDITION OF BLUE ICE: FROZEN ___ PARTIALLY FROZEN ___ THAWED ___

TO BE COMPLETED BY SAMPLER:

COMPANY, UTILITY or PROJECT:	SYSTEM #:	COMPLIANCE SAMPLES ☐ *(check for yes)* — NON-COMPLIANCE SAMPLES ☐ *(check for yes)* - Requires state forms ☐ REGULATION INVOLVED: Type of samples (circle one): ROUTINE SPECIAL CONFIRMATION (eg. SDWA, Phase V, NPDES, FDA,...)
MWH LABS CLIENT CODE:	P.O.# / JOB # / PROJECT :	***SEE ATTACHED BOTTLE ORDER FOR ANALYSES*** ☐ (check for yes), ***OR*** LIST ANALYSES REQUIRED BELOW (enter number of bottles sent for each test for each sample):
SAMPLER PRINTED NAME AND SIGNATURE:	**TAT requested: rush by adv notice only** STD___ 1 week ___ 3 day ___ 2 day___ 1 day ___	

SAMPLE DATE	SAMPLE TIME	STATION # or LOCATION	SITE NAME OR SAMPLE I.D.	MATRIX *	GRAB	COMP													SAMPLER COMMENTS

*** MATRIX TYPES:**
RSW = Raw Surface Water; **RGW** = Raw Ground Water; **CFW** = Chlor(am)inated Finished Water; **FW** = Other Finished Water; **CWW** = Chlorinated Waste Water; **WW** = Other Waste Water; **BW** = Bottled Water; **SW** = Storm Water; **SO** = Soil; **SL** = Sludge

	SIGNATURE	PRINT NAME	COMPANY/TITLE	DATE	TIME
RELINQUISHED BY:					
RECEIVED BY:					
RELINQUISHED BY:					
RECEIVED BY:					
RELINQUISHED BY:					
RECEIVED BY:					

Figure 8-7 Run Logbook

File ID: 090902an SO4

Sample ID	Date	Time	Dil	Raw	Rept.	Limit	Comment
autocal1	08/28/02	12:04	1	0	ND		
autocal2	08/28/02	12:14	1	1.4378	1.4		
autocal3	08/28/02	12:25	1	2.3498	2.3		
autocal4	08/28/02	12:35	1	4.1549	4.2		
autocal5	08/28/02	12:46	1	9.6369	9.6		
autocal6	08/28/02	12:57	1	19.066	19		
autocal7	08/28/02	13:07	1	48.880	49		
autocal8	08/28/02	13:18	1	101.08	100		
autocal9	08/28/02	13:29	1	199.82	200		
MCV	09/09/02	15:12	1	38.980	39	90-110	97.4%
HCV	09/09/02	15:23	1	155.65	156	90-110	97.2%
MRL	09/09/02	15:33	1	2.0927	2.09	50-150	104%
MBLANK	09/09/02	15:44	1	0	ND		
LCS	09/09/02	15:55	1	50.071	50.1	90-110	100%
LCSD	09/09/02	16:05	1	50.256	50.3	90-110	100%
2209050186_1/10	09/09/02	16:16	10	75.929	76		
2209060020_1/10	09/09/02	16:27	10	140.38	140		
2209060023_1/20	09/09/02	16:37	10	108.48	110		
2209090029	09/09/02	16:48	2	134.74	130		
2209090029MS	09/09/02	16:59	2	235.77	236	[101.032]	101%
2209090029MSD	09/09/02	17:09	2	234.68	235	[99.941]	99.9%
2209090029T	09/09/02	17:09	2		100.00	80 - 120	
2209090049_1/10	09/09/02	17:20	10	790.31	790		
2209090050_1/10	09/09/02	17:30	10	1505.8	1500		
2209090051_1/10	09/09/02	17:41	10	1218.1	1200		
MCV	09/09/02	17:52	1	39.511	39.5	90-110	98.7%
CCB	09/09/02	18:02	1	0	ND		
2209090052_1/10	09/09/02	18:13	10	0	ND		
2209090053_1/10	09/09/02	18:24	10	210.09	210		
2209090054	09/09/02	18:34	10	206.05	210		
2209090054MS	09/09/02	18:45	10	706.73	707	[500.688]	100%
2209090054MSD	09/09/02	18:56	10	706.22	706	[500.176]	100%
2209090054T	09/09/02	18:56	10		500.00	80 - 120	
2209090055_1/10	09/09/02	19:06	10	124.43	120		
2209090056	09/09/02	19:17	10	1054.3	1100		
2209090057	09/09/02	19:27	10	279.55	280		
2209090062	09/09/02	19:38	10	32.315	32		
2209090063	09/09/02	19:49	10	1284.7	1300		
MBLANK	09/09/02	19:59	10	0	ND		
LCS	09/09/02	20:10	1	50.356	50.4	90-110	100%
LCSD	09/09/02	20:21	1	50.300	50.3	90-110	100%
HCV	09/09/02	20:31	1	158.08	158	90-110	98.8%

Figure 8-8 Example Work Schedule Printout

```
**********************************************************************************************************************
*
*  DEPARTMENT : Extraction - Organic Prep      (EXTR  )                    MWH Laboratories
*                                                                          WorkSchedule
*  WORKSTATION: BNA Preparation                (BNA01)                     09-sep-2008 03:05:02
*
**********************************************************************************************************************

TEST CODE: @8270SCR 1          8270 Semivolatile, Screen, TIC    UNITS:
METHOD   : EPA 8270            PREP REQUIRED: Y
```

Group#	Sample#	R#	Company Name	Code	Result	LastResult	Project	Sample Source	Priority	Sample	PrepDate	DueDate	Locator
252992	2809050119	0	[redacted]	[redacted]			[redacted]	[redacted]	12-sep-2008	05-sep-2008		14-sep-2008	
	SAMPLE: CUSTSUB = TRIFLURALIN (141 SUB APPL)												
	RUN AND REPORT FOR TICS												

```
TEST CODE: @BNA     1          BNA Extractable                   UNITS:
METHOD   : EPA 625             PREP REQUIRED: Y
```

Group#	Sample#	R#	Company Name	Code	Result	LastResult	Project	Sample Source	Priority	Sample	PrepDate	DueDate	Locator
137074	2410250182	0	Not Available	N/A					25-oct-2004				
137074	2410250183	0	Not Available	N/A					25-oct-2004				
137074	2410250184	0	Not Available	N/A					25-oct-2004				
137074	2410250185	0	Not Available	N/A					25-oct-2004				
137074	2410250186	0	Not Available	N/A					25-oct-2004				
225282	2712180014	0	MWH Laboratories	MDL_IDOC				MDL1	18-dec-2007			17-jan-2008	GWG
225282	2712180015	0	MWH Laboratories	MDL_IDOC				MDL2	18-dec-2007			17-jan-2008	GWG
225282	2712180016	0	MWH Laboratories	MDL_IDOC				MDL3	18-dec-2007			17-jan-2008	GWG
225282	2712180017	0	MWH Laboratories	MDL_IDOC				MDL4	18-dec-2007			17-jan-2008	GWG
225282	2712180018	0	MWH Laboratories	MDL_IDOC				MDL5	18-dec-2007			17-jan-2008	GWG
225282	2712180019	0	MWH Laboratories	MDL_IDOC				MDL6	18-dec-2007			17-jan-2008	GWG
225282	2712180020	0	MWH Laboratories	MDL_IDOC				MDL7	18-dec-2007			17-jan-2008	GWG
225283	2712180021	0	MWH Laboratories	MDL_IDOC				Actual_DOC	18-dec-2007			17-jan-2008	GWG
	SAMPLE: EPA 625												
225283	2712180022	0	MWH Laboratories	MDL_IDOC				DOC1	18-dec-2007			17-jan-2008	GWG
225283	2712180023	0	MWH Laboratories	MDL_IDOC				DOC2	18-dec-2007			17-jan-2008	GWG
225283	2712180024	0	MWH Laboratories	MDL_IDOC				DOC3	18-dec-2007			17-jan-2008	GWG
249798	2808060355	0	Not Available	N/A			APP		13-aug-2008			16-aug-2008	
252820	2809030156	0	Water Administration	[redacted]PDES			APP	[redacted]	10-sep-2008	03-sep-2008		13-sep-2008	

```
TEST CODE: @BNA10   1          BNA Extractables, "Plus 10"       UNITS:
METHOD   : EPA 625             PREP REQUIRED: Y
```

Figure 8-9 Sample Acknowledgement

MWH Laboratories
750 Royal Oaks Drive, Monrovia, CA 91016
PHONE: 626-386-1100/FAX: 626-386-1101

ACKNOWLEDGMENT OF SAMPLES RECEIVED

[redacted]

Customer Code: [redacted]
Group#:
Project#:
Proj Mgr: Tom French
Phone: 480 778 1558

The following samples were received from you on **12/15/06**. They have been scheduled for the tests listed beside each sample. If this information is incorrect, please contact your service representative. Thank you for using MWH Laboratories.

Sample#	Sample Id	Matrix	Sample Date
	Tests Scheduled		
2612150123	COMP3 8046, 8021 001 & 002	Water	14-dec-2006 11:15:00
	@525REG @DIQUAT @ML515.4 @ML531.2 D1613EDD ENDOTHAL		
2612150124	TB-HOLD	Water	14-dec-2006 11:15:00
	@525REG		

Test Acronym Description

Test Acronym	Description
@525REG	525 Semivolatiles by GC/MS
@DIQUAT	Diquat and Paraquat
@ML515.4	Herbicides by 515.4
@ML531.2	Aldicarbs by 531.2
D1613EDD	2,3,7,8-TCDD 1613 DW (subbed)
ENDOTHAL	Endothall

Figure 8-10 Operations Report

Backlog of Incomplete Groups for ADE
As of 23 October, 2004
Page 1

Due	Group #	Client	CJL	CBG	COL	DIL	MER	DEB	WIM	WAM	CSD
-161	126818	MWH EDC	4		4						
-161	126828	MWH EDC	4		4						
-160	126869	MWH EDC	3		3						
-132	128403	WW RIX	13		13						
-56	132040	MDL_IDOC	5		RDY						
-14	135778	MP CLO4	6							RDY	4
-14	135779	MP CLO4	12						RDY	RDY	6
-14	135793	BW	5			RDY	1				1
-14	136257	MP CLO4	1							RDY	
-13	135926	BW	5			RDY	1				1
-13	135927	BW	5			RDY	1				1
-13	135929	BW	5			RDY	1				1
-11	136153	MP CLO4	1							RDY	
-11	136159	PILO	12			3			RDY	3	3
-9	136644	MP CLO4	1							RDY	
-8	136214	BW	5			RDY	1		RDY		1
-7	136255	MP CLO4	7						RDY	RDY	4
-7	136278	-MP CLO4	10							RDY	
-7	136279	DRINKING	2							2	
-4	136516	MP CLO4	31							11	
-4	136518	MP CLO4	8						6	2	
-3	136685	MP CLO4	2							2	
-2	137033	MP CLO4	1							RDY	
-1	136589	BW	8			4	2		RDY		1
-1	136613	CLO4	2							2	
0	136625	CLO4	20						3	11	4
0	136627	CLO4	37						15	12	6
0	136628	CLO4	24		3	3	3		RDY	6	6

Figure 8-11 Weekly Lab Turnaround Time

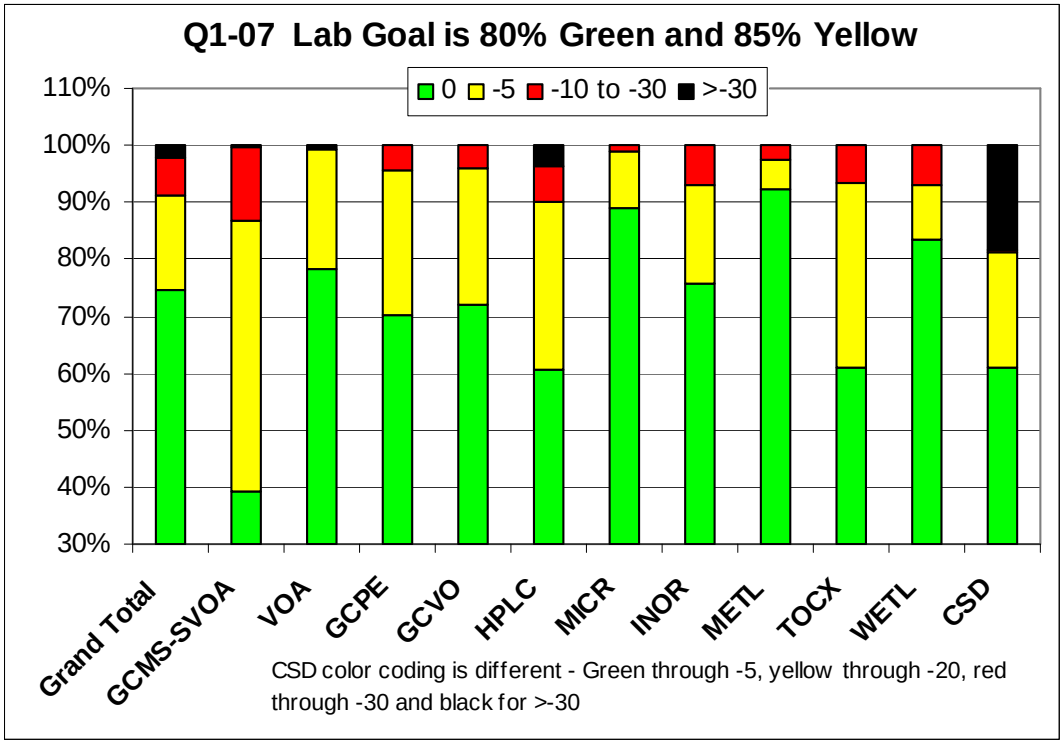


Figure 8-12 Work Load Report by Test and Matrix

Confidential Partial Workload Report Q1-2007

Department	Testcode	Matrix	Count	Method
Dept: GCMS	@525PLUS	water	130	525.2
Dept: GCMS	@525REG	water	70	525.2
Dept: CSD	@525UL	water	12	525.2 subbed
Dept: GCMS	@525WHO	water	1	525.2
Dept: GCMS	@525-WRD	water	8	525.2
Dept: GCMS	@528SODA	water	7	528
Dept: HPLC	@531CTR2	water	1	531.2
Dept: HPLC	@531WHO	water	95	531.2
Dept: HPLC	@532WHO	water	102	532
Dept: GCVO	@551HAN	water	108	551.1
Dept: GCVO	@551-ICR	water	21	551.1
Dept: CSD	@608EDD	water	7	608 subbed
Dept: VOA	@624LF1	water	7	624
Dept: CSD	@8081EDD	water	6	8081 subbed
Dept: CSD	@8141EDD	water	7	8141 subbed
Dept: VOA	@8260COP	water	22	8260
Dept: CSD	@8321EDD	water	6	8321 subbed
Dept: GCMS	@ACIDS	water	9	8270
Dept: CSD	@ACOPEDD	water	1	7110 subbed
Dept: HPLC	@ACRYLAM	water	97	LC-MS-MS
Dept: GCVO	@ALDEHYD	water	42	6252
Dept: METL	@AS-SPEC	water	15	200.8
Dept: TOCX	@BDOC	water	22	WQTC 1996
Dept: INOR	@BETA	water	2	900
Dept: GCMS	@BNA	water	21	625
Dept: GCMS	@BNA10	water	13	625
Dept: GCMS	@BNA-AP9	water	2	625
Dept: CSD	@BNAEDD	water	3	625 subbed
Dept: GCMS	@BNALF	water	24	625
Dept: CSD	@BNATEDD	water	3	625 subbed
Dept: VOA	@BTEX-DW	water	7	524.2
Dept: INOR	@CARBOX	water	17	IC
Dept: GCVO	@CH	water	110	551.1
Dept: GCVO	@CLDEMAN	water	5	SM4500-CL
Dept: INOR	@CLO4-MA	water	17	314

9.0 ANALYTICAL PROCEDURES

9.1. SOURCES FOR METHODS

9.1.1. **Standard Methods**

9.1.1.1. The laboratory shall evaluate the Precision and Bias of a standard method for each analyte of concern for each quality system matrix according to the single-concentration four-replicate recovery study procedures in NELAC Appendix C.1 (or alternate procedure documented in the quality manual when the analyte cannot be spiked into the sample matrix and QC samples are not commercially available). (NELAC Appendix C.3.3.a).

9.1.1.2. The analytical methods performed by MWH Laboratories are based primarily on methods specified by various federal, state, and local regulations. If more stringent standards or requirements are included in the mandated test method or by regulation, the laboratory ensures that all SOPs meet such requirements even if the requirement is more stringent than the corresponding NELAC standard. If it is unclear which requirements are more stringent, the laboratory follows the standard from the method or regulation. All analysts must follow all the Quality Control protocols and all essential QC measures specified by the laboratory's method manual (SOPs). The majority of methods come from the U.S. Environmental Protection Agency. Other methods are from Standard Methods for the Examination of Water and Wastewater, 19th, 20th, 21st and online Editions. Additional methods may be used when appropriate.

Methods from the EPA are listed in section 9.6, the references section.

9.1.2. **Non Standard Methods**

9.1.2.1. Methods not covered by standard methods are properly validated before use. Non-standard methods when used by the laboratory are subjected to agreement with the Client incorporating the Client's specification requirements, including the purpose of the environmental test. The method is validated appropriately before use. [NELAC 5.5.4.4].

9.1.2.2. For laboratory-developed test methods or non-standard test methods as defined in NELAC 5.5.4.3 and 5.5.4.4 that were not in use by the laboratory before July 2003, the laboratory must have a documented procedure to evaluate precision and bias. The laboratory must also compare results of the precision and bias measurements with criteria established by the client, by criteria given in the reference method or criteria established by the laboratory.

9.1.2.3. Laboratory developed methods may be used when the client does not specify the method to be used or where methods are employed that are not required by

regulations, as in the Performance Based Measurement System Approach, the methods shall be fully documented and validated (NELAC 5.5.4.2.2, 5.5.4.5 and Appendix C), and be available to the Client and other recipients of the relevant reports. The laboratory shall select appropriate methods that have been published either in international, regional or national standards, or by reputable technical organizations, or in relevant scientific texts or journals, or as specified by the manufacturer of the equipment. Laboratory-developed methods or methods adopted by the laboratory are used only if appropriate to the intended use and are validated. The laboratory informs the Client as to the method chosen. [NELAC 5.5.4.2.1c)]

9.1.2.4. The laboratory informs the Client when the method proposed by the Client is considered to be inappropriate or out of date. (NELAC 5.5.4.2.1).

9.1.3. The introduction of environmental test and calibration methods developed for the laboratory for its own use is a planned activity and is assigned to qualified personnel equipped with adequate resources.

9.2. INITIAL TEST METHOD EVALUATION PROCEDURES

For all test methods other than microbiology or methods where LOD/LOQ determinations are not relevant the following LOD and LOQ requirements apply.

9.2.1. Limit of Detection (LOD)

9.2.1.1. The laboratory shall determine the LOD by performing the MDL studies determination to conform to CFR136 for the method for each target analyte of concern in the quality system matrices. All sample-processing steps of the analytical method shall be included in the determination of the LOD.

9.2.1.2. The validity of the LOD shall be confirmed by quantitative identification of the analyte(s) in a QC sample in each quality system matrix containing the analyte at no more than 2-3X the LOD for single analyte tests and 1-4X the LOD for multiple analyte tests. This verification must be performed on every instrument that is to be used for analysis of sample and reporting data.

9.2.1.3. An LOD study is not required for any component for which spiking solutions or quality control samples are not available such as temperature, or, when test results are not to be reported to the LOD (versus the method reporting limit or working range of instrument calibration). Where an LOD study is not performed, the laboratory may not report a value below the Limit of Quantitation. Since the EPA Manual for Drinking Water 5th Edition requires MDL studies, the laboratory conducts LOD determinations for all drinking water methods where applicable.

9.2.2. Limit of Quantitation (LOQ)

9.2.2.1. The laboratory shall determine the LOQ for each analyte of concern according to a defined, documented procedure. LOQ/MRL is 2-3x LOD/MDL. At a minimum, MRL=MDL.

9.2.2.2. The LOQ study is not required for any component or property for which spiking solutions of quality control samples are not commercially available or otherwise inappropriate (e.g., pH).

9.2.2.3. The validity of the LOQ shall be confirmed by successful analysis of a QC sample containing the analytes of concern in each quality system matrix 1-2 times the claimed LOQ. A successful analysis is one where the recovery of each analyte is within the established test method acceptance criteria or client data quality objectives for accuracy. This single analysis is not required if the bias and precision of the measurement system is evaluated at the LOQ.

9.2.2.4. Precision and Bias

Precision and bias measurements must evaluate the method across the analytical calibration range of the method. The laboratory must also evaluate precision and bias in the relevant quality system matrices and must process the samples through the entire measurement system for each analyte of interest. (NELAC Appendix C .3.3.b).

Examples of a systematic approach to evaluate precision and bias could be the following:

9.2.2.4.1. Analyze QC samples in triplicate containing the analytes of concern at or near the limit of quantitation, at the upper-range of the calibration (upper 20%) and at a mid-range concentration. Process these samples on different days as three sets of samples through the entire measurement system for each analyte of interest. Each day one QC sample at each concentration is analyzed. A separate method blank shall be subjected to the analytical method along with the QC samples on each of the three days. (Note that the three samples of the MRL concentration can demonstrate sensitivity as well). For each analyte, calculate the mean recovery for each day, for each level over days, and for all nine samples. Calculate the relative standard deviation for each of the separate means obtained. Compare the standard deviations for the different days and the standard deviations for the different concentrations. If the different standard deviations are all statistically insignificant (e.g., F-test), then compare the overall mean and standard deviation with the established criteria from above.

9.2.2.4.2. A validation protocol such as the Tier I, Tier II, and Tier III requirements in US EPA Office of Water's Alternate Test Procedure (ATP) approval process.

9.2.2.5. Selectivity

The laboratory evaluates selectivity by following the checks established within the method, which may include mass spectral tuning, second column confirmation, ICP inter-element interference checks, chromatography retention time windows, sample blanks, spectrochemical absorption or fluorescence profiles, co-precipitation evaluations, and electrode response factors. (NELAC Appendix C.3.4)

9.2.3. Detection Limits

9.2.3.1. The method used in the quantitation of detection limits is as described in 40 CFR 136 Appendix B, which in summary is the analysis of at least seven replicates from which a statistically derived Method Detection Limit (MDL) is calculated. The replicates are determined over at least a 3 day period. This statistically derived limit is based on 3.143 times the standard deviation of 7 low concentration replicates (3-5 times the calculated detection limit). It is the laboratory's policy to be conservative when reporting a method detection limit on a non-detected sample.

9.2.3.2. Consequently, the laboratory has implemented the concept of minimum reporting levels (MRLs). The limit used on a laboratory report must be at or above the lowest standard associated with that analytical run. This ensures that all data reported as "detected" will have some degree of analytical precision associated with it. Data reported below these levels must be appropriately qualified. Copies of current MRLs for the laboratory are available upon request. An MRL can be no lower than the calculated MDL.

9.3. ESTIMATION OF UNCERTAINTY

Estimation of uncertainty consists of the sum (combining the components) of the uncertainties of the numerous steps of the analytical process, including, but not limited to, sample plan variability, spatial and temporal sample variation, sample heterogeneity, calibration/calibration check variability, extraction variability, and weighing variability.

The laboratory estimates uncertainty using the standard deviation calculated from routine quality control samples.

9.4. VALIDATION OF METHODS [NELAC 5.5.4.5]

9.4.1. The laboratory shall validate non-standard methods, laboratory-designed/developed methods, standard methods used outside their published scope, and amplifications and modifications of standard methods to confirm that the methods are fit for the intended use. The validation shall be as extensive as is necessary to meet the needs of the given application or field of application. The initial test method evaluation requirements given in Appendix C.3 of NELAC Standard 2003 discussed in Section 4.4, MDL and IDC requirements for new analysts are done in validating new methods and non-standard

methods (NELAC 5.5.4.5.2). This is also applicable when an analyte not currently found on the laboratory's list of accredited analytes is added to an existing accredited test method. Initial evaluation must be performed for that analyte. (NELAC C.1) The laboratory records the results obtained for the IDC, MDL, LOD and LOQ studies. The method is fit for the intended use when the results meet all the MDL and IDC criteria for the method.

9.4.2. The range and accuracy of the values obtainable from validated methods (e.g. the uncertainty of the results, detection limit, selectivity of the method, linearity, limit of repeatability and/or reproducibility, robustness against external influences and/or cross-sensitivity against interference from the matrix of the sample/test object), are assessed for the intended use, and relevant to the Client's needs [NELAC 5.5.4.5.3].

9.5. METHOD EVALUATION

To demonstrate the suitability of a test method for its intended purpose, the laboratory meets the acceptance criteria by the EPA or State program requirements. Also, the laboratory must meet the following criteria per NELAC 5.Appendix D.3.3:

9.5.1. Accepted (official) test methods or commercialized test kits for official methods from recognized national or international standards organizations do not require a specific validation. However to demonstrate proficiency with the test method prior to first use, the laboratory performs comparison to a method already approved for use in the laboratory, or by analyzing a minimum of ten spiked samples whose matrix is representative of those normally submitted to the laboratory, or by analyzing and passing one proficiency test series provided by an approved proficiency sample provider. The laboratory shall maintain this documentation as long as the method is in use and for at least 5 years past the date of last use [NELAC 5.Appendix D.3.3 a)], or 10 years to meet Hawaii requirements.

9.5.2. The laboratory participates in the proficiency test programs identified by NELAP [NELAC 5.4.1.5k)] or [NELAC 5.5.9.1b)]. The results of these analyses are used to evaluate the ability of the laboratory to produce acceptable data.

9.6. METHODS USED/SCOPE OF TESTING

9.6.1. The analytical methods used by MWH Laboratories can be grouped into three major categories: drinking water methods, wastewater methods, and methods for hazardous wastes and solid samples. The following tables provide method descriptions and method numbers for the methods used in these three major groups:

Table 9-1 Method Description for Drinking Water

Table 9-2 Method Description for Wastewater

Table 9-3 Method Description for Hazardous Waste

9.7. METHOD MODIFICATIONS

All method modifications are documented fully in individual SOPs. Methods are modified if and only if the original method goals for precision and accuracy have been met or better. Modifications are usually implemented due to available resources, or to expedite the process without sacrificing quality. Methods are validated prior to analyzing client samples. Validation is based on the method as described in the internal SOP. The validation includes an MDL study, an analyst precision and accuracy study, and subsequent review by the Supervisor, Lab Director and Quality Assurance Officer.

9.8. REFERENCES

Ref	Method Description
1	These methods are available from USEPA, EMSL, Cincinnati, OH 45268. The identical methods were formerly in "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020, March 1983.
2	"Methods for the Determination of Metals in Environmental Samples - Supplement I," EPA-600/R-94-111, May 1994. Available at NTIS, PB 94-184942.
3	USEPA "Methods for the Determination of Organic Compounds in Drinking Water," 12/88. Revised 7/91 (502.2, 515.1, 504, 507, 508, 531.1) EPA 600/4-88-039.
3a	USEPA "Methods for the Determination of Organic Compounds in Drinking Water - Supplement I". EPA-600/4-90-020, July 1990. (547, 551)
3b	USEPA "Methods for the Determination of Organic Compounds in Drinking Water - Supplement II." EPA-600/R-92-129, August 1992. (524.2, 548.1, 549.1)
3c	USEPA "Methods for the Determination of Organic Compounds in Drinking Water, Method 525.2, 504.1, and 508.1"
3d	USEPA "Methods for the Determination of Organic Compounds in Drinking Water, Supplement III (502.2, 504.1, 505, 507, 508, 524.2, 525.2, 531.1, 551.1), EPA/600/R-95/131, 08/95. For 1,2,3-TCP low level, CA DHS "Determination for 1,2,3-Trichloropropane in Drinking Water by Purge and Trap Gas Chromatography/ Mass Spectroscopy," (524.2), 02/02.
4	Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998, American Public Health Association, 1015 Fifteenth Street NW, Washington, D.C. 20005.
4a	Standard Methods for the Examination of Water and Wastewater, 19th Edition, 1995, American Public Health Association, 1015 Fifteenth Street NW, Washington, D.C. 20005.
4b	Standard Methods for the Examination of Water and Wastewater, 21st Edition, 2005, American Public Health Association, 1015 Fifteenth Street, NW, Washington, D.C. 20005.
5	Available from Books and Open-File Reports Section, U.S. Geological Survey, Federal Center, Box 25425, Denver, CO 80225-0425.

6 "Methods for the Determination of Inorganic Substances in Environmental Samples," EPA-600/R-93-100, August 1993. Available at NTIS, PB94-121811.

7 USEPA "Methods for Chemical Analysis of Water and Wastewater," EPA-600/4-79-020, 1983.

8 Method 100.2, "Determination of Asbestos Structure Over 10-mm In Length in Drinking Water," EPA-600/R-94-134, June 1994. Available at NTIS, PB 94-201902.

9 Industrial Method No. 129-71W, "Fluoride in Water and Wastewater," December 1972, and Method No. 380-75WE, "Fluoride in Water and Wastewater," February 1976, Technician Industrial Systems, Tarrytown, NY 10591.

10 40 CFR Parts 100, 136 to 141. July 1, 1995.

11 "Prescribed Procedures for Measurement of Radioactivity in Drinking Water", EPA-600/4-80-032 (1980), US EPA, August 1980.

12 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW-846, 2nd edition, revised April 1985 and 3rd edition, September 1986.

13 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW-846, Update III.

14 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW-846, Update II

15 Methods for the Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater – Volume 1 – EPA 821/R-93-010A. August 1993. Revision 1. Method 614. The Determination of Organophosphorus Pesticides in Municipal and Industrial Wastewater.

16 Method 300.1 Determination of Inorganic Anions in Drinking Water by Ion Chromatography, Revision 1.0 1997 (Stand Alone Method)

17 Federal Register, 12/1/99, USEPA 40 CFR Parts 141 & 143 National Primary & Secondary Drinking Water Regulations: Analytical Methods for Chemical & Microbiological Contaminants & Revisions to Laboratory Certification Requirements; Final Rule

17a Methods Update Rule, March 12, 2007, 40 CFR Parts 122, 136 and 141. Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; National Primary Drinking Water Regulations; and National Secondary Drinking Water Regulations; Analysis and Sampling Procedures; Final Rule.

18 Method 515.4 Determination of Chlorinated Acids in Drinking Water by Liquid-liquid Microextraction, Derivatization, And Fast Gas Chromatography with Electron Capture Detection, Revision 1.0, April, 2000, EPA 815-R-00-014

19 Method 531.2 Measurement of n-Methyl Carbamoyloximes and n-Methylcarbamates in Water by Direct Aqueous Injection – HPLC with Postcolumn Derivitization, Revision 1.0, September, 2001, EPA 815-B-01-002

20 USEPA "April 2000 draft – Method 1602." April, 2000.

Table 9-1 Method Description for Drinking Water

(A) Inorganics – Wet Chemistry

Parameter/Method Name	Method Number	Method Description	Reference
Alkalinity	SM2320B	Titrimetric	4
Ammonia	EPA350.1	Colorimetric	1
Bromate	EPA 300.0 / 300.1	Ion Chromatography	6/16
Bromide	EPA300.0/300.1	Ion Chromatography	6/16
Chloride	EPA300.0	Ion Chromatography	6
Chlorate	EPA 300.0/300.1	Ion Chromatography	6/16
Chlorite	EPA300.0/300.1	Ion Chromatography	6/16
Chromium VI (Dissolved)	EPA 218.6/ SM 3500 Cr-B	Ion Chromatography	2/4
Color	SM2120B	Visual	4
Conductivity	SM2510B	Wheatstone Bridge	4
Cyanide	SM4500CN-F	Selective Electrode Method	4
Cyanide	EPA335.4	Manual Distillation, Spectrophotometric	6
Fluoride	SM4500 F-C	Potentiometric - Ion Selection Electrode	4
Foaming Agents/ Surfactant (MBAS)	SM5540C	Colorimetric	4
Nitrate/Nitrite	EPA300.0	Ion Chromatography	6
Nitrite/Nitrate + Nitrite	EPA 353.2	Automated Cadmium Reduction, RFA	6
Odor	SM2150B	Odor	4
Perchlorate	EPA 314.0 EPA 331	Ion Chromatography LCMS	6
pH	EPA 150.1/SM4500-HB	Electrometric	1/4
o-Phosphate	EPA300.0	Ion Chromatography	6
o-Phosphate	SM4500 P-E/PF	Color, Ascorbic Acid	4
Residual Chlorine (Total/Free Chlorine)	SM4500 Cl-G	DPD Colorimetric/HaCH	4
Silica	EPA200.7	ICP	2
Dissolved Silica/Reactive Silica	SM 4500 SiO2C	Molybdosilicate	4
Solids (TDS)	SM2540C	Gravimetric	4
Sulfate	EPA300.0	Ion Chromatography	6
Temperature	SM2550B	Thermometric	4
Total Organic Carbon(TOC)/ Dissolved Organic Carbon (DOC)	SM5310C	UV Persulfate	4
Turbidity	EPA180.1	Nephelometric	6

Parameter/Method Name	Method Number	Method Description	Reference
UV 254	SM5910B	Determination of UV absorbing organic constituents by UV absorption method at 254 nm	4
TOX (Total Organic Halogen) or Dissolved Organic Halogen (DOX)	SM 5320B	Adsorption-Pyrolysis-Titrimetric Method	4

(B) Inorganics – Metals

Parameter/Method Name	Method Number	Method Description	Reference
Asbestos	EPA 100.2	TEM (Transmission Electron Microscopy)	8
Metals (except Hg)	EPA 200.7	ICP (Inductively Coupled Plasma)	2
Metals (except Hg)	EPA 200.8	ICPMS (Inductively Coupled Plasma Mass	2
Mercury	EPA 245.1	Manual Cold Vapor	2

(C) Microbiology/Microscopy Tests

Parameter/Method Name	Method Number	Method Description	Reference
Drinking Water Source Enumeration (MTF)	SM9221B	Multiple Tube Fermentation (MTF)	4
Drinking Water Source Enumeration/Colilert 24 hr & 8 hr	SM9223B	MMO-MUG Test/Colilert	4
Fecal Coliforms/EC Medium	SM9221E	Multiple Tube fermentation (MTF) / EC Medium	4
Heterotrophic Plate Count	SM9215B	Pour Plate Count	4
Total Coliform & E. Coli	SM9223B	Colisure	4
Total Coliform (MF) Enumeration	SM 9222A, B, C	Membrane Filtration	4
Total Coliforms	SM9221B	Multiple Tube Fermentation (MTF)	4
Total Coliforms + --E. Coli / Present or Absent	SM9223B	MMO-MUG Test/Colilert	4
Coliphage	EPA 1602	Coliphage	20

(D) Organics

Parameter/Method Name	Method Number	Method Description	Reference
DBCP/EDB	EPA504.1	Microextraction, GC/ECD	3d
Organohalide Pesticides and Commercial Polychlorinated Biphenyl (PCB) Products in water by Microextraction and Gas Chromatography	EPA505	Microextraction, GC/ECD	3d

Parameter/Method Name	Method Number	Method Description	Reference
Chlorinated Herbicides	EPA515.4	GC, Electron Capture Detector (ECD)	18
Purgeable Organic Compounds/ Halogenated & Aromatic Volatiles/Trihalomethanes/Di-isopropyl Ether(DIPE),Tertiary Amyl Methyl Ether (TAME), Tert-Butyl ethyl ether (ETBE), TBA, CS2, MIBK	EPA524.2	Purge and Trap capillary Column, GCMS	3d
1,2,3-Trichloropropane (TCP)	CA DHS 524.2		
Semi-Volatile Organics -- Acid/Base Neutrals including ThioBencarb	EPA525.2	Liquid Solid Extraction (LSE), capillary column, GCMS	3d
N-Methylcarbamoyloximes and N-Methylcarbamates	EPA531.2	HPLC with Fluorescence Detector	19
Glyphosate	EPA547	HPLC/Post Column Reactor - Fluorescence Detector	3a
Endothall	EPA548.1	GCMS, Liquid Solid Extraction (LSE)	3b
Diquat & Paraquat	EPA549.2	HPLC, Liquid Solid Extraction (LSE) UV Detector	17
Trihalomethanes	EPA 551.1	GC, Electron Capture Detector (ECD), liquid liquid extraction	3d
Haloacetic Acids	SM6251B	GC, Electron Capture Detector (ECD)	4

(E) Radiochemistry

Parameter/Method Name	Method Number	Method Description	Reference
Uranium	EPA 200.8	ICP MS	2
Gross Alpha	EPA900.0	Proportional Counting	11
Gross Beta	EPA900.0	Proportional Counting	11
Radium 228	EPA 904.0	Radiochemical	11
Radon 222	SM 7500 Rn-B	Liquid Scintillation	4

Table 9-2 Method Description for Wastewater

(A) Inorganics – We Chemistry

Parameter/ Method Name	Method Number	Method Description	Reference
Alkalinity, Total (Bicarbonate, Carbonate, & Hydroxide)	SM2320B	Titrimetric, Potentiometric	4

Parameter/ Method Name	Method Number	Method Description	Reference
Ammonia	EPA350.1/SM 4500 NH3H (18th) and NH3G (19th/20th)	Colorimetric	1/4/4a
Biochemical Oxygen Demand (BOD)	SM5210B	BOD/Probe	4
Boron	EPA200.7	ICP	2
Bromide	EPA300.0	Ion Chromatography	6
Carbonaceous Biochemical Oxygen Demand (CBOD)	SM5210B	BOD/Probe with Nitrification Inhibitor	4
Chemical Oxygen Demand (COD)	EPA410.4	Colorimetric	1
Chloride	EPA300.0	Ion Chromatography	6
Chlorine, Total Residual	SM4500 Cl G	Spectrophotometric, DPD, HACH	4
Chromium VI	EPA 218.6/ SM3500D Cr-B	0.45 micron Filtration Followed by Colorimetric	2/4
Cyanide, Total	EPA 335.4	Manual Distillation followed	1
Cyanide, Amenable to Chlorination	SM 4500CN G	Automated Colorimetric after	4
Fluoride	SM4500 F-C	Ion Selective Electrode	2/4
Hardness	EPA 200.7/SM 2340B	Calculation Ca plus Mg as CO3-	4
Kjeldahl Nitrogen	EPA351.2	Colorimetric, Semi-auto block digester	1
Nitrate	EPA353.2 EPA300.0	Cadmium Reduction Ion Chromatography	1 6
Nitrite	EPA300.0 EPA 353.2	Ion Chromatography Cadmium Reduction	6 1
Total Residue	SM 2540B	Gravimetric	4
Orthophosphate	SM4500 P-E/PF EPA300.0/HACH 8048	Manual Single Reagent Ion Chromatography	4 6
Perchlorate	EPA 300.0/314	Ion Chromatography	6
Phenols	EPA 420.1/420.4	Manual Distillation Followed by Colorimetric	1
pH	SM4500-HB	Electrometric	4
Phosphorus, Total	SM4500 P-F	Persulfate Digestion followed by Manual Colorimetric	4
Residue, Filterable (Total Dissolved Solids--TDS)	SM2540C	Gravimetric	4

Parameter/ Method Name	Method Number	Method Description	Reference
Residue, Non-filterable (Total Suspended Solids--TSS)	SM2540D	Gravimetric	4
Residue, Settleable (Settleable Solids)	SM 2540F	ImHoff Cone	4
Specific Conductance	EPA120.1/SM2510 B	Wheatstone Bridge	1/4
Sulfate	EPA300.0	Ion Chromatography	6
Sulfide (Total & Soluble)	SM 4500S-2D	Colorimetric	4
Total Organic Carbon (TOC)	SM5310C	UV Persulfate	4

(B) Inorganic – Metals

Parameter/Method Name	Method Number	Method Description	Reference
Metals (except Hg)	EPA200.7 EPA200.8	Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP) Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	2 2
Mercury, Hg	EPA245.1	Digestion, Cold Vapor Manual	1
Silica Dissolved	SM4500SiO2C	Molybdosilicate	4

(C) Microbiology/Microscopy Tests

Parameter/Method Name	Method Number	Method Description	Reference
Asbestos	EPA 100.2	Transmission Electron Microscopy	8
Total Coliforms By Multiple Tube Fermentation (MTF)	SM9221B	Multiple Tube Fermentation (MTF)	4
Fecal Coliforms By Multiple Tube/EC	SM9221E	MTF (EC Medium)	4
Fecal Streptococci and Enterococci by MTF	SM9230B	Multiple Tube Fermentation (MTF)	4
Heterotrophic Plate Count	SM9215B	Pour Plate Count	4

(D) Organics

Parameter/Method Name	Method Number	Method Description	Reference
Halogenated/Aromatic Volatiles	EPA624	GC/MS	10
Semi-Volatiles Acid and Base/ Neutral Compounds	EPA625	GC/MS	10

(E) Radiochemistry

Parameter/Method Name	Method Number	Method Description	Reference
Gross Alpha	EPA900.0	Proportional Counting	11
Gross Beta	EPA900.0	Proportional Counting	11

Table 9-3 Method Description for Hazardous Waste

(A) Inorganics – Wet Chemistry

Parameter/Method Name	Method Number	Method Description	Reference
Chromium VI	EPA7196A	Colorimetric	13
Total Organic Halides	EPA 9020 B	Absorption - Pyrolysis - Titrimetric Method	13/14

(B) Inorganics – Metals

Parameter/ Method Name	Method Number	Method Description	Reference
Antimony, Sb	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13 13/14
Barium, Ba	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13 13/14
Berrylium, Be	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13 13/14
Boron, Br	EPA6010B	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP)	13
Cadmium, Cd	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13 13/14
Chromium, Cr	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13 13/14
Cobalt, Co	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13 13/14

Parameter/ Method Name	Method Number	Method Description	Reference
Copper, Cu	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13 13/14
Lead, Pb	EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13/14
Mercury, Hg	EPA7471A	Manual Cold Vapor/Solid or Semi Solid (CV)	13/14
Molybdenum, Mo	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13 13/14
Nickel, Ni	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13 13/14
Selenium, Se	EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13/14
Silver, Ag	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13 13/14
Thallium, Tl	EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP)	13/14
Vanadium, V	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma Emission Spectroscopy (ICP)	13 13/14
Zinc, Zn	EPA6010B EPA6020	EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS) EPA3005A/3010A Acid Digestion, Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	13 14

(C) Organics

Parameter/Method Name	Method Number	Method Description	Reference
Halogenated Volatiles	EPA8260B	Purge & Trap, GC/MS	13
Aromatic Volatiles	EPA8260B	Purge & Trap, GC/MS	13
Semi-Volatile Organic Compounds (BNAs)	EPA8270C	EPA3550A Extraction, GC/MS	13
EDB/DBCP	EPA 8011	Microextraction, GC/ECD	13

10.0 PURCHASING SERVICES AND SUPPLIES/ MEASUREMENT TRACEABILITY

10.1. PURCHASING SERVICES AND SUPPLIES

10.1.1. Documented procedures for the purchase, receipt and storage of reagents and standards (consumable materials) used for the technical operations of the laboratory must be followed by all personnel as per NELAC 5.5.6.4.

10.1.2. Purchased supplies and services that affect the quality of environmental tests are of he required quality by using approved suppliers and products.

10.2. REAGENTS AND REFERENCE STANDARDS

10.2.1. All chemicals used by MWH Laboratories are ACS Reagent Grade, or better. Wherever possible, standards are from sources that are traceable to the National Institute for Standards and Technology (NIST). The laboratory ensures the use of reagents of same or better purity than that specified in the method. Thus, the analyst checks the label of the container to verify that the purity of the reagents meets the requirements of the particular method.

10.2.2. Procedures shall be in place to ensure prepared reagents meet the requirements of the test method. If the method does not specify reagent quality, at a minimum the laboratory uses analytical "Reagent Grade" or better quality for all reagents [NELAC 5.5.6.4.e)]

10.2.3. **Calibration Standards**

10.2.3.1. Stock standards are obtained from the EPA Repository, or suppliers traceable to NIST, for the organic compounds. The metal stock solutions are obtained from NIST traceable sources. Initial calibration verification standards are obtained from a second "Manufacturer or lot" if lot can be demonstrated from the manufacturer as prepared independently from other lots [NELAC 5.5.5.2.2.1d)]. Stock solutions for surrogate parameters and other inorganic compounds are made up by the analysts from the appropriate reagent grade chemical specified in the procedure.

10.2.3.2. Stock standards are utilized to make working standards of lower concentration, which are then used to make calibration standards for the analytical run. The holding periods of stock standards, working standards, and calibration standards for the different analyses are provided in Table 10-2.

10.2.3.3. Stock standards, working standards, and calibration standards are all prepared in accordance with the method procedure. A logbook is maintained for standards preparation providing the initials of the analyst preparing the standard, the date of preparation, the concentration made up, and the lot numbers and suppliers. Since only one set of working standards is prepared at a time, the date of an analytical run

can be keyed to the date of the working standards preparation to provide traceability to the particular lots of reagents from which the calibration standards were derived.

10.2.3.4. Calibration standards are run at the beginning of each day's analysis and a single standard is run at intervals throughout the analysis and at the end of the run to check for instrument drift. This "check" standard can also be used as an additional measure of analytical precision in addition to the LCS. As per NELAC 5.5.5.10.b) beginning and ending check standards must be at varying concentration within the established calibration range. If an internal standard is used, one CCV check must be analyzed per batch and an ending CCV may not need to be run unless required by method.

10.2.3.5. At the beginning of each day of analysis, all instruments must be calibrated. The calibration standards used must encompass a range of low, mid and high level concentrations to determine the calibration curve. The low level standard must be at or below the MRL value, the high level standard must be at the high end of the linear range and the mid level standard must be approximately midway between the low and high concentrations. Calibration procedures vary for the different instrumental methods and are summarized on Table 11-1. Section 11.1 summarizes the lab policy for calibration.

10.2.4. **Policy on Verification of Standards**

All information relating to standards preparation and verification must be documented in the Standards Preparation notebook for that analysis. All documentation required must be examined by the analyst and signed off by the section supervisor. All documentation for each group must be stored in a central location (i.e. the standards preparation room). For microbiology, performance checks including the organisms used, their culture collection reference, date of issue of specification, or statements assuring that the relevant batch meets the product specifications is verified [NELAC 5.Appendix D.3.6 b)].

10.2.4.1. **Mixtures**

New standard mix preparations must be compared to the previous mix. The concentrations calculated for the new standard should be within 10% of the "true" value (or as per the specific SOP). If the new standard does not agree within 10%, a third standard must be prepared by a different analyst and compared to the previous two. The third standard should agree with either the "old" standard or the "new" standard. If the third standard agrees with the "old" standard the third standard is used as the "new" standard. If the third standard agrees with the "new" standard the "old" standard is discarded and both the "new" and third standards can be used. In both cases the "new" standard must be verified by comparing to a "known" reference standard before discarding the old standard. Note that for some methods it may not be possible for the new standard to agree within 10% (see the specific SOP).

A table must be prepared in the Standards Notebook for each standard prepared comparing the cumulative percent difference for each compound in that standard. The cumulative percent difference must not exceed 10%. If it does, a new standard must be prepared. For example, if the difference between the first and second standards was -8% and the difference between the second and third standards was +3%, the cumulative percent difference would be -5%.

A new calibration curve must be prepared analyzing both the new standard and a known reference sample. The calculated value must fall within the acceptance limits for the reference sample.

10.2.4.2. **Neat Compounds**

The identity and purity of any new bottle of neat material must be verified either by the method it will be used to monitor or, preferably, by a different method.

For Organics, a solution of the new neat material must be compared to the old standard as a check on identity and purity. Acceptance criteria are detailed in the previous Mixtures section. For inorganics the new stock standard must be compared to the old stock standard as a check on concentration.

10.3. DOCUMENTATION RECORDS OF REAGENTS AND STANDARDS

10.3.1. A logbook is maintained for all standards. Each log contains the date of fresh stock preparation, the manufacturer's lot number and supplier, the preparer's initials, the weight of material and the final volume used to prepare the stock.

10.3.2. The laboratory shall retain records for all standards, reagents, reference materials and media including the manufacturer/vendor, the manufacturer's Certificate of Analysis or purity (if supplied), the date of receipt, recommended storage conditions, and an expiration date after which the material shall not be used unless it is verified by the laboratory. [NELAC 5.5.6.4a)]

10.3.3. Original containers (such as provided by the manufacturer or vendor) shall be verified and labeled with an expiration date. [NELAC 5.5.6.4b)]

10.3.4. Records shall be maintained on standard and reference material preparation. These records shall indicate traceability to purchased stocks or neat compounds, reference to the method of preparation, date of preparation, expiration date and preparer's initials.

10.3.5. Where traceability to NIST is not applicable, the laboratory shall provide satisfactory evidence of correlation of results, example participation in proficiency testing or independent analysis. [NELAC 5.5.6.2.2]

10.3.6. All containers of prepared standards and reference materials must bear a unique identifier and expiration date, and be linked to documentation requirements in 9.2.c above. (NELAC 5.5.6.4.d)

10.3.7. All containers of prepared reagents must bear a preparation date. An expiration date shall be defined on the container or documented elsewhere as indicated in the laboratory's quality manual or SOP. [NELAC 5.5.6.4.f), 5.5.9.2 a) 6) and D.1.4 b)]

10.4. REAGENT STORAGE AND DISPOSAL

10.4.1. Standards are stored in designated refrigerators or freezers. Samples/extracts/digestates are not stored in these refrigerators due to the potential for cross-contamination.

10.4.2. All reagents, solvents and reactive chemicals are stored in their original containers in appropriate cabinets or storage closets specifically designed for this use. See Table 10-1, for storage instruction. Date received and date opened must be recorded on each reagent container.

Table 10-1 Reagent and Standard Storage

Chemical	Method of Storage
Nitric Acid	Stored in original containers in cabinet designed for acid storage.
Hydrochloric Acid	Stored in original containers in cabinet designed for acid storage.
Sulfuric Acid	Stored in original containers in cabinet designed for acid storage.
Flammable Solvents	Stored in original containers in flammable storage cabinets.
Oxidizers	Stored separately from flammable in cabinet designed for oxidizers.
Ethyl Ether	Stored in original containers in flammable storage cabinets. New lots are tested for peroxides. Each bottle is tested before and after peroxide removal with an activated alumna column
Stock Standard Solutions	Stored in freezer at 0°C in unbroken ampules
Working Standard Solutions	Stored in refrigerator at 4°C labeled with prep information and expiration date.
Reagent Chemicals	Stored in cabinets in air conditioned laboratory areas
Hazardous Chemicals	Any chemical which is a health toxin and a known carcinogen, is stored in a secured area with restricted access

Table 10-2 Standard Storage and Holding Periods for Stock and Working Standard Solutions

Analyte	Stock Standard	Source Storage	Working Standard	Storage	Calibration Standard
ICP Metals	Expiration date	RT	6 months	RT	1-month
ICPMS Metals	Expiration date	RT	6 months	RT	1-month
Volatile 524.2	Expiration date	FZ	Monthly	FZ	Monthly
BNA Compounds	3 months if opened	FZ	Monthly if opened	FZ	3 months
	Expiration date If sealed	FZ	6 months If sealed	FZ	
Pesticides/PCBs/HAAs					
505	Expiration date	FZ	2 months	RF	2 months
525.2	Expiration date	FZ	6 months	RF	6 months
HAA's	2 months	FZ	2-Months	FZ	Daily
Inorganics					
300.0/300.1	6 Months	RF	Daily	RT	Daily
Nutrients	Semi-annually	RT	Monthly	RT	Daily
Phenol, Cyanide	Semi-annually	RT	Monthly	RT	Weekly
TOX	Yearly	RT	Monthly	RT	Daily
TOC	Yearly	RF	6 Months	RF	Daily
NO2/Nitrate	1 Month	RF	Daily	RT	Daily
Chlorine	Yearly	RF	Daily	RT	Daily
UV 254	Yearly	RF	Monthly	RF	Daily

* Bimonthly - every two months
* Biweekly - every two weeks

RT - Room Temperature
RF - Refrigerated at 4°C
FZ - Frozen at 0°C

Table 10-3 Sources of Standard Materials

Analysis	Vendor Source
ICAP/ICPMS Metals	JT-Baker
Volatile Gases	Ultra Scientific, EM Science Ampules
Volatiles	Ultra Scientific, EM Science Ampules
BNA Compounds	Ultra Scientific, Accu Standard, Absolute Standard
Pesticides/PCBs	Accu-Standards
Anions	EM Science/Baker, Fisher
Nutrients	EM Science/Baker
Phenol, Cyanide	EM Science/Baker
TOX,TOC	CPI

11.0 CALIBRATION PROCEDURES AND FREQUENCY

The production of analytical data of known, defensible and documented quality requires adherence to standardized procedures, which cover all aspects of laboratory operation. The following sections provide details of the standardized procedures relating to instrumentation calibration.

11.1. INITIAL INSTRUMENT CALIBRATION

Prior to use, every instrument must be calibrated according to a specified procedure found in the method-specific SOP. Table 12-1 lists all major laboratory equipment. Table 11-1 lists the minimum calibration frequency of use and the acceptance criteria for the various calibration techniques, on a method by method basis. Table 11-2 also summarizes the calibration procedures that are used on an instrument basis. Table 11-5 lists the ion abundance criteria, which must be met during calibration, for mass spectroscopy methods. Calibration frequency and criteria included in the tables are only for representative reference methods. Calibration procedures for other methods can be found in relevant SOPs.

Each instrument, and support equipment including reference standards of measurements such as Class S weights or equivalent weights, and traceable thermometers are marked and identified to indicate its calibration status such as “Calibration not needed”, “Calibrate before use”, “Calibration due date”.

11.1.1. **Applicability**

11.1.1.1. The creation of this or any other policy is designed to be a guideline to ensure that all data are treated alike, and thus ensuring that data generated on any particular day of analysis are representative of the norm. The policies are not intended to be absolute criteria for the acceptance or rejection of any analytical data.

11.1.1.2. There is no substitute for the inherent familiarity that each analyst has with his or her specific analysis, and consequently their assessment of the data must be considered in cases where the acceptance criteria outlined in policy or SOPs cannot be achieved. Data generated in situations where one or more of the requirements outlined cannot be met will be reviewed on a case-by-case basis by the QA staff and the appropriate supervisor for acceptance. A detailed Quality Investigation Report (QIR) should have been completed and included in the data package to justify any deviation from policy or SOP protocols. Example of a QIR is shown in Figure 15-2.

11.1.2. **Linearity**

11.1.2.1. All calibrations should be linear unless otherwise defined in the specific SOP. Many organic methods may require the use of a quadratic fit for some compounds. Linearity here is defined as a calibration curve that meets the back-calculation criteria

presented below, unless the SOP contains different criteria. Specific protocols outlined in a given SOP will always take precedence over generic policies outlined in this QA Manual.

11.1.2.1.1. Linear Regression

$y = mx + b$

Where:

- y = Response A_x for External Standard or A_x/A_{is} for Internal Standard
- x = Concentration C_x for external standard, or C_x/C_{is} for internal standard
- m = Slope
- b = Intercept

11.1.2.1.2. Linear Regression Statistical Equations

Slope (m) → $m = \frac{[(Swx_i y_i \times Sw) - (Swx_i \times Swy_i)]}{[(Sw \times Swx_i^2) - (Swx_i \times Swx_i)]}$

Intercept (b) → $b = y_{ave} - (m \times (x_{ave}))$

Correlation Coefficient (r) →

$$r = \frac{[(SW \times Swx_i y_i) - (Swx_i - Swy_i)]}{\sqrt{[Sw \times Swx_i^2) - (Swx \times Swx_i)] \times [(Sw \times Swy_i^2) - (Swy_i \times Swy_i)]}}$$

Coefficient of Determination (r^2) → $r^2 = r \times r$

Where:

- n = number of x, y pairs
- x_i = individual values for the independent variable
- y_i = individual values for the dependent variable
- w = weighting factor, for equal or no weighting w = 1
- x_{ave} = average of the x values
- y_{ave} = average of the y values
- S = the sum of all the individual values

11.1.2.1.3. Quadratic Regression Equation

$y = ax^2 + bx + c$

Where:

- y = Response A_x for external standard, or A_x/A_{is} for internal standard
- x = Concentration Cx for external standard, or Cx/Cis for internal standard

11.1.2.1.4. Equation for Concentration

External Standard Equation → $C_x = \frac{(A_x - b)}{m}$

Internal Standard Equation → $C_x = \frac{{}^{A_x}/_{A_{is}} - b}{m \times C_{is}}$

11.1.2.2. If the method does not specify the acceptance criteria for the linear fit, the laboratory will establish a policy for acceptance criteria of 0.995 for correlation coefficient. The calibration curve is verified using any one of the following:

11.1.2.2.1. Coefficient of Determination (r^2)

$$r^2 = \frac{S(y_i - y_{ave})^2 - [{}^{(n-1)}/_{(n-p)} \times (S(y_i - Y_i)^2]}{S(y_i - y_{ave})^2}$$

Where:

y_i = individual values for each dependent variable
x_i = individual values for each dependent variable
y_{ave} = average of the y values
n = number of pairs of data
p = number of parameters in the polynomial equation (i.e., 3 for third order, 2 for second order

$$Y_i = \frac{\left\{\left[2a \times \left({}^{C_x}/_{C_{is}}\right)^2\right] - b^2 + b + (4ac)\right\}}{4a}$$

S = the sum of all the individual values

11.1.2.2.2. An initial calibration verification standard (ICV's) is immediately run after the curve. The standard is preferably obtained from a 2nd source or different lot if the lot can be demonstrated from the manufacturer as prepared independently from other lots [NELAC 5.5.5.2.2.1d)]. Concentrations that lie in the middle of the curve should have an acceptable recovery of ± 10% of the true value.

11.1.2.2.3. The linear curve will be acceptable if the curve meets the back-calculation criteria, i.e. back calculating the initial calibration standards against the developed model, with an acceptance criteria of ± 10 % recovery of the true value.

11.1.3. **Selection of Quantitation Technique (Organics)**

11.1.3.1. For organic analysis, a decision must be made during the validation process (and detailed in the SOP) as to whether an internal or external quantitation technique will be routinely employed.

11.1.3.2. The internal standard method of quantitation cannot be employed unless all of the following conditions are met:

11.1.3.2.1. The internal standard must be added post-extraction. For NDMA (1625) and Method 525.2, it is added pre-extraction.

11.1.3.2.2. The internal standard must be added quantitatively.

11.1.3.2.3. Any analyte that is a target analyte using the method of interest may not be selected for use as the internal standard.

11.1.3.2.4. The concentration of the internal standard(s) must not exceed the calibration range of the method target analytes. In cases where the target analytes are associated with more than one calibration range (i.e. analytes "1-4" are calibrated from 1 to 10 µg/L, while analyte "5" is calibrated from 10 to 100 µg/L, and analytes "6-10" are calibrated from 2.5 to 25 µg/L), the concentration of the internal standard should be prepared at a level between the highest calibration standard of the highest and lowest absolute calibration range. (e.g. approximately 50 µg/L in the example given).

11.1.3.3. The use of internal standard quantitation is of greatest benefit in those methods subject to a great deal of injection variability, and thus a great deal of variability in the absolute mass injected onto the column(s) employed. The drawback to this technique for GC methods is that any compound that exhibits a similar retention time as the compound used for the internal standard will be identified as the internal standard, leading to erroneous quantitation. For this reason, the internal standard technique is most useful for GC/MS where deuterated analytes not naturally occurring can be detected and quantified.

11.1.4. **Selection of Calibration Method**

11.1.4.1. During the method validation process, a least square regression is initially tried as a calibration method. The responses from each of the calibration standards must then be input into the linear regression equation to determine whether or not the corresponding concentrations meet the acceptance criteria outlined below. If the acceptance criteria cannot be met using a linear regression, then a second order polynomial fit can be used to fit the data, with $R2 \geq 0.99$ as the acceptance criteria. In the event that neither a simple linear regression nor a second order polynomial fit result in an equation which meets the calibration acceptance criteria, then the calibration range must be broken down into two or more smaller ranges. Each of the subsequent ranges must individually meet all of the requirements for a single

calibration range. If a linear regression works, a single average response factor may be used if the calibration is linear through the origin and it is consistent with the referenced method.

11.1.4.2. As part of the validation process, the specific calibration range and calibration algorithm must be determined and documented in the SOP. Once determined in this manner, the same protocols must be followed each time the method is employed. This will ensure that data reduction is not performed differently on separate data sets or by different analysts.

11.1.5. **Minimum Number of Calibration Levels**

The calibration for linear fits must include a minimum of three initial calibration standards plus a blank unless specified otherwise in the SOP. Polynomial fits must include at least 5 standards. The minimum requirement for a NELAP Lab as per NELAC Standard 5.5.5.2.2.1.j) is: a minimum of two (2) standards (one of which is lowest quantitation limits, not including a blank or zero standard), if the reference method does not specify the minimum number of initial calibration standards.

11.1.6. **Selection of Calibration Levels**

11.1.6.1. To avoid weighting a calibration curve to create a better fit than is warranted, three standards must be included per order of magnitude of concentration of the calibration curve. For example 0.1, 0.5, 1.0, 5.0, 10.0 has 3 standards per order of magnitude (0.1, 0.5 and 1.0, and 1.0, 5.0 and 10.0).

11.1.6.2. The lowest calibration standard shall be the lowest concentration for which quantitative data are to be reported. Any data reported below the lower limit of quantitation is considered to have an increased quantitative uncertainty and is reported using either "J" flags or explained in the case narrative [NELAC 5.5.5.2.2.1.f)].

11.1.6.3. The highest calibration standard shall be the highest concentration for which quantitative data are to be reported. Any data reported above the highest standard is considered to have an increased quantitative uncertainty and is reported using "E" flags or explained in the case narrative [NELAC 5.5.5.2.2.1.g)].

11.1.6.4. Measured concentrations outside the working range are reported as having less certainty and are reported using "E" flags or explained in the case narrative. The lowest calibration standard must be above the limit of detection, usually at MRL level except for ICP that allows zero point and single point calibration. [NELAC 5.5.5.2.2.1.h)].

11.1.6.5. A good approach to select calibration levels when the calibration range is expected to span at least one order of magnitude is to set the levels at 1 MRL, 5 MRL, and 10

MRL for a simple 3 point calibration. If more points are desired, then they would follow the same scheme, i.e. 50 MRL, 100 MRL.

11.1.7. **Calibration Analytical Sequence**

11.1.7.1. The calibration must progress from the analysis of the lowest to highest standard unless the instrumentation does not permit it or the method requires calibration from high to low. A blank must be analyzed after the highest calibration standard.

11.1.7.2. If the analysis requires an initial high standard to set the gain a blank must be run before starting with the low calibration standard unless the instrumentation does not permit it.

11.1.8. **Calibration Acceptance Criteria**

For linear fits, in general, the calculated value for standards (using the calibration curve or response factor) must be within 10% of the nominal value for mid-level standards. However, the value determined by the calibration curve for the lowest standard (conc. is at the MRL) must be within ± 50% of the true value or ± 25% of the true value if the lowest standard is >5X & <10X MRL. Accurate quantitation at the MRL level may require use of a second order fit or separation of the curve into multiple linear segments. Mid level standards (conc. > 10X MRL) should be within ± 10% of the true value. Relevant SOPs should be reviewed for the method and laboratory calibration verification specific criteria, which may be different from those stated here.

11.2. CONTINUING INSTRUMENT CALIBRATION

11.2.1. Continuing calibration (CC) is run as required by the method. Refer to specific SOPs to determine the frequency and acceptance criteria of continuing calibration verifications.

11.2.2. The continuing calibration standard must be near the mid-point of the calibration curve unless the method requires rotation of concentration levels.

11.2.3. The calculated value for the continuing calibration standard must be within control limits stated in the specific SOP.

11.2.4. Calibration shall be verified for each batch for each compound, element, or other discrete chemical species, except for multi-component analytes such as Aroclors, Chlordane, or Toxaphene where a representative chemical related substance or mixture can be used.

11.2.5. Instrument calibration verification must be performed:

11.2.5.1. At the beginning and end of each analytical batch (except, if an internal standard is used; only one verification needs to be performed at the beginning of the analytical batch).

11.2.5.2. Whenever it is expected that the analytical system may be out of calibration or might not meet the verification acceptance criteria.

11.2.5.3. If the time period for calibration of the most previous calibration has expired, or

11.2.5.4. For analytical systems that contain a calibration verification requirement.

11.2.6. If the method does not specify criteria for the acceptance of a continuing instrument calibration, verification must be established, e.g., relative percent difference.

11.2.7. If the continuing instrument calibration verification results obtained are outside established acceptance criteria, corrective actions must be performed.

11.3. UNACCEPTABLE CONTINUING INSTRUMENT CALIBRATION VERIFICATIONS

11.3.1. If routine corrective action procedures fail to produce a second consecutive (immediate) calibration verification within acceptance criteria, then either the laboratory has to demonstrate acceptable performance after corrective action with two consecutive calibration verifications, or a new initial instrument calibration must be performed.

11.3.2. If the laboratory has not verified calibration, sample analyses may not occur until the analytical system is calibrated or calibration verified. If samples are analyzed using a system on which the calibration has not yet been verified the results shall be flagged.

11.3.3. If these criteria are not met, a second continuing calibration standard must be run (either freshly prepared or a second injection, as appropriate). No individual analyte can fail the CC criteria two consecutive times. If the criteria are still not met, a new initial calibration must be run and the new calibration curve verified. The laboratory qualifies the data with "V" flag if the sample data is associated with failed calibration verification.

11.3.4. As per NELAC 5.5.5.10.e, data associated with an unacceptable calibration verification may be fully useable under the following special conditions:

11.3.4.1. If there was a high bias and there is a failed continuing calibration verification, the lab reports only data associated with samples that are non-detects.

11.3.4.2. If there was a low bias and there is a failed continuing calibration verification, the lab reports only data associated with samples that have a result greater than the maximum regulatory limit/decision level.

Table 11-1 Minimum Calibration Frequency and Acceptance Criteria

Analysis	Method	Calibration Technique	Acceptance Frequency	Criteria
Organohalide Pesticides and PCB products	505	Endrin Breakdown Initial Calibration Cal Verification Std	Daily beginning and end of analysis beginning and end of analysis	< 20% degradation % RSD < 20 80 – 120 %
		LRB	before start of analysis; each time set of samples extracted or reagents changed	< RL
		LFB	Every 20 samples (all samples extracted within a 24-hr period) points	%R = 70 – 130% Require control charts after 30 data
		MRL checks	Daily	50 – 150% Requires control charts after 30 data points
		LFM IDC, 7 LFBs QCS	Every 10 samples Initial set up Quarterly	%R = 65-135 % RSD ≤ 20 % %R= 70 – 130 %
Volatile Organics Including DIPE, TAME, ETBE Low level 1,2,3-TCP	524.2	BFB Sensitivity	Every 12 hours of operation	Ion abundance criteria (Table 11-3)
		Initial Calibration (7-pt)	Prior to analysis, or when CC fails	<20 % RSD / r≥0.99
		Continuing Calibration	Every 12 hours of operation and at the end of analytical batch (highly recommended by Method)	RF within 30% of the initial calibration
		Surrogate	added to CCV, every sample & all initial calibration stds. (Not required for TCP).	70-130 % Rec
		MS/MSD (upon client request)	Every 20 samples. (Not required for TCP).	70-130 % Rec. %R = 65-135% (TCP)
		LCS/LFB	Every 20 samples Every 12 hrs or every 10 samples (TCP)	70-130 % Rec. low %R=60-140%(TCP) high %R=70-130%(TCP)
		LFB Dup (TCP: can be used in place of Lab Duplicate)	Quarterly	RPD </=20%
		Blank	Every 20 samples. Every 10 samples for TCP.	<MRL
		QCS (TCP)	1 per set of samples; once a week (TCP)	% RSD < 20 (TCP) %R = 60-140% (TCP)
		MRL checks	Daily	± 50% of the true value
		Lab Duplicate (TCP)	1 per 10 samples (TCP)	% RPD < 20% (TCP)

Analysis	Method	Calibration Technique	Acceptance Frequency	Criteria
Semi- Volatiles Organics	525.2	DFTPP Sensitivity	Every 12 hours of operation	Endrin Breakdown <20% must meet EPA specific criteria for method
		Initial Calibration	Prior to analysis, when CC fails	% RSD< 30
		Continuing Calibration	Every 12 hours of operation and at the end of analytical batch (highly recommended	%D ± 30 of true value for linear curves.
		MS	5 % or 1 per sample set Extracted whichever is more frequent	70-130 % Rec
		LCS/ LFB	5 % or 1 per sample set Extracted whichever is more frequent	70-130 % Rec
		Method Blank	1 per sample extraction set	< RL
		Surrogates	added to each sample before extraction	% R =70-130%
		MRL Checks	Analyzed with each extraction batch	50 – 150% Requires control charts after 30 data points
		IS	added to each sample before extraction	area count must not decrease by >50 % from initial calibration and 30% for CCC.
Trihalomethane /Chloral Hydrate/ Haloacetonitrile	551.1	Initial calibration (Extracted)	Beginning of analysis	< 10 % RSD
		Lab Performance Check	Beginning of analysis	Table 7 of the method
		Endrin Breakdown	Beginning of analysis	< 20 %
		Calibration verification (CCV=LFB)	every 10 samples	% R = 80-120 % -90 % analytes & 75-125 % for all analytes
		LRB (Lab Reagent Blank)	1 per extraction Batch	< MRL
		LFB (Lab Fortified Blank)	Every 10 samples. (Not Required).	% R = 80-120 % -90 % analytes & 75-125 % for all analytes
		LFM	every10 samples	80-120 %
		LFM/Duplicate	see sample duplicate	RPD < 20 for 90 % of analytes, RPD <25% for all analytes
		Sample Duplicate	10 %	
		Surrogate	All samples	80-120 %
		QCS	Quarterly	same as CCV
		IDC, 7 LFBs	Initial set up new analyst	R = 80-120 %, < 15 % RSD
		Stock solutions	every new lot	< 20% RPD

Analysis	Method	Calibration Technique	Acceptance Frequency	Criteria
		Verification; Outside Source		
Volatile Organics	624	BFB Sensitivity	Every 12 hours of operation	Ion abundance criteria (Table 11-3)
		Initial Calibration	Prior to analysis, or when CC fails	RF <35 % RSD
		Continuing Calibration (QC Check Std)	Every 12 hours of operation	All analytes' %R must meet % R as specified in Table 5 of Method 624 (See SOP)
		Surrogate	added to CCV, every sample & all initial calibration stds.	70-130 % Rec 80-120 % Rec
		MS/MSD	Every 20 samples	All analytes' %R must meet % R as specified in Table 5 of Method 624
		MRL check	Daily, prior to sample analysis	50 – 150% Requires control charts after 30 data points
		LCS/LFB	Every 20 samples	All analytes' %R must meet % R as specified in Table 5 of Method 624
Base Neutrals and Acids	625	DFTPP Sensitivity	Every 12 hours of operation	Ion abundance criteria (Table 11-3)
		Initial Calibration	Prior to analysis, when CC fails	All analytes RF>35% RSD
		Continuing Calibration (same as MRL Check)	Every 12 hours of operation	All analytes w/in ±20% Of the predicted response
		MS/LFM	Every 20 samples	All analytes' %R must meet % R as specified in Table 6 of the method
		LCS/LFB	Every 20 samples	All analytes' %R must meet % R as specified in Table 6 of the method
HAA	6251B	Calibration curve	each batch	r > 0.995
		Method Blank	1 per 20 samples	< ½ MRL
		LCS/ LFB	5 % or 1 per sample set extracted or 20 samples w/in 24-hrs whichever is greater	Control Charts Limits updated annually
		MRL check	1 per sample set extracted or 20 samples	Control Chart Limits updated annually
		MS/LFM	1 per sample set extracted or 20 samples	Control Chart Limits updated annually
ICP Metals	200.7/6010	Calibration curve (2-pt)	Each batch	
		Method blank	Every 20 samples	< ½ MRL

Analysis	Method	Calibration Technique	Acceptance Frequency	Criteria
		MS/MSD	Every 20 samples	70-130%
		MRL Check	Beginning and end of the run	50 – 150%
		LCS/LFB	Every 20 samples	85-115%
ICPMS Metals	200.8/6020	Tuning Solution	At the start of QC program or after major maintenance or every 2 weeks	Good Performance: 0.75 amu peak width at 5% peak height Mass calibration: <0.1 amu from unit Mass Instrument stability: 5x run; <5% RSD
		Quality Control Sample(QCS)	Immediately after calibration, also 1 with every set of spls.	90 –110%
		Initial Calibration Verification	Every batch analyzed daily	90–110% Rec
		Calibration blank	Each batch	< ½ MRL
		Linearity Check 5x CCV/upper limit of Calibration Range	Prior to sample sequence	90-110% Rec
		Replicate Integration	3 replicates	≤ 20% RSD
		Continuing Calibration Verification (CCV)	Every 10 samples	85-115 % Rec
		Minimum Report Limit (MRL), Check/CRDL	Beginning of analysis and end of the sample run	50-150% or 75-125 % (see sec. 9.3.8)
		Laboratory Fortified Matrix (LFM)	Every 10 samples	70-130% Rec
		Laboratory Fortified Matrix (LFM) Duplicate	Every 20 samples	20% RPD
		LCS/LFB	Immediately after calibration, one per batch of 20	85-115% Rec
		Internal Standards (IS)	Spike each sample, standard and blank	60-125% of the response in the calibration blank
		Method Blank	1- per batch of 20-samples	<1/2 MRL or <1/2 CRDL
		Instrument Blank	Prior to Calibration	<MRL
Cr VI (Dissolved)	218.6/3500CrB	Initial Calibration	Daily	r > 0.995
		IPC(CCV)	1-per 10 samples	95-105 % Rec
		LRB (Lab Reagent Blank)	1-per 10 samples	< ½ MRL
		LFB/QCS	1-per 10 samples	90-110% Rec (external source)
		LFM	1-per 10 samples	90-110% Rec
		LFMD	1-per 20 samples	90-110% Rec (RPD <10%)

Analysis	Method	Calibration Technique	Acceptance Frequency	Criteria
		MRL Check	Daily	50 – 150%
		QCS	Quarterly (see LFB)	90-110%
		LDR	Start of program	minimum 7 stds

Automated Wet Chemistry:

Analysis	Method	Calibration Technique	Acceptance Frequency	Criteria
Cyanide Fluoride Nitrate Nitrite Phenolics	335.4, 9012B SM4500F C 353.2, 300.0 353.2, 300.0 420.1, 420.4	Linear Calibration curve (7-11 pt)	Each batch	r > 0.995 (correlation coefficient)
		Calibration blank	1-per 10 samples	< ½ MRL
		MRL check	Each batch	50 – 150%
		MS/MSD	Every 20 samples (Phenol 420.4 – every 10 samples)	Limits: Fl; 73-124% Phenol; 90-110% CN, NO3; 90-110%
		LCS/LFB	Every 20 samples (Phenol 420.4 – every 10 samples)	Method Limits: Fl; 81-116% CN, NO3, Phenol; 90-110%
Residual Chlorine	SM 4500 Cl-G	LCS/LFB	Every 20 samples	85-115%Rec
		MS/LFM	Not Required	20 % RPD
		MRL check	1 per batch of 20 or less	50-150%
		Duplicate	Every 20 samples	20 % RPD
Anions by IC	300.0/300.1/317	Calibration curve (7-11-pt)	Each batch	r > 0.995 correlation
		Calibration blank	1-per 10 samples	< ½ MRL
		Method Blank	1- per batch of 20-samples	< ½ MRL
		MRL Check	At the beginning of the run	50-150%
		MS/MSD	Every 20 samples	80-120 %
		LCS/LFB	Every 20 samples	90-110 %
Total Dissolved Solid	SM2540C	Method Blank	Each time used	<MRL
		Weight Check	Reweigh till weight difference is <4% or 0.5mg	<4% difference
		MRL Check	Daily	50-150%
Total Suspended Solids	SM2540D	Method Blank	Every 10 samples	<MRL
		MRL Check	Each batch	50-150%
Total Solids	SM 2540B	Method Blank	Every 10 samples	<MRL

Analysis	Method	Calibration Technique	Acceptance Frequency	Criteria
Total Volatile Solids	160.4	LCS	Every 10-samples	± 15 % of the expected value
Settleable Solids	SM 2540F	LCS	Every 10-samples	± 15 % of the expected value
pH	150.1/SM4 500H+B	3 buffers	Each time used	± 0.1 pH unit of true value
Conductivity	120.1/SM 2510B	1 check solution	Each time used	± 1 % of true value
		MRL Check	Daily	50-150%
TOC	SM 5310C	Calibration curve (6-pt)	Each batch	r > 0.995 correlation
		Blanks	Each batch	< MRL
		MS/MSD	Every 20 samples/batch	90-110%
		LCS/LFB/CCV	Every 10 samples	90-110 %
		MRL Check	Daily	50-150%
		LCS1/MRL Check	Every batch	50-150%
		Lab Duplicate	All samples	<10 % RPD (TOC > 2.0 mg/L) <20 % RPD (TOC < 2.0 mg/L)
UV 254	SM 5910B	Calibration curve (4-pt) Verification	Prior to analysis of samples	90-110 %
		Blank/UV absorbance @ 254	One per analysis/ batch	< ½ MRL
		LCS/LFB UV absorbance @ 254 nm	Every 10 samples	85-115 %
		MRL Check	Daily	50-150%
		MS/LFM	Not Required	
		Lab Duplicate	All samples analyzed in duplicate	≤20 % RPD (UV 254 < 0.045 cm –1) ≤10 % RPD (UV 254 > 0.045 cm –1)

NOTE: 1) Any deviations from the listed criteria are specified in the SOP.
2) Concentrations for all continuing calibrations are in the middle of the linear range.
3) For all other methods not listed in the QA Manual, see calibration frequency and acceptance criteria in individual SOPs.

Table 11-2 Calibration Procedures

Instruments	Minimum # of Calibration Standards	Calibration Method
TOX	3 points standard (for precision only)	Titration
Anions, Nutrients (Ion Chromatography)		
Nitrate, NO3 Nitrite, NO2 Chloride, Cl2 Sulfate, SO4	11-points 11-points 7 - points 10-points	Quadratic Quadratic Quadratic Quadratic
Phenol, Cyanide	5 point	Linear Regression
Fluoride	3 point minimum	Linear Regression (log)
pH	3 point, 2 point	Slope
Radiation	Single point	Efficiency Curve
Microbiology	2 point	Positive/Negative Controls
TOC (TOC Analyzer)	6 Point	Linear Regression
UV 254 (Spectronic 601) Spectrophotometer	3 Point	Efficiency Curve
524.2 (GCMS)	5-6 Points	Linear Regression
HAA (GC)	3 Point	Linear Regression

For all other methods not listed in the QA Manual, see calibration procedures in individual SOPs.

Table 11-3 Ion Abundance Criteria

(A) BROMOFLUOROBENZENE (BFB) (524.2)

Mass	Ion Abundance Criteria
50	15 - 40% of mass 95
75	30 - 60% of mass 95 (624) ; 30-80 % mass 95 (524.2)
95	Base peak, 100% relative abundance
96	5 - 9% of mass 95
173	Less than 2% of mass 174
174	Greater than 50% of mass 95
175	5 - 9 % of mass 174
176	Greater than 95%, and less than 101% of mass 174
177	5 - 9% of mass 176

(B) DECAFLUOROTRIPHOSPHINE (DFTPP) (525.2)

Mass	Ion Abundance Criteria
51	10-80% of the Base Peak
68	Less than 2% of mass 69
70	Less than 2% of mass 69
127	10-80% of the base peak
197	Less than 2% of mass 198
198	Base Peak or >50% of 442
199	5 - 9% of mass 198
275	10 - 60% of the base peak
365	Greater than 1% of the base peak
441	Present, but less than mass 443
442	Base Peak or Greater than 50% of mass 198
443	15-24% of mass 442

Table 11-4 Initial Calibration Acceptance Criteria

Anions/Nutrients	Initial calibration value for standards must be within 10% of the nominal value. $r > 0.995$
GC	Initial Calibration RF <20% RSD or second order fit, continuing calibration. RF ≤ 20% Difference. Must meet specific method calibration criteria.
GCMS, EPA 524.2	Initial Calibration < 20 % RSD, $r \geq 0.995$
HAAs	Initial Calibration correlation coefficient $r \geq 0.995$, ≤ 20 % RSD
HPLC	Correlation coefficient must be >0.995 or 20% RSD
Metals	Initial calibration value for standards must be within 10% of the nominal value.
pH	Values for 4, 7, 10 buffers must be ± 0.1 pH unit of the nominal value
Radiation	Known reference must be within acceptance limits
TOC	Initial calibration value for standards must be within 20% of the nominal value. $r > 0.995$
TOX	Initial calibration value for standards must be within 20% of the nominal value. $r > 0.995$
UV 254	Initial Calibration value for the standards must be within 10 % of the normal value.

12.0 EQUIPMENT

12.1. ANALYTICAL EQUIPMENT

12.1.1. All equipment is properly maintained, inspected, and cleaned.

12.1.2. Table 12-1 Equipment, contains a list of the major analytical equipment used during sample preparation and analysis. For Microbiology, pressure cookers are not used for sterilization of growth media (NELAC D.3.8.b.2.1).

12.2. SUPPORT EQUIPMENT

12.2.1. Balances

Analysts are responsible for daily calibration verification checks of the analytical balances in the laboratory with Class S weights and annual calibrations of the drying ovens with an NIST traceable certified thermometer. Documentation of the balance and oven checks is maintained in the appropriate logbook. Reference certified thermometers are calibrated every five years. A yearly thermometer calibration check is done for all other thermometers and all thermometers are labeled showing any necessary correction to achieve true readings. Balances are calibrated annually and Class S-weights are calibrated every 5 years by an outside vendor. Copies of these balance and thermometer records are filed with the QA records for the laboratory. All Class S weights and traceable thermometer standards are used for calibration only and for no other purpose to ensure that the performance as reference standards are always valid.

Balance calibration is verified on the day of use prior to weighing samples, standards or reagents. If balance does not meet the acceptable criteria of ± 0.1 %, the analyst reports to QA that balance needs service. The instrument is labeled "out of service" until repaired. The Analyst records the problem and identifies corrective action, date of service, and if corrective action resolved the problem.

12.2.2. Temperature Monitoring

Refrigerators, incubators, temperature are monitored 2 times daily in at least 4 hour intervals. If the temperature measured is not meeting the acceptance criteria of 4± 2°C, analyst reports to the QA department. QA then monitors the temperature after 2 hours and more often if needed. If non-compliance is still observed, QA calls for service. The instrument is labeled "out of service" until repaired. QA records the problem identified, corrective action, date of service, if called, and if corrective action resolved the problem.

12.2.3. Pipets

Eppendorf pipette function verification is done on the day the standards are prepared for pipets used for the preparation of both the primary and secondary standards. Monthly

frequency is done for pipets used either for the preparation of either the primary or secondary standards and for Class A pipets used for the preparation of the other set of standards. When used over a range of settings, the pipet is calibrated at the highest and lowest settings. If not meeting the acceptable range of ± 2 % of the set value, the analyst investigates and identifies the problem. The pipet is cleaned if needed and inspected for signs of wear or damages or for residual liquids that may have been sucked in the pipet. After the appropriate Corrective Action, the pipet is again calibrated. Corrective Action taken and problem identified is recorded. If corrective action did not resolve the problem, the analyst documents in the logbook that the pipet is off-line. The pipet is also labeled "out of service" until repaired.

12.2.4. **Microbiology Volumetric Equipment [NELAC 5.Appendix D.3.8.b)3)]**

Volumetric Equipment shall be calibrated as follows:

12.2.4.1. Equipment with movable parts such as automatic dispensers, dispensers/diluters, and mechanical hand pipettes shall be verified for accuracy quarterly.

12.2.4.2. Equipment such as filter funnels, bottles, non-class A glassware and other marked containers shall be calibrated once per lot prior to its use.

12.2.4.3. The volume of the disposable volumetric equipment such as sample bottles, disposable pipettes, and micropipette tips shall be checked once per lot.

12.2.5. **Glassware**

Table 12-3, contains the SOP for glassware cleaning. All class volumetric glassware is dried at room temperature rather than oven baked.

The washing and sterilization procedures for laboratory glassware are tested annually by testing glassware for inhibitory residues as shown in Standard Methods.

12.2.6. **Water Quality File**

The pure water system for MWH Laboratories was assembled by US Filter in January 2003. It consists of reverse osmosis, mixed bed deionizers, ultraviolet disinfection, filtration, and an organic scavenger side stream return loop. The system is connected to a conductivity meter which signals when the mixed bed resin demineralizers need to be changed.

On-going water quality is monitored at the organic and inorganic taps by analyzing monthly samples for plate count, TOC, conductivity, NH3, and residual chlorine when maintenance is performed on the water treatment system, or at startup after a period of disuse longer than one month. Annually, trace metals, inhibitory residue, and suitability

ratios are monitored. These reports are sent to the QA Department for filing and are maintained for ten years.

The quality of laboratory pure water is analyzed monthly for conductivity, pH, chlorine residual, TOC, and standard plate count and annually for water suitability ratio, inhibitory residue (annually, each time new lot of detergent and for new washing procedures), and trace metals (Pb, Cd, Cr, Cu, Ni, and Zn). Table 12-4 lists the acceptance criteria for these analytes. This data is recorded and submitted to the QA department.

12.2.7. **Out of Service**

All major instruments if off line will be labeled "out of service" until repair.

12.3. PREVENTIVE MAINTENANCE

12.3.1. **Routine Maintenance Activities**

MWH Laboratories carries maintenance contracts on all major laboratory equipment, under which much of the preventative maintenance is performed. Routine servicing, such as cleaning of rods, source, or detectors, is performed on a regular basis by the analyst. This type of service is performed according to the procedures and at the frequency specified by the manufacturer. Routine maintenance is done when instrument performance starts to degrade as demonstrated by a failure to meet one or more QC criteria, decreased ion sensitivity, degrading peak resolution, lowered response factors, or shifts in calibration curves. Activities that are performed on a routine basis can be found in Table 12-2.

12.3.2. **Documentation**

Instrument maintenance logbooks are maintained for most major instruments. All repairs and any routine or non-routine maintenance activities are recorded in the logbooks. The date of the activity, the person performing it, and the nature of the activity are recorded. Expendable items for all major instruments are kept on hand to minimize downtime.

The following are documented in the instrument logbooks:

12.3.2.1. Name of the item of the equipment

12.3.2.2. Manufacturer's name, type identification and serial number or other unique identification

12.3.2.3. Date received and date placed in service

12.3.2.4. Current location, where appropriate

12.3.2.5. Condition when received (e.g. new, used, reconditioned)

12.3.2.6. Copy of manufacturer's instructions where available

12.3.2.7. Dates and results of calibrations and/or verifications and date of the next calibration and/or verification

12.3.2.8. Details of maintenance plan carried out to date and planned for the future

12.3.2.9. History of any damage, malfunction, modification or repair

12.3.2.10. Records of service calls

12.3.2.11. Calibration status for instrument that are calibrated outside the direct control of the laboratory are checked before use (after an instrument is returned from outside repair) [NELAC 5.5.5.9]

12.3.3. **Contingency Plans**

12.3.3.1. An effort is made to have a functionally equivalent backup instrument available in case of a catastrophic instrument failure. Maintenance contracts are carried on the major instruments and generally provide for 24-48 hour response for repairs. If necessary, MWH Laboratories has a list of qualified laboratories to subcontract work to, upon client approval.

12.3.3.2. In the event a holding time expires while the sample is in the custody of MWH Laboratories, a project manager will call the client to inform them of this situation. Based on subsequent arrangements made between the lab and the client, fees for re-sampling and subsequent analysis may be incurred by the lab.

Table 12-1 Equipment

	Vendor	Model	Year Acquired	Detectors	Tests	Serial #
Metals	Perkin-Elmer	Elan DRC II	2003	ICP/MS	200.8	Q1280212
	Perkin-Elmer	ELAN 6000	1999	ICP/MS	200.8	3929707
	Optima	4300 DV	2003	ICP	200.7	077N2121801
	Perkin-Elmer	FIMS400	2000	Mercury Analyzer	Mercury	4605
	Environmental Express	Hot Block	2000	Digestion Block	Metals Prep	
	Agilent	7500CE	2007	IPC/MS	200.8	JP51201349
Rad	Protean 8 channel	MPC9604	1998	Proportional Counter	Gross Alpha/Beta and Ra 228	83023
	Gamma Products Inc	T7500	2006	Proportional Counter	Gross Alpha/Beta and Ra 228	
	Beckman	6500	1993	Liquid Scintillation System	Radon	7067177
	Beckman Coulter	Allegra 6	2003	Benchtop Centrifuge	Ra 228	ALS02M09
	Linberg Blue	HP53025C	2001	Hot Plate	Gross Alpha/Beta	W01K-496436-WK
Ion Chromatography	Dionex	DX120	1997	IC-detector-CD20	Anions	970750115
	Dionex	DX-500	1998	IC-detector-CD20	Perchlorate	98080693
	Dionex	AD25	2001	IC-detector-UV/VIS	CR-VI	00120138
	Dionex	AD20	1998	IC-detector-UV/VIS	317/300.1	00120038
	Dionex	IC25	1998	IC	300.1	00120038
	Dionex	ICS2000	2005	IC	300.0/314	03080229
	Dionex	ICS3000	2006	IC	314/300.1	6030479

	Vendor	Model	Year Acquired	Detectors	Tests	Serial #
	Dionex	ICS3000	2007	IC	314/300.0	06120153
General Minerals	Seal	AQ2	2005	AQ2 Analyzer	Cyanide, Nitrate	090497
	Mettler	Multi-7 Meter	2007	pH/Ion Meter	pH, EC	1228045058
	Lachat	Quickchem 8000	2002	Colorimetric	CN, Phenol, OPO4	A83000-2064
	Lachat	Quickchem 8000	1992, 1999	Colorimetric	Nutrients	2000-0636
	ManTech	PC-1000-102	2002	Titrimetric, Colorimetric	EC, pH, Alk, F, Turbidity	MS-0E2-307
	HACH	2100AN	2004	Nephelometric	Turbidity	040300006425
	ManTech	PC-1000-10214	2005	Interface Module	EC, F, pH, Alk	MS-0M4-381
	RGW Instrument	MIDI-STIL	2000	Distillation System	Phenol, CN	
	HACH	16500-10	1996	COD Digestor	COD	991000019578
	COSA	TOX-100	2007	Coulometric	TOX	
	Sievers	AS-800	2003	UV-Persulfate	TOC, DOC	910404628
	Teledyne Tekmar	Phoenix 8000	2005	UV-Persulfate	TOC, DOC	
	HACH	DR/4000U	2003	UV/VIS	UV254	1225267116
	Corning	450	2000	pH/Ion Meter	pH/ISE	002024
	HACH	DR/4000V	2002	Spectrophotometer	COD, R-SIO2, etc	0006V0000995
	HACH	DR/4000V	2005	Spectrophotometer	UV 254, COD, SiO2, Ferrous, Cr-VI.	
	WTN	OX1730P	2006	DO Meter/Probe	BOD, CBOD, DO	06440156
Misc	Reliance Glass	Midi-Still	1998	Distillation	Cyanide/Phenol/Ammonia	NA
	Olympus	BH-2	1192	Fluorescence Microscope	Protozoan	T2-105170

	Vendor	Model	Year Acquired	Detectors	Tests	Serial #
	Orion	101	1990	Conductivity	Conductance	127
	Hitachi-TEM	600AB	2000	X-Ray	Asbestos	542-50-03

	Type	Model	Year Acquired	Detectors	Tests	ID	Serial #
GC Systems	Varian	3800	2001	Dual ECDs	504.1	21	3800-100193
	Varian	3800	2001	Dual ECDs	505/504.1 (Low Level TCP)	22	3800-08107
	Varian	3800	2002	Dual ECDs	515.3/505	23	3800-08827
	Agilent	3800	2003	Dual ECDs	HAA – 6251B	24	US10306042
	Agilent	3800	2003	Dual ECDs	HAA – 6251B	25	US10315084
	Agilent	3800	2003	Dual ECDs	515.3/515.4	26	US10315085
	Varian	3800	2004	Dual ECDs	505	27	3800-11203
	Agilent	6890N	2005	Dual ECDs	515.4/551.1	29	US10440020
	Agilent	6890N	2005	Dual ECDs	HAA – 6251B	30	US10512068
	Agilent	6890N	2006	Dual ECDs	HAA – 6251B	31	3400-13835
	Agilent	6890N	2006	Dual ECDs	HAA – 6251B	32	3400-13835
	Varian	3800	2006	Dual ECDs	504.1	33	3800-12789
	Agilent	6890N	2007	Dual ECDs	6252B	34	CN10706031
	Agilent	6890N	2007	Dual ECDs	551.1	35	CN10706032
	Agilent	6890N	2007	Dual ECDs	6251B (HAA)	36	CN10706030
	HP	5890/5972	1997	VOA - MS	524.2, 624, 8260	J	3118A02321
	HP	5890/5972	1995	VOA - MS	524.2, 624, 8260	H	3501A02407
	Type	Model	Year	Detectors	Tests	ID	Serial #

	Type	Model	Year Acquired	Detectors	Tests	ID	Serial #
			Acquired				
GC MS Systems	Varian Ion Trap w/ CI/MS	Saturn	2000	Semivoa - MS	SPME/6040D	ITS2	MS 110125
	Varian Ion Trap	Saturn 2000	2001	Semivoa - MS	521/Nitrosamines	ITS3	13 MR01
	Agilent	6890/5973	2003	MSD	524/624/8260	L	US33246003
	Agilent	5973/6890	2005	MS	524	N	US4647377
	Agilent	5973/6890	2005	MS	524	P	US4467375
	Thermo	Trace2000	2001	GC	548.1/Endothal/528	SQ2	TR101935
	Thermo	PolarisQ	2001	MS	548.1/Endothal/528		MS110125
	Thermo	Trace2000	2000	GC	1625/NDMA	SQ1	TR101558
	Thermo	PolarisQ	2000	MS	1625/NDMA		MS110003
	Thermo	Trace2000	2002	GC	528/Endothal	T3	20004158
	Thermo	TraceMS	2002	MS	528/Endothal		16425
	Agilent	5890II	1996	GC	625/8270	F	3336A60560
	Agilent	5972	1996	MS	625/8270		3524A02890
	Agilent	6890N	2005	GC	525. 526, 527	M	CN10416008
	Agilent	5973 inert	2005	MS	525, 526, 527		US40610242
	Agilent	6890N	2006	GC	EDC4	S	CN10534101
	Agilent	5975N	2006	MS	EDC4		US52420838
	Agilent	6890N	2005	GC	529	R	CN10517080
	Agilent	5973 inert	2005	MS	529	R	US44610770
	Agilent	6890N	2003	GC	525, 526, 527	K	CN10331006
	Agilent	5973N	2003	MS		K	US30945838

	Type	Model	Year Acquired	Detectors	Tests	ID	Serial #
	Varian	CP-3800	2006	GC	521/Nitrosamines	ITS5	9050
	Varian	4000CIMSM	2006	MS	521/Nitrosamines	ITS5	4873
	Waters	2690	2004	HPLC	549.2, 555	HPLC4	DOOSM9-382M
	Waters	Ultima	2004	MS/MS	CLO4, Acrylamide, EDC	LC-1	VB125
	Waters	996	2004	LC Detector	CLO4, Acrylamide, EDC	LC-1	DOOSM9-382M
	Dionex	U3000	2006	HPLC	CLO4, Acrylamide, EDCLC-2	LC-2	2240601
	API 5000	Ultima	2008	GCMS	CLO4, Acrylamide, EDC	LCMS4	AG22860808
	API 4000	1200	2007	MS/MS		LCMS2	V20670708
HP LC	Dionex	P580	2001	Fluorescence	531.1, 531.2	P580	1530109
	Waters	2690/2487	1998	UV Detector	532, 549, 555	2	H96SM4168R
	Dionex	P680	2005	Fluorescence	547	P680	1000205
	Agilent	5975 6850	2007	GCMS GC	524, 624, 8260	U	US6511537 CN10646018

Table 12-2 Preventive Maintenance Requirements

Instrument	Items Checked or Serviced	Frequency
Analytical Balance	Verify accuracy	Before each use
	Clean pans and compartment	After each use
	Annual Calibration, Clean electronics, gear trains and internal weights	Annually
Autoclave	Pressure check	Annually
	Temperature device calibration	Annually
Chemistry Analyzers Titrators (automated) (RFA, Lachat, Seal)	Change pump tubes	Every 1-5 runs
	Clean system with Chemwash	Every 1-5 runs
	Clean optic filters and dialyzer membranes	Each time used
	Replace poly transmission tubing	4-6 months
Autosamplers, GC & GC/MS	Clean/replace syringe	Weekly, or as needed
	Clean/replace rinse solvents	Daily/each use
BOD5	Check temperature of incubators	Start and end of cycle
Conductivity Probe	Clean probe w/diluted Acid – keep in water	As needed -as indicated by change in cell constant
Dessicators	Replace dessicant	As indicated by Color
Dissolved Oxygen Meter	Change probe filling solution and membrane	Quarterly or as needed
DPD Colorimeter	Clean test tubes and wipe color disk to be free of residue	Before every analysis
FIMS (Mecury Analyzer)	Check tubing tightness	Each analytical day
	Check and dry nebulizer, check filter for	Each analytical day
	Dry sample carrier tubing	Each analytical day
	Clean column lens windows and column	Each analytical day
	Check gas pressure on cylinder and gauge	Each analytical day
	Calibrate	Each analytical day
Gas Chromatographs	Change septum	As needed
	Replenish Hall Detector solvents	As needed
	Clean photo-ionization detector	As needed
	Remove first foot of capillary column	As needed
	Change in-line filters	As needed
	Replace capillary columns	As needed
	Clean ECD	As needed
Gas Chromatography/Mass Spectrometers	Change septum	As needed
	Remove first foot of capillary column	As needed
	Chang in-line filters	As needed
	Change Capillary column	As needed
High Pressure Liquid Chromatograph, HPLC-1	Filter and degas solvent	Prior to use
	Check DAD	Prior to use
	Filter Samples	Daily/each use

Instrument	Items Checked or Serviced	Frequency
	Check autoinject or post column purge gases	Daily/each use
Inductively Coupled Plasma Spectrophotometer	Clean nebulizer	As needed
	Replace peristaltic pump tubes	As needed
	Empty rinse waste container	As needed
	Remove, clean injector and/or torch assembly	As needed
	Check and clean optic windows	As needed
Ion Chromatograph	Check plumbing	Daily/each use
	Replace guard column	Bi-monthly (or if too noisy)
	Clean conductivity cell with diluted HCl	monthly
	For 317 – Clean UV conductivity cell with diluted HCl	monthly
Laboratory ware	Presence of residue (Inhibitory Residue)	Annual and each time lot of detergents or washing
	Check at least one piece of lab ware possible acid or alkaline residue	At least once daily, each day of use
Liquid Chromatograph/Mass Spectrometer	Filter and degas solvent	Prior to use
	Check DAD	Prior to use
	Filter samples	Daily each use
	Check autoinject or post column purge gases	Daily each use
	Backup data disks	As needed
	Check nitrogen gas pressure	Prior to use
	Check vacuum pressure	Prior to use
	Record column head pressure	Daily/each use
	Inspect and clean IMS Interface chamber to ensure no salt or deposition on the interface	Prior to use
	Inspect vacuum pump oil	Every 3 months
Mantech	Calibrate	Each analytical day
	Clean tubing	Every 4 months
	Clean wash	Every 4 months
Ovens	Check temperature	Daily/each use
pH meters	Check pH probe response with 3 buffers	Daily/each use
Refrigerators	Check temperature	Each run
Seal	Daily startup	Each run
	Clean syringe mechanism	Monthly
	Change lines	Yearly
	Replace reagents	As necessary
	Empty/replenish water bottle	Each analytical day
	Change regeneration coil	As needed
	Change syringe	As needed
	Adjust alignment	As needed

Instrument	Items Checked or Serviced	Frequency
Spectrophotometer (UV 254)	Clean cells	Daily/each use
	Change lamp	As needed
TEM	Align Beam	Daily/each use
	Saturate filament	Daily/each use
	EDS Cu K line	Daily/each use
	Liquid Nitrogen added to dewar to cool	Every 2 days
	Camera constant	Monthly
	Screen magnification	Monthly
	Negative magnification	Monthly
	Magnification factor	Monthly
	Spot size	Monthly
	TEM servicing by a qualified technician	Biannually
TOC Analyzer (Phoenix)	Add potassium persulfate to reactor cell and reservoir	Daily/each use
	Check O2 pressure	Daily/each use
	Add new tin to tin trap	As needed (~monthly)
	Change O2 tank	As needed (~ 2 months)
	Change pump tubing	As needed
	Drain waste	As needed
	Replace filters	As needed (~ monthly)
	Clean detection cell	As needed
	Check for tin and copper in the chloride trap for discoloration or clumping	3 months, replace granules as needed
	Check for back pressure problem, water level in the u-tube	3 months
	Check chloride scrubber for clumping. Check permeation dryer tube	Monthly
	Check for low pressure, water level in the u-tube. If water level is higher than the mark, check for displaced septa in reaction vessel and the u-tube	Monthly
	Inorganic carbon check	Once per quarter
TOC Analyzer (Sievers)	Inorganic Carbon Check	Once per quarter
	Replace acid cartridge and oxidizer cartridge	Every 3 months
	Replace UV lamp	Suggested every 6 months
	Calibration by manufacturer	Yearly
TOX Analyzer	Change acetic acid in cell	Before and after each run
	Clean inlet tube	As needed
	Clean outlet tube	As needed
	Electronics check	Bi-monthly
	Change solutions in electrode cells	Each analytical day

Table 12-3 Glassware Washing Procedures

Cleaning Procedures:

A. Miscellaneous glassware:

1. Wash all glassware with hot tap water and a brush using Extran detergent. Any glassware that can be placed in the automatic dishwasher safely will be washed in the dishwasher using approximately 10 milliliters of Extran detergent per load.
2. Rinse thoroughly with hot tap water.
3. Rinse thoroughly with deionized water.
4. Invert and air dry in contaminant free environment.

B. Extractable Organics:

1. Step 1, 2 and 3 above under miscellaneous.
2. Cover all openings with double layers of foil wrapped tightly.
3. Bake at 800°F for five to eight hours based on amount of glassware in the oven.
4. Remove from oven when completely cool and distribute to laboratories maintaining the foil coverings.

C. Bacteriological Glassware:

1. Step 1, 2, and 3 above under miscellaneous except use Neodisher UW detergent in step 1.
2. Cover all openings with double layers of foil wrapped tightly.
3. Place sterility indicator tape on each piece of glassware or autoclavable plasticware.
4. Place into the autoclave and sterilize at 121°C for 15 minutes.
5. Remove from autoclave when cool and place in laboratory without disturbing the foil covering.

D. Asbestos Glassware:

1. Immerse all glasswares in deionized water until all glasswares are fully covered in the sonicator.
2. Put approximately 30 grams of Alconox in the water
3. Turn on sonicator for 10 minutes.
4. After sonication, rinse three times with deionized water.
5. Place glasswares in clean tub and cover with foil.

Table 12-4 Water Quality Parameters

Parameter	Acceptance Criteria
Ammonia	< 0.1 mg/L (monthly check)
Residual Chlorine	< 0.10 mg/L
TOC	< 1 mg/L
pH	5.5 - 7.5
EC	<2 µmhos/cm @ 25oC
	<2 µS (µsiemens/cm)
Trace Metals (Cd, Cr, Cu, Ni, Pb, Zn)	<0.05mg/L each collectively <0.1 mg/L
Bacteriological (HPC) Colony forming units/ml	<500 cfu (NELAC < 10000 cfu/ml)
Bacteriological Quality of Reagent Water (Suitability Ratio or Ratio of Growth Rate)	0.8 - 3.00
Student's t	< 2.78 for annual use test
Inhibitory Residue	<15% difference in average count

13.0 DOCUMENT MANAGEMENT/CONTROL OF RECORDS

13.1. ANALYTICAL DOCUMENTATION

A critical dimension of any quality assurance program is the ability to document what is occurring in the laboratory. Accordingly, MWH Laboratories uses a number of forms to document various aspects of laboratory procedures. A discussion of these forms follows.

13.1.1. Analytical Data and Quality Control Forms

Printed forms are used by analysts to standardize the format of routine analyses. For analyses where forms are not available, the analyst records all required information in a notebook. The forms are designed to minimize calculation errors and provide a summary of all quality control data generated for the run.

Analysts are responsible for maintaining these forms. The QA group spot checks these forms periodically. These forms are actively maintained in hardcopy or electronically for a minimum period of 2 years and then stored electronically or stored in hardcopy offsite.

13.1.2. Chromatograms and Data Processing

Chromatograms and strip chart recordings are assigned unique alpha-numeric codes and backed-up on the server or an external hard drive. Information contained within the code includes; test, date and numerical sequence.

Computer records are stored by internal sample ID and test and therefore can be queried on this information.

Scanned hardcopy outputs of chromatograms and data processing are filed with the analytical data forms. Chromatograms and library searches are stored on magnetic tape and the information is retrievable upon client request.

13.1.3. Inventory Control Logs

Records are maintained on the purchase of laboratory supplies detailing the vendor, purchase order number, date of order, and date of receipt. Bottles of reagents are dated upon received so that the shelf life can be monitored.

13.1.4. Stock Standard Logs

A logbook is maintained for preparation of analytical stock standards for each group. Each log contains the date of fresh stock preparation, the lot number and supplier, the preparer's initials, and the weights used to prepare the stock.

13.1.5. **Bacteriological Growth Media Log**

Upon receipt of new microbiological media, the date received is noted upon the container. Media supplies are dated not only upon receipt but also when initially opened. A written record of quality control on media, materials, and equipment is logged into the Micro QC book. The record includes the results of the check, the initials of the individual performing the check, and the date. Media prepared in the lab is logged into the Prepared Media Log by the analyst. These records include media lot number, date of preparation, manufacturer and lot number, type and amount of media prepared, sterilization time and temperature, final pH, the analyst's initials, and expiration date.

13.1.6. **Instrument Monitoring and Maintenance Logs**

13.1.6.1. When in use, the operating temperatures of incubators, water baths, hot air ovens, and refrigerators are checked daily and recorded. Adjustments or service calls are made when required. Autoclave sterility checks, using ampules of bacterial spores, are made at least quarterly, or whenever a problem is suspected but all items are autoclaved with sterility indicator tape. Records of the maintenance are maintained in equipment logs.

13.1.6.2. A separate maintenance logbook is maintained for each analytical instrument. These logs contain a record of routine maintenance as well as any repair work required during instrument set-up.

13.1.7. **Corrective Action**

The form, presented in Figure 15-2, requires documentation on the determination of the out-of-control event or variance, the diagnostics performed to bring the event back under control, and the manner in which re-establishment of control was demonstrated. A flow chart of QIR process can be found on Figure 15-3. The analyst and their supervisor sign the form electronically or in hardcopy and submit it to the QA department for review. Then, QA will distribute the corrective action to the appropriate Project Manager so that the client may be contacted if necessary. The analysts keep hardcopies of original corrective action forms and file them with the appropriate raw data package.

13.2. CONTROL OF RECORDS

Figure 13-1 to 13-2 are example of worksheets and notebooks used in data reduction.

13.2.1. **General Records**

13.2.1.1. The laboratory’s document control procedure includes identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. Quality records include reports from internal audits and management reviews

as well as records of corrective and preventive actions. Records are in the form of hard copy or electronic media.

13.2.1.2. All records are required to be legible and are stored and retained in such a way that they are readily retrievable in facilities that provide a suitable environment to prevent damage or deterioration and to prevent loss. Records are retained for 5 years held secure and in confidence [NELAC 5.4.12.1.3]., 10 years for Hawaii samples.

13.2.1.3. The laboratory has implemented procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records by setting up level of security and/or designating appropriate personnel responsible for the security of the records.

13.2.1.4. The following information is documented as per NELAC 5.4.12.1.5.

13.2.1.4.1. The records include the identity of personnel involved in sampling, sample receipt, preparation, calibration, or testing.

13.2.1.4.2. All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.

13.2.1.4.3. The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes by setting format for naming electronic files.

13.2.1.4.4. All changes to records are signed or initialed by responsible staff. The reason for the signature or initials is clearly indicated in the records such as “sampled by”, “prepared by”, or “reviewed by”.

13.2.1.4.5. All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent ink. (NELAC 5.4.12.15.e).

13.2.1.4.6. Entries in records are not obliterated by methods such as erasures, overwritten files or markings. All corrections to record keeping errors are made by one line marked through the error. The individual making the correction signs (or initials) and date the correction. These criteria also apply to electronically maintained records [NELAC 5.4.12.1.5.f]. The laboratory keeps correspondence relating to lab activities for specific projects. Documentation includes email correspondence between the Project Manager and client.

13.2.2. **Technical Records**

13.2.2.1. The laboratory retains technical records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each test report issued, for a defined period. The record for each environmental test or calibration contains sufficient information to facilitate and to enable the environmental test to be repeated under conditions as close as possible to the original. The records include the identity of personnel responsible for the performance of each environmental test and checking of results.

13.2.2.2. Observations, data and calculations are recorded at the time they are made and are identifiable to the specific task.

13.2.2.3. When mistakes occur in records, each mistake is crossed out, not erased, made illegible or deleted, and the correct value entered alongside. All such alterations to records are initialed and dated by the person making the correction. In the case of records stored electronically, equivalent measures are taken to avoid loss or change of original data. When corrections are due to reasons other than transcription errors, the reason for the correction shall be documented (NELAC 5.4.12.2.3).

13.2.2.4. Each report or documents issued shall include the name(s), function(s) and signature(s) or equivalent electronic identification of person(s) authorizing the report or documents, and date of issue. Use of computer password unique to each analyst and level of security prevents loss of original data and change of data.

13.3. DATA STORAGE

13.3.1. MWH Laboratories maintains scanned report files and the supporting raw data offsite for at least 3 years and for a total of 5 years, or 10 years for Hawaii. The report files are organized alphabetically by client and contain a copy of the report sent to the client, custody information and scheduling information. These files are centrally located and a custodian is assigned to maintain, retrieve, and copy files as needed. Electronic copies of reports and raw data are maintained for a total of ten years in a secured data storage facility. All data stored include subcontractor reports.

13.3.2. Instrument raw data is stored on each instrument's computer. Data is backed-up to a network server or an external hard drive (Chromeleon is backed up to the network server and GCMS/LCMS is backed up to an external hard drive. If instruments are direct read and transcribed into notebooks, then the notebooks are stored in the lab until they are scanned and filed.

13.3.3. All raw data is organized by instrument or test, then chronologically. Logbooks such as sample custody or balance calibration are organized chronologically.

13.3.4. Electronic data from LIMS is stored on tape reels.

13.4. DOCUMENT CONTROL

13.4.1. Document Control procedures are implemented that allow for adequate documentation and control of specific documents. These procedures use a unique identification system that allows for tracking, training documentation, traceability of official copies and the time period the procedure or document was in force. Documents issued to all personnel in the laboratory as part of the Quality System (QS) shall be reviewed and approved for use to authorized personnel prior to use. The list will identify the current revision status to ensure that invalid or obsolete documents are not used. The document control procedures includes that the authorized editions of documents are accessible by the analysts and invalid or obsolete documents are promptly removed from use. All QS documents such as SOP, QAM, logbooks are uniquely identified including the following:

- Date of issue and/or revision ID
- Page numbering
- Total number of pages or markings to signify end of documents.
- Issuing authorities [NELAC 5.4.3.2]

13.4.2. To ensure that QA Manual and SOPs remained controlled documents, the master SOPs and QA Manual (original official version of the SOP and QA Manual) and copies of the SOP and QA Manual will be identified. The cover page of each copy will contain a unique identification indicating that the document is controlled copy ___ of ____ copies, initialed and dated by the QA Officer in red ink. This ensures that the analyst is currently using the right update or version.

13.4.3. A SOP/QA Manual Distribution Form will be prepared for each SOP/QAM that will include the SOP/QAM ID, control number, individual receiving the SOP/QA Manual, date of issue and the date of completion of the analyst SOP/QAM training documentation.

13.4.4. Record management system is also implemented for control of laboratory notebooks; instrument logbook; standard logbook; and records for data reduction validation storage and reporting. Laboratory archival system will also be implemented to laboratory books and logbooks.

13.4.5. Notebooks and Logbooks are assigned unique ID numbers for control of laboratory records. Upon completion of the book, the analyst returns the book to QA. A new number is assigned to the newly issued notebook. See Table 13-1 for the laboratory document control system for notebooks and logbooks.

13.4.6. Changes to documents shall be reviewed and approved by the same function that performed the original review unless specifically designated otherwise. The designated personnel shall have access to pertinent background information upon which to base their review and approval.

13.5. DOCUMENT CHANGES TO CONTROLLED DOCUMENTS

13.5.1. All documents and/or changes issued to personnel in the laboratory are reviewed and approved for use by the Technical Director and Quality Assurance Manager prior to use. A master list or an equivalent document control procedure identifying the current revision status and distribution of documents in the laboratory are established and are readily available to preclude the use of invalid and/or obsolete documents.

13.5.2. Any changes/alterations to laboratory documents are tracked and properly identified. Amendments are clearly marked, dated and initialed and revised documents are formally re-issued immediately. Any obsolete documents are removed from corresponding binders are archived and stored in a secured place.

13.6. ARCHIVAL SYSTEM

An archival system is implemented for managing and removal of all outdated documentation. Records that are archived are; Training Records for personnel no longer with the laboratory; Outdated QA Manual/SOPs, only current versions of the QA Manual/SOPs are retained in the laboratory areas. All outdated versions of the QA Manual/SOPs are returned to the QA Officer for archiving. In addition all outdated logbooks/workbooks including maintenance books are turned in to the QA Officer for archiving. Archived information is stored in-house for 3 years and is transferred off-site, for storage after 3 years. Archived information is documented in an access logbook kept by the QA Officer identifying the type of record archived and the date the record is archived and stored for 5 years, or for 10 years for Hawaii.

13.7. STANDARD OPERATING PROCEDURES (SOP)

13.7.1. Laboratories shall maintain SOPs that accurately reflect all phases of current laboratory activities such as assessing data integrity, corrective actions, and all test methods.

13.7.2. When an amendment to the SOP is needed, such as a minor update to the entire procedure, the laboratory will handwrite the update with initials and date of the person who made the change in the original copy of the SOP. Also, when a minor mistake is found in the SOP, the laboratory will strike the section with one line, date and initials of the person who does the change in the original copy of the SOP. For any of these minor updates, the analyst(s), supervisor and QA will be notified and they will be included in the next update of the SOP.

13.7.3. The following format must be used for all final technical SOPs. Draft SOPs may or may not be written in this format. This is not of great concern since it is only essential that the critical information presented below be included in some manner.

13.7.3.1. **Header** - A header must be included in the upper right corner of each page of the SOP. The header must include the SOP reference name or number, the revision number, the date the revision began, page number and total number of pages.

13.7.3.2. **Cover Page -** The SOP cover page consists of a summary of the most recent revision information and the signatures of the Analyst, Group Supervisor, QA Officer, and Technical Director/Lab Director stating that they approved the SOP including the date that they read and signed the SOP. The approval and effective dates are included on the cover page. The effective date is two weeks after the approval date.

13.7.3.3. **Body**

13.7.3.3.1. **Title**

13.7.3.3.2. **Scope and Application** - A brief description of the types of matrices the method is applicable to as well as the regulatory programs that may be supported by the use of the method. This section is also used to indicate any special training or level of ability required to perform the method.

13.7.3.3.3. **Method Summary** - A brief description of the method, simple statement of analytical technique and any pre-treatment steps.

13.7.3.3.4. **Interferences** - This section should include any known interferences, as well as potential interferences, particularly for GC/conventional detector methods. It should also include any interferences that may be present as a result of improper sampling procedures, equipment cleaning or analytical technique must be listed here.

13.7.3.3.5. **Safety Considerations** - Specify any known or suspected carcinogens, mutagens, or teratogens among the standards or reagents used. Indicate that the MSDS (material safety data sheets) are available and where they are located. Each analyst is required to familiarize him/herself with the contents of the MSDS before performing the analysis.

Each SOP includes reference to the Laboratory Chemical Hygiene Plan as per OSHA Standard 29 CFR 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories-Final Rule.

13.7.3.3.6. **Instrumentation/Apparatus** - The instrumentation used, including specific columns employed for GC, LC, or GC/MS and whether or not there is a primary and confirmatory column.

13.7.3.3.7. **Reagents and Standards** - The sources of all standards and reagents are listed.

13.7.3.3.8. **Sample Collection, Preservation and Handling** - Indicate bottle type, preservative and volume necessary for analysis. Include holding times for standards.

13.7.3.3.9. **Calibration Procedure** - Detailed preparation instructions for each calibration, LCS or MS/MSD standard should be included. A table should be present to show how daily calibration and control standard solutions are prepared from working stock standards. Calibration frequency should be specified. Expiration information should be included for each type of standard prepared.

13.7.3.3.10. **Analytical Procedure** - Since the purpose of a SOP is to provide clear instruction to avoid loss of key information from one analyst to another, it is critical that this section be detailed enough that any analyst can anticipate and take appropriate corrective action in the event that a problem should arise.

13.7.3.3.11. **Quality Control Requirements** - This section should describe the components, concentrations, frequency, and acceptance criteria for the LCS or MS/MSD samples, as well as any other method specific QC requirements, such as tuning, blanks, or calibration requirements.

13.7.3.3.12. **Calculations** - All relevant calculations should be included, such as how instrument response relates to concentration, the calculation of response factors, etc.

13.7.3.3.13. **Method Performance** - The results of the initial method validation process should be included. The following information should be present:

- Statistically calculated MDLs (40 CFR Part 136 Appendix B),

- MDL spike levels, MWH Laboratories' MRLs, Accuracy for each compound (mean recovery of each compound determined from analysis of a minimum of 4 replicates spiked at 10 x MRL), precision data (RSD of the 4 replicates spiked at 10 x MRL).

This data will be used to set interim LCS and MS/MSD control limits (3 sigma) until sufficient data is accumulated to calculate limits based on actual laboratory historical data.

13.7.3.3.14. **References** - A list of method references, such as the relevant 500 or 600 series method, the SW-846 methods (including revision number and date), or Standard Methods should be provided.

13.7.3.3.15. **Deviations from Referenced Methodology** - A review of the referenced method is carefully made and MWH Laboratories will specify any areas in which our method does not conform to referenced method requirements. If any such

deviations are noted, an explanation as to what alternative was used and why is described. There are two basic types of method modifications: (1) those that are hardware related and (2) those that are policy or procedural modifications.

13.7.3.3.16. **Method Detection Limit** - Laboratory procedures of conducting MDL studies and a copy of the initial MDL study will be included.

13.7.3.3.17. **Definitions** - Definitions will be referred to the QA Manual since the QA Manual includes a glossary section that defines all the terms used by the laboratory.

13.7.3.3.18. **Pollution Prevention** - Potential threat of the standards and reagents to the environment is addressed in the SOP.

13.7.3.3.19. **Waste Management** - In addition to the hazardous waste protocol discussed in the SOP, the following references where the information can be find are also included:

- The Lab Hazwaste Management Plan
- The federal hazardous waste management regulations –Resources Conservation and Recovery Act (RCRA)-Title 40 of the Code of Federal Regulations, Parts 260 through 270 (40 CFR 260-270)
- CA Hazardous Waste Control Law (HWCL)-CCR Title 22 where 40 CFR was duplicated into CCR Title 22

13.7.3.3.20. **Revisions** - Revisions are discussed including the dates when revisions are made and the appropriate section numbers where the revisions could be found.

13.7.3.3.21. **Attachments** - A copy of the bench sheet used for the analysis and where applicable, an example chromatogram of the standards, calculations and any other relevant attachments.

Table 13-1 Laboratory Document Control

	Control No.
Instrument Sequence Log Books and Instrument Run Logs	1-200
Maintenance Log Books	201-400
QC Log Books (pH, Micro air monitoring, travel blank, etc.)	401-600
Reagent Prep Books	601-800
Sample Prep/Extraction Books	801-1000
Sample Data Records	1001-1200
Standard Log Books	1201-1400
SOP Books	1401-1600
Support Equipments Log Books (Balance, Pipette, Refrigerator, Incubator, Thermometer, etc)	1601-1800
MSC.	1801-2000
Certification Books	2001-2200
Forms Template	2201-2400

Figure 13-1 Sample Worksheet

PHENOL - LF

PHENOL/EPA METHOD 420.1

7-9-4

ANALYST:

Date of Analysis: 7.7.04
Date of Digestion: 7.6.04

For all reported samples:
Are all Instrument Performance Check Samples (IPC) within 80-120%: Y N
Are all Calibration Blanks (CB) less than MRL 0.01 ppm: Y N
Is the MRL standard recovery within 50-150%: Y N
Is the Correlation Coefficient of the Standard Curve >= 0.995: Y N

Sample I.D.	Dilution Factor	Final conc. (mg/L)	Percent Recovery (%)	Acceptance Limit	Comment
Initial Calibration Verification (ICV)	1	0.200	100%	90-110% Rec (0.18-0.22)	True Value 0.2 ppm (mg/L)
Initial Calibration Blank (ICB)	1	ND	NA	< 0.01ppm	
MRL	1	0.009	90.0%	50%-150% Rec (0.005 - 0.015)	True value - 0.01 ppm (mg/L)
LFB	1	0.0501	100%	80-120% Rec (0.04 - 0.06)	True value - 0.05 ppm (mg/L)
Method Blank	1	ND	NA	< 0.01ppm	
LCS - 1		0.0424	84.8%	80-120% Rec (0.04 - 0.06)	True value - 0.05 ppm (mg/L)
LCS - 2 (duplicate)		0.0436	87%	80-120% Rec (0.04 - 0.06)	True value - 0.05 ppm (mg/L)
Spiked Sample 1. 240702 0001		ND			
Laboratory Fortified Matrix (LFM/MS)		0.043	86%	80-120% Rec (0.04 - 0.06)	True value - 0.05 ppm (mg/L)
Laboratory Fortified Matrix DUP (LFMD/MSD)		0.044	88%	80-120% Rec (0.04 - 0.06)	True value - 0.05 ppm (mg/L)
2. 240702 0012		ND			
3. 0014		ND			
4. 0016		ND			
5. 0037		0.014			
6. 240619 0113		0.197			
7. 0114		0.113			
8. 240701 0165		0.095			
9.		NA			
10.					
Continuing Calibration Blank (CCB)	1	ND	NA	< 0.01ppm	
LFB	1	0.05	100%	80-120% Rec (0.04 - 0.06)	True value - 0.05 ppm (mg/L)
Continuing Calibration Verification (CCV)	1	0.099	99%	90%-110% (0.09 - 0.11)	True value - 0.1 ppm (mg/L)
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
Continuing Calibration Blank (CCB)	1		NA	< 0.01ppm	
LFB	1			80-120% Rec (0.04 - 0.06)	True value - 0.05 ppm (mg/L)
Continuing Calibration Verification (CCV)	1			90%-110% (0.09 - 0.11)	True value - 0.1 ppm (mg/L)

Figure 13-2 Example Notebook

Referenced Methods: ***EPA 525.2***				Batch #:	
Start Date:		Init:		Matrix:	*water*
Comp Date:		Init:		Reagent H2O:	***Ultrapure*** mfg/lot
QC'd:		Init:		Solvent: MeOH	***EM*** mfg/lot
Solutions: ***50% HCl***	Prep Date:			EtAc	***EM*** mfg/lot
	Prep Date:			MeCl2	***EM*** mfg/lot
	Prep Date:			Salt: Na2SO4	***EM*** mfg/lot
	Prep Date:			Na2SO3	***JTBaker*** mfg/lot
Room temp:	Chiller Temp:			Disk/Cartridge: C18HC	***JTBaker*** mfg/lot
Bath temp:	Heater Temp:			Vacuum (in Hg):	

Surr/IS Spk Soln#:	Exp:	Volume:	Syringe Lot #:
LFB/LFM Spk Soln#:	Exp:	Volume:	Syringe Lot #:
LFB/LFM Spk Soln#:	Exp:	Volume:	Syringe Lot #:
UCMR Spk Soln#:	Exp:	Volume:	Syringe Lot #:
MDL Spk Soln#:	Exp:	Volume:	Syringe Lot #:
Terphenyl-d14 Spk Soln#:	Exp:	Volume:	Syringe Lot #:

Group	Sample #	Client Code	Sample Source	Test Code	Vi (mL)	Vf (mL)	pH	Cl- ppm	Ext#
Click here and insert left of this line – delete before move									
LRB									
LFB1									
LFB2									
LFB3									
LFM									
LFMD									
DUP									
LFM2									

Batch Comments:

14.0 DATA REDUCTION, VALIDATION, AND REPORTING

The process of transforming raw analytical data into a finished report involves steps which are generally grouped into the categories of data reduction, data validation, and reporting. It involves mathematical modeling of the standard calibration curves, statistical analysis of the acquired data, calculations to account for preparation steps and dilution, verification of adherence to quality assurance procedures, and the generation of hardcopy output.

14.1. DATA REDUCTION

At MWH Laboratories the analyst performing an analysis has the primary responsibility for reducing raw data. This process consists of converting raw data values into final, reportable values by comparing individual sample results to those obtained for calibration purposes and then accounting for any dilution or concentration procedures.

The extent to which raw data from the instrument needs to be mathematically processed varies depending on the analysis. For the following methods finished data is directly read from the instrument; pH, conductivity, spectrophotometric/colorimetric measurements (i.e.: Chemical Oxygen Demand (COD), Chromium VI, phenols, phosphorus, Methylene Blue Activated Substances (MBAS, or commonly known as surfactants), odor and presence/absence bacteriological tests. Other methods require mathematical calculations and in some cases, such as for pesticides by GC, qualitative assessment of actual presence.

Below is an outline of the data reduction techniques used by technology.

14.1.1. GC AND GC/MS

A data reduction software system is used to calculate target compound concentrations. These concentrations are calculated by multiplying the average response factor for the compound by the area count as determined by the instrument. Average response factors are determined through linear regression during initial calibration, and may only be used if the correlation criteria have been met. This assumes linearity of the calibration curve through the origin. If linearity is not established then a second order fit (logarithmic regression) may be used to determine response factors. Another alternative is to use single point calibration, which matches the area counts from a single calibration point to the area counts of the sample, upon which a sample concentration is determined. Single point calibration is rarely used. When method allows second order fits and single point calibrations are used as a temporary calibration; action is immediately taken to re-establish a linear calibration.

In all cases data is reduced by the data reduction software. Programs for linear, logarithmic and single point calibrations are available on command. Sample dilution

factors are entered into the data reduction software prior to analysis and calculated into the final result.

14.1.2. GC/MS

Reportable results are provided by the data reduction software for GC/MS analyses using linear average response factors, or 2nd order fits, as described, except for diluted samples. For diluted samples the result from the system is multiplied by the dilution factor. Reporting limits are adjusted manually as well.

All regressions and calibration calculations are performed by the system software.

14.1.3. METALS

ICP & ICPMS results are processed and transferred directly into the LIMS system. Dilution and calibration information is entered and processed by the ICP software prior to data transfer.

All other results are reportable directly off the system.

14.1.4. HPLC / IC / SPECTROPHOTOMETRIC / POTENTIOMETRIC

All results are reportable directly off the system software or directly read off instrument. The cell constant for the conductivity meter is 1. All samples and standards are allowed to come to room temperature prior to analysis. Temperature correction is not needed.

14.1.5. MICROBIOLOGY

The ability of an individual analyst to count colonies accurately shall be verified at least once per month, by having two or more analysts count colonies from the same plate on one positive sample. Counts must be within 10% difference to be acceptable [NELAC D 3.2].

14.2. DATA VALIDATION

Upon completion of each analytical run, the analyst fills out analytical raw data and QC summary sheets. Depending on the test, data entry is made into the LIMS. Entries are then reviewed by the analytical Supervisor or a backup peer analyst. They verify that all quality control parameters (including all those specified for each method in Section 11) fall within acceptance limits and also review the analytical data for calculation errors and inconsistencies. The raw data review includes all documentation associated with the samples, including chromatograms, instrument run logs, digestion logs, and other instrument printouts. Upon approval, the analyst enters the data into the computer. When all analytical results for a sample have been entered, a report is generated on the computer for screen validation by the Supervisor. Approved reports are batch printed

each day. The Supervisor/Validation Group reviews and validates all of the reports in a report group. Validated reports are batch printed and reviewed by the Project manager.

All logbooks such as sample preparation, instrument maintenance, calibration, internal custody, and disposal are reviewed by the supervisor or manager of that group. Initials and date of review will be written on the final page reviewed. The review will focus on completeness, accuracy, trends and opportunities for improvement and compliance.

14.3. DATA REVIEW POLICY/CORRELATION OF RESULTS

All analytical data must be reviewed by a peer analyst qualified in that analysis or the group supervisor. Supervisors are ultimately responsible for the quality of reported results. Data review includes the following:

14.3.1. Checking all QC data against the QC criteria.

14.3.2. All the sample calculations must be checked. Samples which are spot checked must be marked by the reviewing analyst.

14.3.3. The analytical run sheet must be signed by the primary analyst and the reviewing peer analyst. Changes to records must be signed and initialed by responsible staff [NELAC 5.4.12.1.5. d)].

14.3.4. All secondary reviewers or Supervisors must check all data sheets. For inorganics and metals they must verify data entry for those samples by checking the database. The secondary reviewer or Supervisor must initial each run sheet they review. For organics, the secondary reviewer or Supervisor must cross check all reports for transcription error from bench sheets.

14.3.5. All Supervisors must validate the data reported into the computer system. The data validation group then reviews and validates the final reports electronically. The reports are then printed and reviewed by the Project Manager.

14.3.6. As part of the periodic system audits, the Quality Assurance Manager or QA staff must spot check data sheets to insure that the peer reviews are being performed and that review process is traceable to the peer review.

14.3.7. Correlation of results for different characteristics of a sample (example Total Phosphate ≥ Orthophosphate or TKN ≥ NH3 [NELAC 5.5.9.1e)]

14.4. DATA REPORTING

To meet the NELAC report requirement, the laboratory provides the following information in the final test report:

14.4.1. A Title

14.4.2. Name/address of laboratory

14.4.3. Phone number and name of contact person

14.4.4. Unique identification of the certificate or report and unique identification of each page, and the total number of pages

14.4.5. Name and address of client, where appropriate and project name if applicable

14.4.6. Description and unambiguous identification of the tested sample including the client identification code

14.4.7. Identification of results derived from samples that did not meet NELAC acceptance requirements such as improper container, holding time, or temperature. [NELAC 5.5.10.3.1 b)]

14.4.8. Date of receipt of sample, date and time of sample collection, date(s) of performance test, and time of sample preparation and/or analysis if the required holding time for either activity is less than or equal to 72 hours [NELAC 5.5.10.2g)]

14.4.9. Identification of the test method used, or unambiguous description of any non-standard method used.

14.4.10. Qualification of numerical results with "E1-E7" flags for values outside the working range. [NELAC 5.5.10.3.1 f)]

14.4.11. Any deviations from, additions to or exclusions from the test method, and any other information relevant to a specific test, such as environmental conditions including the use of relevant data qualifiers and their meaning

14.4.12. Measurement, examinations and derived results and identification of any failures (such as failed quality control). Radiochemistry results shall be reported with associated measurement uncertainty [NELAC D.4.6]

14.4.13. Identification whether the data are calculated on dry weight or wet weight, reporting units and when required a statement of the estimated uncertainty of the test result

14.4.14. Signature and title of the person(s) accepting responsibility for the content of the report and date of issue

14.4.15. Clear identification of all data provided by outside sources (subcontracted laboratories, clients, Non-NELAP accredited work, etc.)

14.4.16. Clear indication of numerical results with values outside of quantitation limits. Test results provided by subcontracted laboratories are identified by subcontractor name or applicable accreditation number.

When the validation steps are completed, and the managers and supervisors have keyed in their initials in the appropriate LIMS field to reflect this, the report number is automatically transferred to an electronic listing in LIMS. Reports on this list are printed out daily. The reports are reviewed for correctness against the data in LIMS and signed off by the project manager prior to being copied for the files and delivery to the client. An example of an analysis report form is shown in Figure 14-1. A sample of a QC Report is shown in Figure 14-3. After the report is issued to the client, the laboratory reports remain unchanged. The report shall not be reproduced except in full, without the written approval of the laboratory. (NELAC 5.5.10.2.L). After issue of report, material amendments to the test report is done in the form of further document or data transfer including the statement "Supplement to test report, group number _____". For MWH revised report, cover page – report # xxxxxx'r'. Comment, report # xxxxxx'r' replaces the original test report. Also, amendments to the formal report must meet all the NELAC reporting requirements. The laboratory notifies clients in writing of any event such as the identification of defective measurement or test equipment that casts doubt on the validity of results given in any test report or amendment to a report [NELAC 5.13.13.2]. The laboratory also ensures that the NELAC reporting requirements are met for test results transmitted by telephone, telex, facsimile or other electronic or electromagnetic means and that all reasonable steps taken to preserve client confidentiality. Final laboratory report includes a statement in the cover page "Laboratory certifies that the test results meet all NELAC requirements unless noted in the comments section or the Case Narrative".

If Client requires monthly reports of data that does not include all items listed in 14.4, the laboratory is still required to provide all information in standard NELAC report format required by the Client for use in preparing such regulatory reports [NELAC 5.5.10.1 and NELAC 5.5.10.9 – Amendments to Test Reports and Calibration Certificates].

Copies of all client reports are filed electronically in a centralized server by year and client name. Scanned files are maintained for 5 years, accept Hawaii clients which are maintained for 10 years.

14.5. ELECTRONIC TRANSMISSION OF RESULTS

In the case of transmission of environmental test results by telephone, facsimile or other electronic means, the laboratory ensures preservation of Client confidentiality by attaching a cover page that includes the following statement:

> "This transmission and/or attachments contain information which is confidential and/or privileged. The information is intended for the addressee only. If you are not the intended recipient, any dissemination,

distribution or copying of this communication is prohibited. If you have received this communication in error, please notify and return the original communication to the sender" [NELAC 5.5.10.7].

14.6. GOOD AUTOMATED LABORATORY PRACTICES (GALP)

The laboratory assures that all requirements of the NELAC standard are complied with where computers or automated equipment are used for the capture, processing, manipulation, recording, reporting, storage or retrieval of test data.

Section 8.1 through 8.11 of the EPA document 2185 – GALP is adopted by the laboratory for its computer use even though GALP is not part of NELAC standard requirements. The laboratory ensures that the computer software is adequate for use and documented. To protect the integrity of data entry or capture, data storage, data transmission and data processing, the laboratory establishes and implements procedures in compliance to good automated laboratory practices. In addition, appropriate procedures are established for computer and automated equipment to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of calibration and test data. Also the laboratory establishes and implements appropriate procedures for the maintenance of security of data including the prevention of unauthorized access to and the unauthorized amendment of computer records. The laboratory LIMS system provides several levels of security. The first level is the entry of a password to initially log on to the computer, then the person must be designated as a qualified user of multi-LIMS. Additionally, the department to which a person is assigned governs accesses to the various functions of the system. The system also provides for read – only access to results to further protect the data from unauthorized modification or deletion. See laboratory GALP SOP for the Implementation of Good Automated Laboratory Practices. Implementation of the GALP includes data point comparison and manual calculations to test LIMS accuracy to be done during the data package review by the Quality Assurance Unit (QAU) (QAM section 16.1.2). LIMS Audit Report form will be completed to document results of the LIMS audit. The laboratory QA group will ensure that all corrective actions are done when deficiencies are observed.

Figure 14-1 Example Analysis Report Form

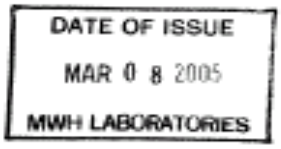
750 Royal Oaks Drive, Suite 100
Monrovia, California 91016-3629
Tel: 626 386 1100
Fax: 626 386 1101
1 800 566 LABS (1 800 566 5227)

Laboratory Report

for

MWH LABS

Attention: NILDA COX



NBC Nilda Cox
Project Manager

Report#: 141133

Laboratory certifies that the test results meet all **NELAC** requirements unless noted in the Comments section or the Case Narrative. Following the cover page are Comments,QC Report,QC Summary,Data Report,Hits Report, totaling 86 page[s].

MWH Laboratories
A Division of MWH Americas, Inc.
750 Royal Oaks Drive, Suite 100
Monrovia, California 91016-3629
Tel: 626 386 1100
Fax: 626 386 1101
1 800 566 LABS (1 800 566 5227)

Laboratory
Hits Report
#141133

MWH LABS
NILDA COX

Samples Received
13-jan-2005 11:08:49

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
	2501130040	ERA 22 WP120 BASE NEUTRAL				
02/14/05	4-Bromophenylphenylether		163		ug/l	20
02/14/05	4-Chlorophenylphenylether		92.6		ug/l	5.0
02/14/05	Acenaphthylene		18.4		ug/l	5.0
02/14/05	Anthracene		60.8		ug/l	5.0
02/14/05	Benzo(a)anthracene		35.6		ug/l	5.0
02/14/05	Benzo(a)pyrene		19.4		ug/l	5.0
02/14/05	Benzo(b)fluoranthene		28.7		ug/l	5.0
02/14/05	Benzo(g,h,i)perylene		25.0		ug/l	10
02/14/05	Butylbenzylphthalate		181		ug/l	20
02/14/05	Chrysene		41.2		ug/l	5.0
02/14/05	Di(2-Ethylhexyl)phthalate		79.2		ug/l	4.0
02/14/05	Di-n-butylphthalate		153		ug/l	40
02/14/05	Di-n-octylphthalate		27.2		ug/l	10
02/14/05	Diethylphthalate		26.3		ug/l	5.0
02/14/05	Dimethylphthalate		94.6		ug/l	5.0
02/14/05	Fluoranthene		27.4		ug/l	5.0
02/14/05	Fluorene		15.7		ug/l	5.0
02/14/05	Hexachlorocyclopentadiene		47.6		ug/l	10
02/14/05	Hexachloroethane		57.9		ug/l	5.0
02/14/05	Indeno(1,2,3-c,d)pyrene		28.6		ug/l	10
02/14/05	Isophorone		155		ug/l	20
02/14/05	N-Nitrosodi-N-propylamine		49.5		ug/l	5.0
02/14/05	N-Nitrosodimethylamine		67.5		ug/l	5.0
02/14/05	Naphthalene		79.2		ug/l	5.0
02/14/05	Phenanthrene		48.1		ug/l	5.0
02/14/05	Pyrene		39.0		ug/l	5.0
02/14/05	bis(2-Chloroethoxy)methane		42.6		ug/l	10
02/14/05	bis(2-Chloroethyl)ether		93.0		ug/l	10
02/14/05	bis(2-Chloroisopropyl)ether		74.3		ug/l	10
02/14/05	m-Dichlorobenzene (1,3-DCB)		79.0		ug/l	5.0

SUMMARY OF POSITIVE DATA ONLY.

MWH Laboratories
A Division of MWH Americas, Inc.
750 Royal Oaks Drive, Suite 100
Monrovia, California 91016-3629
Tel: 626 386 1100
Fax: 626 386 1101
1 800 566 LABS (1 800 566 5227)

Laboratory
Hits Report
#141133

MWH LABS
NILDA COX

Samples Received
13-jan-2005 11:08:49

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
	2501130037	ERA 19 WP120 PESTICIDES				
02/04/05	Alpha-BHC		4.50		ug/l	1.0
02/04/05	Beta-BHC		4.27		ug/l	1.0
02/04/05	Delta-BHC		23.7		ug/l	4.0
02/04/05	Dieldrin		1.10		ug/l	0.20
02/04/05	Endosulfan I (alpha)		22.3		ug/l	4.0
02/04/05	Endosulfan II (beta)		28.7		ug/l	4.0
02/04/05	Endosulfan sulfate		24.6		ug/l	4.0
02/04/05	Endrin		7.52		ug/l	0.50
02/04/05	Endrin Aldehyde		5.47		ug/l	1.0
[illegible]/04/05	Endrin Ketone		7.94		ug/l	1.0
02/04/05	Gamma-BHC		15.9		ug/l	2.0
02/04/05	Heptachlor		0.722		ug/l	0.050
02/04/05	Heptachlor Epoxide		0.858		ug/l	0.050
02/04/05	Methoxychlor		7.08		ug/l	2.0
02/04/05	p,p' DDD		5.92		ug/l	1.0
02/04/05	p,p' DDE		4.22		ug/l	1.0
02/04/05	p,p' DDT		3.97		ug/l	0.40
	2501130038	ERA 20 WP120 CHLORDANE				
02/04/05	Chlordane		9.19		ug/l	1.0
	2501130039	ERA 21 WP120 TOXAPHENE				
02/05/05	Toxaphene		2.05		ug/l	0.50
	2501130040	ERA 22 WP120 BASE NEUTRAL				
02/14/05	2,4-Dinitrotoluene		22.6		ug/l	5.0
02/14/05	2-Chloronaphthalene		43.5		ug/l	5.0

SUMMARY OF POSITIVE DATA ONLY.

MWH Laboratories
A Division of MWH Americas, Inc.
790 Royal Oaks Drive, Suite 100
Monrovia, California, 91016-3629
Tel: 626 386 1100
Fax: 626 386 1101
1 800 566 LABS (1 800 566 5227)

Laboratory
Hits Report
#141133

MWH LABS
NILDA COX

Samples Received
13-jan-2005 11:08:49

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
	2501130040	**ERA 22 WP120 BASE NEUTRAL**				
	2501130041	**ERA 23 WP120 NDMA**				
01/26/05	N-Nitroso dimethylamine (NDMA)		75000		ng/l	2000
	2501130042	**ERA 24 WP120 ACIDS**				
02/14/05	2,4,5-Trichlorophenol		69.7		ug/l	5.0
02/14/05	2,4,6-Trichlorophenol		37.9		ug/l	5.0
02/14/05	2,4-Dichlorophenol		34.7		ug/l	5.0
02/14/05	2,4-Dimethylphenol		36.4		ug/l	5.0
02/14/05	2,4-Dinitrophenol		113		ug/l	50
02/14/05	2-Chlorophenol		77.4		ug/l	5.0
02/14/05	2-Methylphenol		84.3		ug/l	5.0
02/14/05	2-Nitrophenol		35.0		ug/l	5.0
02/14/05	4,6-Dinitro-o-cresol		121J		ug/l	200
02/14/05	4-Methylphenol		78.7		ug/l	5.0
02/14/05	4-Nitrophenol		55.5		ug/l	10
02/14/05	Pentachlorophenol		121		ug/l	80
02/14/05	Phenol		104		ug/l	5.0
02/14/05	p-Chloro-m-cresol		82.9		ug/l	5.0
	2501130043	**ERA 25 WP120 BORON**				
01/25/05	Boron, Total, ICAP		7.30		mg/l	0.25
	2501130044	**ERA 26 WP120 MBAS**				
01/18/05	Surfactants		0.415	0.5	mg/l	0.050

SUMMARY OF POSITIVE DATA ONLY.

Figure 14-2 Example Analysis Report Form (Report Comment)

MWH Laboratories
A Division of MWH Americas, Inc

750 Royal Oaks Drive
Suite 100
Monrovia, California 91016-3629
Tel: 626 568 6400
Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Report Comments #103868

Group Comments

Analytical results for TBTSUB are submitted by East Bay Municipal Utilities District, Oakland,CA. CA ELAP #1060.

(QC Ref#: 2212110016)
Test: Subcontracted Analyses ( )
Metals SB,AS,BE,CD,CR,CU,PB,HG,NI,SE,AG,TL,ZN; 524.2, Mercury by 1631.

(QC Ref#: 2212110018)
Test: Subcontracted Analyses ( )
Metals SB,AS,BE,CD,CR,CU,PB,HG,NI,SE,AG,TL,ZN; 524.2, Mercury by 1631.

(QC Ref#: 2212110019)
Test: Subcontracted Analyses ( )
524.2

(QC Ref#: 2212110020)
Test: Subcontracted Analyses ( )
524.2

(QC Ref#: 2212110023)
Test: Subcontracted Analyses ( )
Results for Sulfite by EPA 300.0 are submitted by Sierra Environmental Monitoring, Reno, NV.

(QC Ref#: 2212110024)
QC Type: Y
CUSTSUB FOR SULFITE
Test: Subcontracted Analyses ( )
Results for Sulfite by EPA 300.0 are submitted by Sierra Environmental Monitoring, Reno, NV.

Figure 14-3 Example QC Report Form

MWH Laboratories
A Division of MWH Americas, Inc.

750 Royal Oaks Drive, Suite 100
Monrovia, California 91016-3629
Tel: 626 386 1100
Fax: 626 386 1101
1 800 566 LABS (1 800 566 5227)

Laboratory
QC Report
#141133

MWH LABS
(continued)

MSD	Ammonia Nitrogen	1.00	0.945	MGL	94.5	(90-110)	0.00

QC Ref #258971 Hexavalent chromium (Cr VI)

QC	Analyte	Spiked	Recovered	Units	Yield (%)	Limits (%)	RPD (%)
LCS1	Hexavalent chromium (Cr VI)	0.050	0.0494	MGL	98.8	(85-115)	
LCS2	Hexavalent chromium (Cr VI)	0.050	0.0488	MGL	97.6	(85-115)	1.2
MBLK	Hexavalent chromium (Cr VI)	ND	<0.0035	MGL			

QC Ref #258980 Total Organic Halogen

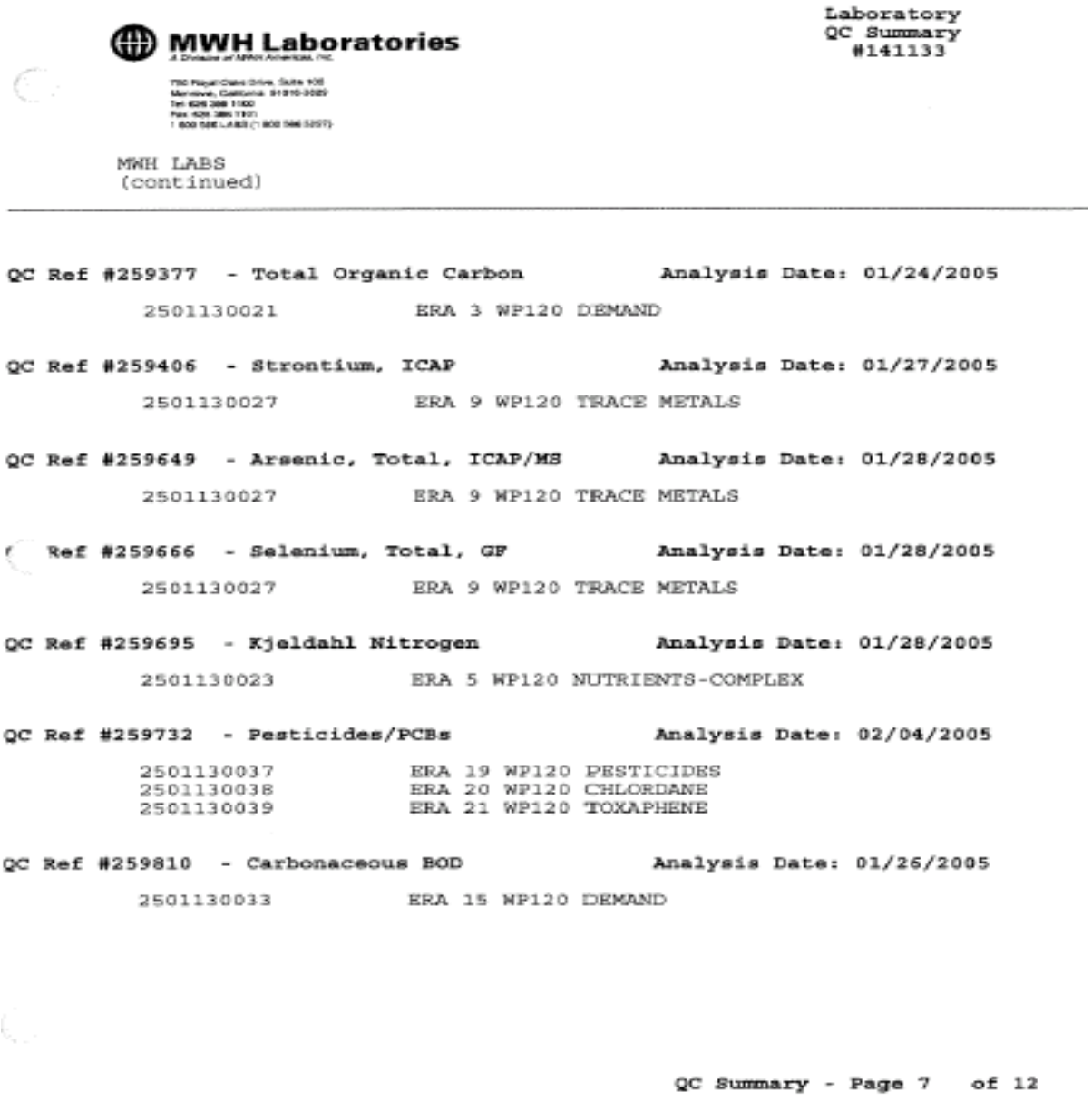
QC	Analyte	Spiked	Recovered	Units	Yield (%)	Limits (%)	RPD (%)
MS	Spiked sample	Lab # 25	01180021	UGL		(0-0)	
LCS1	Total Organic Halogen	10	11.8	UGL	118.0	(85-115)	
LCS2	Total Organic Halogen	100	100	UGL	100.0	(85-115)	
MBLK	Total Organic Halogen	ND	<10	UGL			

QC Ref #259000 Purgeable Halocarbons

QC	Analyte	Spiked	Recovered	Units	Yield (%)	Limits (%)	RPD (%)
LCS1	1,1,1-Trichloroethane	4.0	4.38	UGL	109.5	(43-136)	
LCS2	1,1,1-Trichloroethane	4.0	4.04	UGL	101.0	(43-136)	8.3
MBLK	1,1,1-Trichloroethane	ND	<0.50	UGL			
LCS1	1,1,2-Trichloroethane (1,1,2-T	4.0	4.36	UGL	109.0	(39-136)	
LCS2	1,1,2-Trichloroethane (1,1,2-T	4.0	3.83	UGL	95.8	(39-136)	12
MBLK	1,1,2-Trichloroethane (1,1,2-T	ND	<0.50	UGL			
LCS1	1,1-Dichloroethane	4.0	4.19	UGL	107.2	(28-167)	
LCS2	1,1-Dichloroethane	4.0	3.89	UGL	97.3	(28-167)	9.8
MBLK	1,1-Dichloroethane	ND	<0.50	UGL			
LCS1	1,2-Dichloroethane	4.0	4.31	UGL	107.7	(47-132)	
LCS2	1,2-Dichloroethane	4.0	4.01	UGL	100.2	(47-132)	7.2
MBLK	1,2-Dichloroethane	ND	<0.50	UGL			
LCS1	c-Dichloroethenes (1,2-DCE)	4.0	4.36	UGL	109.0	(0-224)	

Spikes which exceed limits and Method Blanks with positive results are highlighted by Underlining. Criteria for MS and DUP are advisory only. Batch control is based on LCS. Criteria for duplicates are advisory only, unless otherwise specified in the method.

Figure 14-4 Example QC Report Form (QC Summary)



MWH Laboratories

Laboratory
QC Summary
#141133

MWH LABS
(continued)

QC Ref #259377 - Total Organic Carbon **Analysis Date: 01/24/2005**

2501130021 ERA 3 WP120 DEMAND

QC Ref #259406 - Strontium, ICAP **Analysis Date: 01/27/2005**

2501130027 ERA 9 WP120 TRACE METALS

QC Ref #259649 - Arsenic, Total, ICAP/MS **Analysis Date: 01/28/2005**

2501130027 ERA 9 WP120 TRACE METALS

Ref #259666 - Selenium, Total, GF **Analysis Date: 01/28/2005**

2501130027 ERA 9 WP120 TRACE METALS

QC Ref #259695 - Kjeldahl Nitrogen **Analysis Date: 01/28/2005**

2501130023 ERA 5 WP120 NUTRIENTS-COMPLEX

QC Ref #259732 - Pesticides/PCBs **Analysis Date: 02/04/2005**

2501130037 ERA 19 WP120 PESTICIDES
2501130038 ERA 20 WP120 CHLORDANE
2501130039 ERA 21 WP120 TOXAPHENE

QC Ref #259810 - Carbonaceous BOD **Analysis Date: 01/26/2005**

2501130033 ERA 15 WP120 DEMAND

QC Summary - Page 7 of 12

15.0 CONTROL OF NON-CONFORMING WORK, CORRECTIVE ACTION, AND PREVENTIVE MEASURES

Corrective actions may be required when there is a failure to meet quality control acceptance criteria, or when internal or external audit samples are not acceptable. Quality control measures for which control limits are established and maintained include: LCS, duplicates, method blanks, surrogate recoveries, MS/MSD, MRLs, calibrations, continuing calibrations and sensitivity checks.

15.1. CORRECTION ACTION PROCEDURES, BY METHOD

Specific corrective actions on a method-by-method basis can be found in the Table 15-1. This SOP lists the processes and flags used to qualify data for submittal to clients. Corrective action will be initiated as a result of findings from internal or external audits, not acceptable results from performance samples, large variation from split samples and inadequate quality as determined by data validation review.

15.2. CORRECTIVE ACTION PROCEDURES, ROOT CAUSE, PREVENTIVE MEASURES, DATA QUALIFIERS, AND REPORT COMMENTS

15.2.1. Selection and Implementation of Corrective Actions

Failure to meet criteria of the LCS, surrogate spikes, internal standards, continuing calibration standards, holding time exceedance, improperly preserved samples, method blank contamination are QC failures that trigger the generation corrective actions to identify the root cause of the problem. Root causes of the problem are documented in the Quality Investigation Report (QIR).

For instance, when a matrix spike failure occurs during trace metals analysis, the analyst first checks the %RSD for the multiple measurements to see if the %RSD is less than 20%. Then the calibration verification will be checked along the calibration blank, preparation blank, and the second source LCS standard recovery. The standards and reagents preparation and expiration dates are reviewed. Spiking solutions are verified to ensure that here are no errors made in calculations and in spiking. If the MS/MSD recoveries are outside the internal QC limits and all the associated QCs for the bath are acceptable, the RPD for MS/MSD recoveries should be checked. If the RPD is found to be within the 20% criteria, the unacceptable recoveries are annotated in the report as suspect due to matrix effect. If the concentration of the background is much higher than the spiking amount the report will be annotated also. If the RPD is outside the limits, the sample that was spiked is checked visually to see if the sample is homogenous, if the sample is homogenous the batch will be reanalyzed.

15.2.2. Documentation of Corrective Actions

15.2.2.1. All corrective action taken for all QC failures is documented by generating a Quality Investigation Report (QIR). All other corrective action taken is documented on a Corrective Action Report (CAR). See Figure 15-2 for an example QIR.

Additional information is documented about the QC failures in the bench by the analyst.

15.2.2.2. Results are flagged not only for quality control failures where QIRs have been generated but also for all other QC failures that have impact on the data quality of the result. All results are flagged if data is suspect or QC was not acceptable.

15.2.2.3. Data qualifiers are used by the laboratory in reporting analytical results to flag the user about the data. Some of the qualifiers below were requested by a specific client as required in the Project's Quality Assurance Plan to ensure that the Data Quality Objectives of the project are met.

15.2.2.4. Comments on the results are provided to the clients on the final report for QC nonconformance. In addition, any QC data exceeding QC acceptance criteria are underlined to flag the user about the QC failure and its impact to the data quality of the associated samples in the batch.

15.2.2.5. Depending on the significance of nonconformance, the Client is notified by the Project Manager and work recalled if necessary. The Client is notified immediately for possible re-sampling [NELAC 5.4.9.1d)].

15.2.2.6. Where the identification of nonconformance or departure casts doubts on the laboratory's compliance with its own policies and procedures, or on its compliance with this Standard, the laboratory shall ensure that the appropriate areas of activity are audited (NELAC 5.4.10.5).

15.2.3. **Monitoring of Corrective Action**

15.2.3.1. Corrective actions implemented are monitored if corrective actions are effective to remove problem. (NELAC 5.4.10.4)

15.2.3.2. QA monitors CARs and QIRs for trends and notifies the analyst and supervisor of the need to correct the problem and implement corrective action to prevent the problem from reoccurring.

15.2.4. **Preventive Measures**

15.2.4.1. QIRs require the analyst to document preventive measures to ensure that the problems will not re-occur (NELAC 5.4.11).

15.2.4.2. Preventive action, rather than corrective action, aims at minimizing or eliminating inferior data quality or other non-conformance through scheduled maintenance and review, before the non-conformance occurs.

15.2.4.3. Preventive action includes, but is not limited to, review of QC data to indentify quality trends, regularly scheduled staff quality meetings, annual budget reviews, annual managerial reviews, scheduled column trimming, running a new LIMS in tandem with the old system to assure at least one working system, and other actions taken to prevent problems.

15.2.4.4. All employees have the authority to recommend preventive action procedures, however management is responsible for implementing preventive action.

15.3. ESTABLISHING WARNING/ACTION LIMITS

The incorporation of quality control samples and reference materials into the laboratory quality control program is of little use in maintaining overall analytical quality control unless the laboratory has established acceptance criteria for these samples. Quality control samples falling outside of these criteria serve as flags to signal the production of unacceptable data which must be rerun or reported as suspect data if re-running is not an option due to expired holding times or lack of sample volume.

15.3.1. Approach to Setting Limits

The established acceptance limits for LCS samples for all analyses performed in MWH Laboratories are available on request. They are updated at least once per year. These limits are based upon historical recoveries of LCS samples associated with specific matrices (or where LCS samples are not utilized, they are based on spike recoveries or duplicate limits for matrix specific samples).

For those cases where insufficient historical information exists to set statistically meaningful LCS or matrix specific limits, MWH Labs has set limits based on the expected performance of the analysis until historical limits can be calculated. These limits are then associated with specific control requirements to determine out of control events.

15.3.2. Documentation of Limits

15.3.2.1. Reagent Blanks - Reagent blank values must remain lower than the reported MRL (some methods require ½ or 1/3 MRL) for each analytical procedure. If an analyst notices an increase in the reagent blank which is beginning to approach this limit, the source of contamination must be investigated before further analyses are performed.

15.3.2.2. External Reference Samples - Recoveries on external reference samples must fall within the acceptance limits provided with the true values.

15.3.2.3. Internal and Surrogate Standards - As specified by the methods, internal standards are run with each of the calibration standards and the area counts are recorded on the same form as the response factors. Any standard that has an internal standard area count beyond ±50% of the average internal standard area count for all standards must be rerun to meet these criteria. Any sample with an internal standard count beyond ±50% (or as stated in the particular SOP) of the average internal standard counts for the standards must be rerun. Surrogate standards must meet the recovery limits specified in the analytical method or established historical limits, which are updated periodically.

15.3.2.4. Blind Check Samples - The results of blind check sample analyses must fall within the acceptance criteria provided with the samples.

15.3.3. LCS Control Limits

MWH Laboratories uses method acceptance limits for LCS limits in water matrix to assess analytical control. All analysts have received a copy of these acceptance limits and must ensure that their LCS sample results fall within the stated acceptable ranges. If specific control limits have not been provided for matrix spikes or duplicates, LCS criteria are used until sufficient data is generated to calculate historical limits for the MS/MSD samples for a particular matrix. Any samples associated with unacceptable LCS samples must be re-run unless other criteria are available to allow acceptance of the data without qualification. If a sample cannot be rerun due to exceeded holding times or lack of sufficient sample volume or weight, then the data must be qualified as estimated when reported to the client.

15.4. CONTROL CHARTS

MWH Laboratories collects LCS and MS/MSD data in the LIMS computer system for generation of control chart data and limits. Data can be downloaded and plotted on charts to determine trends, which may indicate problems with the analysis, or out of control events.

MWH Laboratories utilizes a Shewhart mean chart modified to percent recovery to monitor laboratory control sample bias. This procedure is referenced in the EPA Handbook for Analytical Quality Control in Water and Wastewater Laboratories (EPA-600/4-79-019), March 1979, on pages 6-2 to 6-6. Precision is monitored with control charts, but is compared to absolute limits established by the lab based on method specified limits.

Control charts for LCS and MS data are generated with the LIMS software periodically based on a maximum of 30 data points. The control chart limits are re-calculated at least annually. If analysis parameters are changed significantly or method modifications are performed, control chart limits may be re-calculated more frequently. QA reviews the limits and charts to determine whether any of the data is out-of-control. If the control charts indicate an out-of-control event, appropriate corrective action is immediately taken to bring the analysis back into control. An example of the Shewhart percentage recovery control chart is presented in Figure 15-4.

15.5. PROCEDURES FOR DETERMINING AND REPORTING OUT-OF-CONTROL ANALYSES

15.5.1. Defining an Out-of-Control Analysis

An analysis is out-of-control whenever a quality control sample or parameter falls outside of acceptance limits. Quality control parameters are evaluated for their acceptability on a daily basis according to established acceptance limits and are also monitored with control charts to detect trends in variability, which are indicative of a shift in the methodology due to analytical error.

15.5.1.1. Criteria Used

15.5.1.1.1. Daily Quality Controls

The quality control parameters utilized by MWH Laboratories were detailed in Section 11.1. All of these controls are evaluated on a daily basis and must pass the criteria detailed in this section. Each analyst is familiar with the criteria for his/her analyses and is responsible for insuring that all quality control parameters on the analytical run are acceptable. An analyst cannot enter his/her data into the laboratory computer until the data is reviewed and approved by an appropriately trained peer or supervisor. In addition, LCS and MS/MSD data are also entered into the computer and linked to specific batches.

LCS and MS/MSD results must fall within given acceptance limits. These limits are provided for water matrix. Reagent blanks must remain below the MRL established for each parameter. External reference samples must fall within the acceptance criteria provided with the true values. Internal and surrogate standards must meet the recoveries specified in the analytical procedure, if historical control chart based information is not available. A new working standard must be checked against the old reference standard to verify its accuracy and must fall within 10% of its true value. If this agreement is not met, a referee standard must be run. All standards must be traceable to primary standards.

Instrument calibrations must fall within acceptance criteria in order for runs to proceed. Table 11-4 summarizes the instrument's initial calibration acceptance criteria for each analysis.

In addition to monitoring daily QC parameters for acceptability, control charts are utilized and interpreted as described in Section 15.4.

15.5.1.1.2. Approaches to Control Chart Interpretation

The control charts generated by the LIMS System flags the analyst that there is a potential problem whenever seven or more consecutive points fall above or below the mean.

If the above situation is observed, the cause of the shift in mean or increased variability must be investigated, corrected, and documented prior to analyzing any more samples.

15.5.2. Responding to an Out-of-Control Event

It is important to have an operational system within MWH Laboratories for recognizing out-of-control events as soon as they occur so the appropriate action can be taken to bring the analysis back into control. This will insure that no data gets reported from a period when the analysis was out-of-control.

15.5.2.1. Roles and Responsibilities

The analyst has primary responsibility for verifying that all daily QC parameters fall within the acceptance limits before submitting the data for review. Review at the analyst level enables most errors to be caught immediately and prevents reporting delays. Following the analyst's verification, the data is reviewed by an appropriately trained peer analyst or supervisor. All of the quality control parameters are reviewed for compliance with the acceptance criteria and the calculations on the raw data forms are checked for errors in data manipulation. If the reviewer notices a problem, the analyst is notified immediately and corrective action is taken. All samples associated with unacceptable quality control samples are rerun unless there is insufficient sample, in which case the client is notified by the Client Services group [NELAC 5.4.9]. Every out of control event must be documented by filing a Quality Investigation Report (QIR). See Figure 15-2 and Figure 15-3.

The check of daily QC parameters indicates immediate problems with the data, but trends are only evident on the control charts. Both the analyst and the Group Supervisor are responsible for reviewing the control charts to see if any of the out-of-control events summarized in Section 15.5.1 have occurred. If so, the analyst must initiate corrective action before continuing with the analysis.

15.5.2.2. Defining Suspect Samples

Sample data is considered suspect if associated with unacceptable MS/MSD and LCS samples or part of an analytical run that had an unacceptable calibration or an external reference sample was out of an expected range. GC/MS data is considered suspect if the internal or surrogate standards were not recovered within the acceptable range. Sample data is also considered suspect if the reagent blank has substantially increased beyond normal range and exceeds any of the compound MRL's.

15.5.2.3. Ensuring that Suspect Data Are Not Reported

It is the ultimate responsibility of the Group Leader to ensure that suspect data are not reported. The laboratory procedures currently require that analysts may not enter their final data into the computer until their analytical data form and accompanying QC parameters have been reviewed and approved by an appropriately trained peer or supervisor. The QA Group performs periodic system audits to ensure that this procedure is working properly and prepares reports to lab management based on these audits.

15.5.2.4. Corrective Action

15.5.2.4.1. If the calibration fails, the analyst must determine whether the problem lies with the standard, the reagents, or an instrument malfunctions. This is usually determined by reviewing all of the calibration QC parameters and determining which specific parameters do not meet the criteria. For example: 1) the regression statistics and recalculated standards look fine, 2) there was little drift during the run, 3) the peaks appear satisfactory, 4) the reagent blank is low, but 5) the external reference sample was out of range, it is likely that the problem lies with the integrity of the standard used to make up the working standards and a new stock standard should be prepared.

15.5.2.4.2. If calibration appears acceptable but some of the duplicate and spiked samples are unacceptable, the analyst must determine whether there is a matrix problem interfering with the analysis or the preparatory digestion. If all of the unacceptable duplicates and spikes occur on a specific type of matrix, this is good evidence that there is a matrix interference problem. When a preparatory digestion is part of the procedure, the problem can be isolated to the digestion or the instrumental analysis by comparing the LCS, which was carried through the digestion to a LCS sample analyzed without digestion. If a matrix problem is indicated, the analyst must determine the most appropriate procedure for alleviating the interference such as diluting the sample, using standard additions, performing the analysis at a different wavelength, using a different GC column, or modifying the digestion procedure.

15.5.2.4.3. If an unacceptable result is obtained on a blind check sample, the problem must be isolated. To maintain the blind nature of the samples, the run containing the blind

check sample is reviewed by the QA Group to determine if any of the quality control parameters were unacceptable or if the sample was run outside the optimum range of the calibration. If no apparent cause of error is found, a second check sample is submitted to determine whether the error occurred during preparation of the blind check sample.

15.5.2.4.4. If an out-of-control event is indicated by a shift or trend on a control chart, the following diagnostic strategy will be applied:

15.5.2.4.4.1. A shift in the mean of the percentage recovery chart could be caused by incorrect preparation of a standard or a reagent, contamination of the sample, incorrect instrument calibration, instrument component deterioration analyst error, dirty pipettes preventing proper drainage, or other preparatory steps.

15.5.2.4.4.2. A trend of the mean upward could be caused by deterioration of the standard or the reagents or a change in the extraction efficiency

15.5.2.4.4.3. A trend of the mean downward could be caused by concentration of the standard due to evaporation, deterioration of reagents, and a change in the extraction efficiency or instrument component failure

15.5.2.4.4.4. Increased variability could be caused by switching to a different analyst, deviation from the procedure, variable extraction efficiencies

15.5.2.4.4.5. A shift in the mean or increased variability can sometimes be caused by a sample load of an unusual matrix. If this is determined to be the cause of the problem, the analysis will not be considered out-of-control but the situation will be documented.

Figure 15-1 Data Qualifiers

Revised on 6/24/09, Based on AZ Data Flag 9/20/07 Rev.3.0 and Attachment A, "Guidance on the Usage of Data Qualifiers"

MWH List

Microbiology:

A1 = Too numerous to count.
A2 = Sample incubation period exceeded method requirement.
A3 = Sample incubation period was shorter than method requirement.
A4 = Target organism detected in associated method blank.
A5 = Incubator/water bath temperature was outside method requirements.
A6 = Target organism not detected in associated positive control.
A7 = Micro sample received without adequate headspace.
A8 = Plate count was outside the method's reporting range. Reported value is estimated.

Method/ calibration blank:

Apply appropriate qualifier to affected analyte in the blank if target analyte is not detected at > RL in the samples. If analytes are detected, then all corresponding analytes for the associated samples should also be qualified.

B1 = Target analyte detected in method blank at or above the method reporting limit.

B2 = Non-target analyte detected in method blank and sample, producing interference.

B3 = Target analyte detected in calibration blank at or above the method reporting limit.

B4 = Target analyte detected in blank at or above method acceptance criteria.

B5 = Target analyte detected in method blank at or above the method reporting limit, but below trigger level or MCL.

B6 = Target analyte detected in calibration blank at or above the method reporting limit, but below trigger level or MCL.

B7 = Target analyte detected in method blank at or above method reporting limit. Concentration found in the sample was 10 times above the concentration found in the method blank.

BA = Target analyte detected in method blank at or above the laboratory minimum reporting limits (MRL), but analyte not present in the sample.
BE= Target analyte detected in method blank is above the method acceptance limits.
BF= Target analyte detected in method blank is above the method acceptance limits, but analyte not present in the sample.
BG = Target analyte detected in method blank (MB) is above the method acceptance limits. Sample concentration was 10 times above the concentration found in MB.

Confirmation:

For methods that require qualitative confirmation. C3 applies to methods that require quantitative confirmation.

C1 = Confirmatory analysis not performed as required by the method.
C3 = Qualitative confirmation performed.
C4 = Confirmatory analysis was past holding time.
C5 = Confirmatory analysis was past holding time. Original result not confirmed.
C8 = Sample RPD between the primary and confirmatory analysis exceeded 40%. Per EPA Method 8000C, the lower value was reported as there was no evidence of chromatographic problems.

Dilution:

If all analytes are reported from the diluted sample, apply qualifier to the entire sample. Otherwise apply qualifier to each analyte that required dilution.

D1 = Sample required dilution due to matrix.
D2 = Sample required dilution due to high concentration of target analyte.
D4 = Minimum Reporting Limit (MRL) adjusted to reflect sample amount received and analyzed.
D5 = Minimum Reporting Limit (MRL) adjusted due to sample dilution; analyte was non-detect in the sample.
D6 = Minimum Reporting Limit (MRL) adjusted due to an automatic 10X dilution performed on this sample for the purpose of reporting traditional drinking water analytes for wastewater requirements.
DA = Sample dilution required due to insufficient sample.

Estimated concentration:

Appropriate qualifier must be used for any analyte result reported outside the calibration range. Affects data reported outside the calibration range or down to the MDL. E8 is only required if additional clarification is necessary.

E1 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not possible due to insufficient sample.
E2 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to sample matrix.
E3 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to holding time requirements.

E4 = Concentration estimated. Analyte was detected below laboratory minimum reporting limit (MRL).
E5 = Concentration estimated. Analyte was detected below laboratory minimum reporting limit (MRL), but not confirmed by alternate analysis.
E6 = Concentration estimated. Internal standard recoveries did not meet method acceptance criteria.
E7 = Concentration estimated. Internal standard recoveries did not meet laboratory acceptance criteria.
E8 = Analyte reported to MDL per project specification. Target analyte was not detected in the sample.
EA = Concentration estimated. Analyte was detected below laboratory minimum reporting limits but above laboratory method detection limits.
EB = Result estimated. Analyte exceeded the highest calibration standard as required by the EPA/SM method
ED = Result estimated. Analyte was detected outside of calibration range as specified by the EPA/SM method.

Hold time:

Qualify samples appropriately when method extraction and/ or analysis holding time have been exceeded.

H1 = Sample analysis performed past holding time. Data not acceptable for regulatory compliance

H2 = Initial analysis within holding time. Reanalysis for the required dilution was past holding time.

H3 = Sample was received and analyzed past holding time. Data not acceptable for regulatory compliance.
H4 = Sample was extracted past required extraction holding time, but analyzed within analysis holding time.
H5 = This test is specified to be performed in the field within 15 minutes of sampling; sample was received and analyzed past the regulatory holding time.
HA= Initial analysis within holding time. Reanalysis was past holding time.

BOD/DBOD:

Qualifiers K4, K5, K6 & K8 indicate situations that may impact all results in an analytical run and should be used to qualify all affected samples as well as any affected quality control samples when reported. K3 was deleted because if the seed depletion was out, then the situation must be explained in the case narrative.

K1 = The sample dilutions set-up for the BOD/CBOD analysis did not meet the oxygen depletion criteria of at least 2 mg/L. Any reported result is an estimated value.
K2 = The sample dilutions set up for the BOD/CBOD analysis did not meet the criteria of a residual dissolved oxygen of at least 1 mg/L. Any reported result is an estimated value.
K5 = The dilution water D.O. depletion was > 0.2 mg/L.
K6 = Glucose/glutamic acid BOD/CBOD was below method acceptance criteria.
K7 = A discrepancy between the BOD and COD results has been verified by reanalysis of the sample for COD.
K8= Glucose/glutamic acid BOD/CBOD was above method acceptance levels.
KA = The seed depletion was outside the method and laboratory acceptance limits. The reported result is an estimated value.

Laboratory fortified blank/blank spike:

Appropriate qualifier must be applied to the affected analytes in the Laboratory fortified blank/blank spike and to all corresponding analytes in the associated samples.

L1 = The associated blank spike recovery was above laboratory acceptance limits.
L2 = The associated blank spike recovery was below laboratory acceptance limits.
L3 = The associated blank spike recovery was above method acceptance limits.
L4 = The associated blank spike recovery was below method acceptance limits.

LA = The associated blank spike recovery was above laboratory acceptance limits. Analyte is only qualitatively identified.
LB = The associated blank spike recovery was below laboratory acceptance limits. Analyte is only qualitatively identified.
LD = Associated blank spike recovery was within the marginal exceedence limits of the LCS.
LE = MRL Check recovery was above laboratory acceptance limits.
LF = MRL Check recovery was below laboratory acceptance limits.
LG = MRL Check recovery was above method acceptance limits.
LH = MRL Check recovery was below method acceptance limits.
LI = The associated blank spike recovery was above method acceptance limits. This target analyte was not detected in the sample.
LJ = The associated blank spike recovery was below method acceptance limits. This target analyte exceeded a maximum regulatory limit/decision level.

Matrix spike:

Appropriate qualifier must be applied to the affected analytes in the matrix spike and should also be added to all corresponding analytes in the associated spiked sample. If a batch spike recovery is outside of the acceptable range, it is permissible to only flag the sample that was spiked and

not the other samples in the batch. As required in the Arizona Adopted Rules A.A.C. R9-14-617.F, clients must always be informed if the batch QC result is unacceptable whether one of their samples was spiked or not. The laboratory can choose how the unacceptable QC is reported to the client (e.g., cover letter or flag). The ADEQ policy 0154.000 can be accessed at http://www.azdeq.gov/function/business/download/spike8.pdf

M1 = Matrix spike recovery was high; the associated blank spike recovery was acceptable.
M2 = Matrix spike recovery was low; the associated blank spike recovery was acceptable.
M3 = The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to spike level. The associated blank spike recovery was acceptable.
M4 = The analysis of the spiked sample required a dilution such that the spike recovery calculation does not provide useful information. The associated blank spike recovery was acceptable.
M5 = Analyte concentration was determined by the method of standard addition (MSA).
M6 = Matrix spike recovery was high. Data reported per ADEQ policy 0154.000.
M7 = Matrix spike recovery was low. Data reported per ADEQ policy 0154.000.

MC = Matrix spike recovery was high; the associated blank spike recovery was acceptable. MS/MSD RPD met acceptance criteria
MD = Matrix spike recovery was low; the associated blank spike recovery was acceptable. MS/MSD RPD met acceptance criteria

General:

Use for events that cannot be described by the approved data qualifiers.

N1 = See case narrative.
N2 = See corrective action report.
N4 = The Minimum Reporting Limit (MRL) verification check did not meet the laboratory acceptance limit.
N5 = The Minimum Reporting Limit (MRL) verification check did not meet the method acceptance limit.
N6 = Data suspect due to quality control failure, reported per data user's request.

Sample Quality:

Flag samples with appropriate qualifier when sample quality may be potentially impacted or when method requirements were not met. The ADEQ policy 0154.000 can be accessed at http://www.azdeq.gov/function/business/download/spike8.pdf

The ADEQ policy 0155.000 can be accessed at
http://www.azdeq.gov/function/business/download/one_pt3.pdf

Q1 = Sample integrity was not maintained. See case narrative.
Q2 = Sample received with head space.
Q3 = Sample received with improper chemical preservation.
Q4 = Sample received and analyzed without chemical preservation.
Q5 = Sample received with inadequate chemical preservation, but preserved by the laboratory.
Q6 = Sample was received above recommended temperature.
Q7 = Sample inadequately dechlorinated.
Q8 = Insufficient sample received to meet method QC requirements. Batch QC requirements satisfy ADEQ policies 0154.000 and 0155.000.
Q9 = Insufficient sample received to meet method QC requirements.
QP = AZ Q10-Sample received in an inappropriate sample container.
QQ = AZ Q11-Sample is heterogeneous. Sample homogeneity could not be readily achieved using routine laboratory practices.

QA = Sample received with incomplete documentation (ID).
QB = Sample received with improper sample label (ISL).
QC = Sample received with signs of damage or contamination (SDC).
QD = Same day sample receipt / sampling time but sample was received with no signs of chilling (c). (SRNC).
QE = Sample was received above method required temperature. Data not acceptable for regulatory compliance.
QF = Sample received without sufficient head space for proper mixing according to the method.

RPD Duplicates:

For use with sample, matrix spike, LFB and LCS duplicates. Qualify all affected analytes. For MS/MSD or sample duplicates qualify only the original source sample.

R1 = RPD/RSD exceeded the method acceptance limit.
R2 = RPD/RSD exceeded the laboratory acceptance limit.
R4 = MS/MSD RPD exceeded the method acceptance limit. Recovery met acceptance criteria.
R5 = MS/MSD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.
R6 = LFB/LFBD RPD exceeded the method acceptance limit. Recovery met acceptance criteria.

R7 = LFB/LFBD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.
R8 = Sample RPD exceeded the method acceptance limit.
R9 = Sample RPD exceeded the laboratory acceptance limit.
RA= MS/MSD RPD exceeded the method acceptance limit. Recovery did not meet acceptance criteria.
RB = MS/MSD RPD exceeded the laboratory acceptance limit. Recovery did not meet acceptance criteria.
RC = Low precision due to analyte concentration close to the MRL.

Surrogate:

Qualify surrogates appropriately when they do not meet criteria. Surrogate failures in quality control samples will most likely require additional narration. S11 & S12 are used to qualify sample surrogates and only in cases where the Laboratory Fortified Blank/LCS has acceptable surrogate recoveries.

S6 = Surrogate recovery was below laboratory and method acceptance limits. Re-extraction and/or reanalysis confirms low recovery caused by matrix effect.
S7 = Surrogate recovery was below laboratory and method acceptance limits. Unable to confirm matrix effect.
S8 = The analysis of the sample required a dilution such that the surrogate recovery calculation does not provide any useful information. The associated blank spike recovery was acceptable.
SP = AZS10- Surrogate recovery was above laboratory and method acceptance limits.
SQ = AZS11- Surrogate recovery was high. Data reported per ADEQ policy 0154.000.
SR = AZS12- Surrogate recovery was low. Data reported per ADEQ policy 0154.000.

SA = Surrogate recovery was above laboratory and method acceptance limits. Re-extraction and or re-analysis confirms high recovery caused by matrix effect.
SB = Surrogate recovery was above laboratory and method acceptance limits. Unable to confirm matrix effect.
SC = The analysis of the sample required a dilution such that the surrogate concentration was diluted below the laboratory acceptance criteria. The associated blank spike recovery was acceptable.

Method/analyte discrepancies:

For use with methods or analytes that are not currently approved under the Environmental Laboratory Licensure Rules.

T4 = Tentatively identified compound. Concentration is estimated and based on the closest internal standard.
T5 = Laboratory not licensed for this parameter.
T6 = The reported result cannot be used for compliance purposes.
T7 = Incubator/Oven temperatures were not monitored as required during all days of use.

Calibration Verification:

Appropriate qualifier must be applied to all affected analytes in any samples associated with the calibration verification. The ADEQ policy 0155.000 can be accessed at http://www.azdeq.gov/function/business/download/one_pt3.pdf

V1 = CCV recovery was above method acceptance limits. This target analyte was not detected in the sample.
V2 = CCV recovery was above method acceptance limits. This target analyte was detected in the sample. The sample could not be reanalyzed due to insufficient sample.
V3 = CCV recovery was above method acceptance limits. This target analyte was detected in the sample, but the sample was not reanalyzed.
V9 = CCV recovery was below method acceptance limits.
VA = Closing standard recovery was above laboratory limits. Closing standard not required by method.
VB = Closing standard recovery was below laboratory limits. Closing standard not required by method.
VC = CCV is high biased, ND data are reportable as per NELAC 5.5.5.10
VF = CCV recovery was below method acceptance limits. The sample could not be reanalyzed due to insufficient sample.
VG = CCV recovery was below method acceptance limits. The sample result exceeded a maximum regulatory limit/decision level.

Internal Standards

IC = CCV Internal Standard recovery was above laboratory and method limits.
ID = CCV Internal Standard recovery was below laboratory and method limits.
IE = Trip Blank Internal Standard recovery was above laboratory and method limits.
IF = Trip Blank Internal Standard recovery was below laboratory and method limits.

Field / trip blank

FA = Target analyte detected in trip blank above the laboratory minimum reporting limit (MRL).

MWH General

NA = The sample was not analyzed
NR = The sample was analyzed but the results not reported due to failure of QC to meet method acceptance limits.

Other States/Clients' Requirements

J = Analyte is positively identified, but tentatively quantified. The reported value is an estimate concentration of the analyte in the sample. The analyte was either detected between MDL and MRL or did not meet any one of the required QC criteria. (MA - CLO4 requirements)

(San Bernardino J Flag)
JA = Detected, not quantified. Estimated Concentration.

(LADWP DNQ Flag)
DN = Detected, not quantified. Estimated Concentration.

Table 15-1 Example Summary of Corrective Action Procedures

Analysis Method	Item	Control Limits	Acceptance Criteria	Corrective Action
Volatile Organics	624	Sensitivity check Ion abundance with BFB	Tune instrument, criteria, see Table 11-3	repeat
		Initial calibration	All analytes RF< 35% RSD	Re-calibrate instrument
		Continuing calibration (QC Check Standard)	All analytes must meet % R as specified in Table 5 of Method 624	Rerun continuing calibration
		Method blank	<MRL	Determine cause of blank problem, reprep set if necessary
		Spiked samples (MS/MSD)	All analytes must meet % R as specified in Table 5 of Method 624	If LCS is in control, qualify LFM data, reprep set if necessary
		Duplicates (Dup)	RPD < than control limits	Re-prep and reanalyze
		Laboratory control samples (LCS)	All analytes must meet % R as specified in Table 5 of Method 624	Re-analyze batch
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
		Surrogate recovery	% R as specified in SOP	Re-prep and reanalyze
Base/Neutral/Acid Extractable Organics	625 with DFTPP	Sensitivity check Ion abundance with BFB	Tune instrument, criteria, see Table 11-3	repeat
		Initial calibration	RF<35% RSD	Re-calibrate
		Continuing calibration	RF ± 20%	Rerun continuing calibration, is still out, re-calibrate instrument
		Method blank	<MRL	Investigate problem, reprep set if necessary
		Spiked samples/LFM	All analytes must meet % R as specified in Table 6 of the method	If LCS in control, qualify LFM data, Reprep set if necessary.
		Laboratory control samples (LFB)	All analytes must meet % R as specified in Table 6 of the method	Re-analyze batch
		Surrogate recovery	% R as specified in SOP	Re-prep and reanalyze
Cyanide	335.4/ 9012B	Initial calibration	r >0.995	Repeat ICAL
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
Phenolics	420.1/ 420.4	Calibration blank	<MRL	Investigate problem, re-digest set if necessary

Analysis Method	Item	Control Limits	Acceptance Criteria	Corrective Action
		Continuing calibration	±10% of the expected value	Rerun continuing calibration, is still out, re-calibrate instrument and rerun samples from last CCV.
		Method blank	<MRL	Investigate problem, re-digest set if necessary
		Laboratory control samples (LFB)	% R of analyte within control limits of the method (90-110)	Re-digest and re-analyze batch
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
		Spiked samples/LFM	%R (90-110)	If LCS in control, qualify LFM data, Reprep set of samples if necessary.
		Duplicates (Dup)	RPD < than control limits	Re-prep and reanalyze
Total Dissolved Solids, TDS	SM 2540C	Balance check	Expected value within 0.01% of balance	Re-calibrate
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
		RPD for reweighing	<4% difference	Reweigh till weight difference is <4% or 0.5mg
Total Suspended Solids, TSS	SM 2540D	Balance check	expected value within 0.01% of balance	Re-calibrate
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
Total Solids, TS	SM 2540B	Balance check	expected value within 0.01% of balance	Re-calibrate
Total Volatile Residue, TV	160.4	Method blank	<MRL	Investigate root cause of blank problem. Reprep set if necessary.
Total Settleable Solids, TSS	SM 2540F			
pH	SM 4500 H+B/ EPA 150.1	3 buffers	within 0.1 pH unit of true value	Re-calibrate instrument
		Duplicates	RPD < than control limits	Re-prep duplicates and reanalyze

Analysis Method	Item	Control Limits	Acceptance Criteria	Corrective Action
	(DW only)	Laboratory control samples (LFB)	% R within control limits of the method	Re-analyze batch
Anions: Perchlorate BrO3, ClO2,ClO3, Cl,NO3, NO2, PO4,SO4	300.0/ 300.1/ 314/ 317	Calibration curve	r ≥ 0.995	Rerun calibration
		Continuing calibration Verification,/LCS/LFB	90-110 % Rec	Recalibrate, rerun last
		Spiked samples/LFM	Must meet 80-120 % R	If LFB in control, no action taken
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
		Method Blank	< ½ MRL	Identify and eliminate source of problem. Do not do further sample analysis until contamination problem is resolved.
Anions: Perchlorate BrO3,ClO2,ClO 3,Cl,NO3, NO2, PO4, SO4	300.0/ 300.1/ 314/ 317	Method Blank	< ½ MRL	Repeat sample prep using another source of reagent if contamination is found to be due to the Reagents used.
TOC	SM 5310C	Calibration curve	r ≥ 0.995	Rerun calibration
		Continuing calibration Verification, /LCS/LFB	90-110 % Rec	Recalibrate, rerun last 10 samples between the failing standard and the last standard meeting the acceptance
		MS/LFM	80-120 %	If LFB in control, no action taken
		Method Blank	< MRL	Identify and eliminate source of problem. Do not do further sample analysis until contamination problem is resolved. Repeat sample prep using another source of reagent if contamination is found to be due to the Reagents used.
		Lab Duplicate	≤ 10 % (TOC ≥ 2.0 mg/L)	Reanalyze sample, if it cannot be reanalyzed,

Analysis Method	Item	Control Limits	Acceptance Criteria	Corrective Action
			≤ 20 % (TOC ≤ 2.0 mg/L)	flag sample not meeting QC criteria.
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
TOX	SM5320	Initial calibration Curve	r >0.995	Repeat ICAL
		Continuing calibration	±10% of the expected value	Rerun continuing calibration, is still out, re-calibrate instrument and rerun last 10 samples.
TOX (con't)	SM5320	Spiked samples/LFM	% R within the control limits	If LCS in control, qualify LFM data, Reprep set of samples if
		Method blank	< ½ MRL	Investigate problem, re-analyze set of samples if necessary
		Duplicates, (all samples)	RPD 15% <100 ppb RPD 10% >100 ppb	Re-analyze to determine if matrix problem
		Laboratory control samples (LFB)	% R within control limits of the method	Re-analyze batch
Mercury by Cold Vapor AAS	245.1/7470A/ 7471A	Initial calibration verification/IPC	± 5% of the expected value	Re-calibrate
		Continuing calibration	±10% of the expected value	Rerun continuing calibration, is still out, re-calibrate instrument and rerun last samples from last Calibration Check
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
		Method Blank	< ½ MRL	Investigate problem, re-digest set of samples if necessary
		Duplicates	RPD < than control limits	Re-prep duplicates and re-analyze
		Spiked samples/LFM	% R within the control limits	If LCS in control qualify LFM data, Reprep set of samples if necessary.
		Laboratory control samples (LFB)	% R within control limits of the method	Re-prep and re-analyze batch

Analysis Method	Item	Control Limits	Acceptance Criteria	Corrective Action
ICP Metals:	200.7/ 6010	Standard validation	± 5% of the expected value	Purchase new concentrates
		Initial calibration verification/IPC	95-105% Rec	Rerun calibration standards
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or respeat tet.
ICPMS Metals	200.8	Calibration blank	<MDL	Investigate problem, re-run blank
		Continuing calibration	±10% of the expected value	Rerun standards, is still out, re-calibrate instrument and rerun samples from last CCV.
		Method blank	< ½ MRL	Investigate problem, re-digest set if necessary
		Spiked samples/LCS	% R within the control limits	If LCS in control qualify LCS data, Reprep set of samples if necessary.
		Laboratory control samples (LCS)	% R within control limits of the method	Re-prep and re-analyze batch
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
Cr VI (Dissolved)	218.6	Initial Calibration	r≥ 0.995 or greater	Identify problem and rerun ICAL
		IPC (CCV)	95-105%	Perform another LPC. If failed again, recalibrate and reanalyze previous 10 samples
		LRB	< ½ MRL	Correct source of contamination and reanalyze sample.
		LFB/QCS (external source)	90-110 %	Procedure is out of control, identify source of problem and resolve before continuing analysis

Analysis Method	Item	Control Limits	Acceptance Criteria	Corrective Action
		LFM	90-110%	If failed but LFB passed, problem is matrix related Flag unspiked sample as "suspect matrix"
Cr VI (Dissolved) (con't)	218.6	LFMD	90-110%/10% RPD	If failed but LFB passed, Problem is matrix related Flag unspiked sample
		QCS LDR	90-110% minimum 7stds	See LFB Start of Program
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
HAAs	6251 B	Initial Calibration Curve	RSD< 20% r ≥ 0.995	If r < 0.995, use second order fit as calibration curve. Check for error if % RSD exceeds 30 %.
		Method blank	< ½ MRL	Identify and eliminate source of problem. Do not do further sample analysis until contamination problem is resolved. Repeat sample prep using another source of reagent if contamination is found to be due to the Reagents used.
		Laboratory control samples LCS/LFB/CCV)	Low ± 50% High ± 15%	If primary column results fail, use results from secondary. If both fail, re-analyze. If repeat fails, re-extract.
		LFM/LCS	Same as LCS/LFB	If LFB is in control, no action taken
		Surrogate recovery	70-130 % Rec	Re-analyze the samples
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
UV 254	SM 5910 B	Calibration curve	90-110 % Rec.	Rerun Calibration

Analysis Method	Item	Control Limits	Acceptance Criteria	Corrective Action
		Method blank	< ½ MRL	Identify and eliminate source of problem. Do not do further sample analysis until contamination problem is resolved. Repeat sample prep using another source of reagent if contamination is found to be due to the Reagents used.
		CCV	90-110%	Rerun continuing calibration, is still out, re-calibrate instrument and rerun last 10 samples between the failing standard and the last standard meeting the acceptance criteria.
		Mid/High Verification	85-115 %	
		LCS/LFB Low	75-125 %	
		Lab Duplicate	< 20 % (UV254 ≤ 0.045 cm-1) < 10 % (UV254 > 0.045 cm–1)	Reanalyze sample. If cannot be reanalyzed, flag not meeting QC criteria.
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
Residual Chlorine	SM 4500 Cl-G	LCS/LFB	85-115 %	Rerun standard. Prepare new standard, if needed.
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
		Duplicate	≤20 % RPD	Reanalyze sample.
Organohalide Pesticides and PCB	505	Instrument Performance	CCV 80-120% Recovery	Determine the cause and eliminate the problem; if necessary, generate a new curve or set of cal factors to verify the decreased response before searching for problem source.

Analysis Method	Item	Control Limits	Acceptance Criteria	Corrective Action
Organohalide Pesticides and PCB (Con't)	505	Endrin breakdown	< 20 % degradation	Perform routine maintenance. Consistent breakdown suggests breakdown occurrence in instrument system; methodology is in control, correct for potential background concentration.
		IDC	%R = 70-130% RSD ≤ 20 %	Source of problem identified and resolved before continuing analysis.
		LFB	%R = 70-130% (need control charts after 30 data points per lab performance)	Source of problem identified and resolved before continuing analysis.
		Initial Calibration Curve	% RSD < 20	Repeat test using a fresh cal std. If results still not agree, generate a new calibration curve.
		Continuing Calibration verification Standard	80-120 %	Reanalyze sample extracts for the suspected field sample analytes after acceptable cal is restored.
		LRB	< MRL	Determine source of contamination and eliminate interference before processing sample.
		LFM	% R = 65-135%	If lab performance is shown to be in control, problem is matrix-related, not system-related. Label result suspect/matrix to inform data user the results are suspect due to matrix effects.
Organohalide Pesticides and PCB (Con't)	505	LFMD	not required 20 % RPD (initial guidance)	

Analysis Method	Item	Control Limits	Acceptance Criteria	Corrective Action
		QCS	70 – 130 %	Done quarterly. Source of problem identified and resolved.
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
Volatiles, DIPE TAME, ETBE	524.2	Sensitivity check Ion abundance with BFB	Tune instrument, criteria, see Table 11-3 by GCMS	Retune Instrument. Ionizer may need to be cleaned before criteria can be met.
		Initial calibration	rf < 20% RSD, r > 0.995	Re-calibrate instrument. Prepare new standard and analyze.
		Continuing calibration (QC Check Standard)	70-130%	Rerun continuing calibration. prepare new CCV std and re-analyze.
			80-120% (TCP)	
		Lab blank	< ½ MRL	Reanalyze. If blank cannot be reanalyzed, flag associated data when samples have hits > MRL.
			< MRL (TCP)	(TCP: source of contamination investigated and measures taken to correct, minimize, or eliminate problem)
		Lab Duplicates (Dup)	< 20 % RPD	Re-prep and reanalyze
		Laboratory control samples (LCS/LFB)	70-130%	Re-analyze batch
			80-120% (TCP)	Problem resolved before additional samples may be reliably analyzed
		Surrogate recovery	80-120 % (initial demonstration of capability , IDOC) 70-130 % (CCV, samples)	Re-prep and reanalyze
		MRL Check	50-150%	MRL check high, flag data. Out low adjust MRL or repeat test.
Trihalomethanes /Chloral Hydrate/ Haloacetonitrile	551.1	Initial calibration curve (5 standards, one std. at MDL conc) (Extracted)	≤ 10 % RSD	recalibrate if fails criteria

Analysis Method	Item	Control Limits	Acceptance Criteria	Corrective Action
		Lab Performance Check	Table 7 of the method	Failed LPC, reevaluate the instrument system, if performance Criteria not met, install new column, correct column flows
		Endrin Breakdown	< 20 %	Perform routine maintenance In the injection port; replace injection port sleeve & all Associated seals & septa.
		Calibration Verification (CCV=LFB) (2 different conc. levels) (MLFB & HLFB)	% R = 80-120 % 90 % analytes & 75-125 % for all analytes	Reanalyze CCV. If failed again recalibrate & the previous samples reanalyzed or analytes out of acceptable range should be reported suspect to the data user.
		LRB	< MRL	Determine source of contamination & eliminate the interference before processing samples
		LFB/CCV	% R = 80-120% -90 % analytes 75-125 % -for all analytes	Reanalyze CCV. If failed again recalibrate & the previous samples reanalyzed or analytes out of acceptable range should be reported suspect to the data user.
		LFM	80-120%	When analyte recovery fails LFM criteria, a bias is concluded & analyte for that matrix is reported to the data user
		LFM/Duplicate	See Sample Duplicate	
Trihalomethanes /Chloral Hydrate/ Haloacetonitrile (Con't)	551.1	Sample Duplicate	RPD <20 for 90% of analytes, RPD <25% for all analytes	If failing, repeat analyses. Upon repeated failure, sampling must be repeated or analyte out of control must be reported as suspect to the data user.

Analysis Method	Item	Control Limits	Acceptance Criteria	Corrective Action
		Surrogate	80-120 % Recovery	Deviations in surrogate recovery may indicate a problem: Renalyze extract if extraction upon reanalysis, recovery is failing extract fresh sample. If not, data for all analytes from the sample should be reported as suspect.
		CCV Surrogate	80-120% Recovery	Recalibrate if fails criteria
		Sample Peak	Within the linear range of calibration curve	Dilute final extract and reanalyze

Note: Refer to individual SOPs for detailed corrective action procedures for all methods.

Figure 15-2 Sample Quality Investigation Report (QIR)

Received by Supervisor on 27-feb-2007
QIR initiated by:jwc

QUALITY INVESTIGATION REPORT QIR No.: GCMS_197165

Analysis date: NA
Analyst: NA
Method reference: EPA 526
Analytical instrument: NA
Extraction Date: 022307
Prepared By: jlc

Group	Sample#	Sample ID	Customer	QC Ref	Test	PM
196056	2702140073	070212-2 THROCKMORTO	MARIN		@UCM526	JCH
196056	2702140136	070212-10 MILLER CRE	MARIN		@UCM526	JCH
196056	2702140135	070212-9 OAK MANOR T	MARIN		@UCM526	JCH

Brief Description:(include reason for non-compliance-Root Cause)

Corrective Action Taken/Prevention:

Impact on Data Quality:

Data Disposition/Acceptable/Method/Regulations:

Client Contact:

Figure 15-3 Quality Investigation Report (QIR) Flow Chart

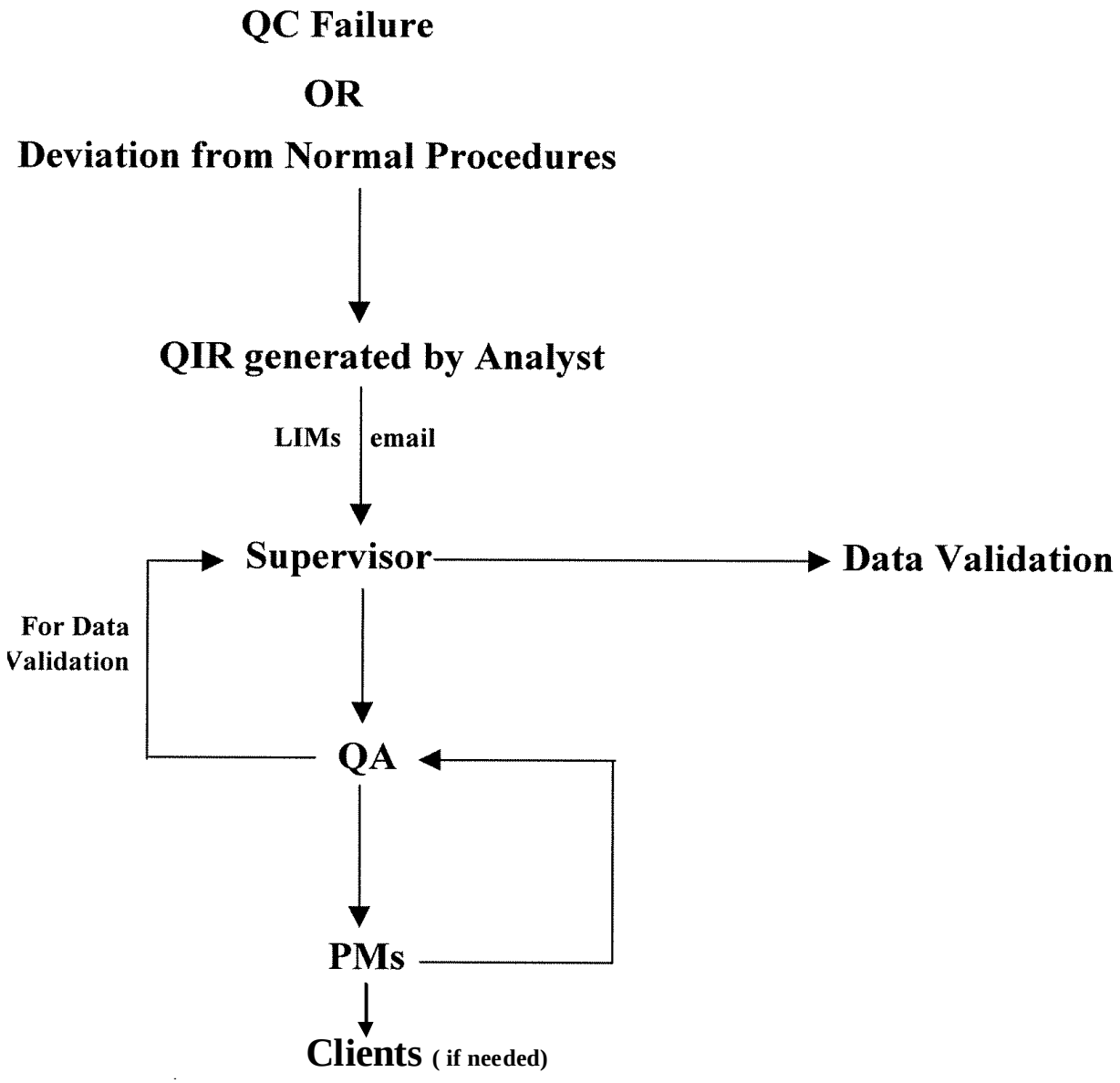
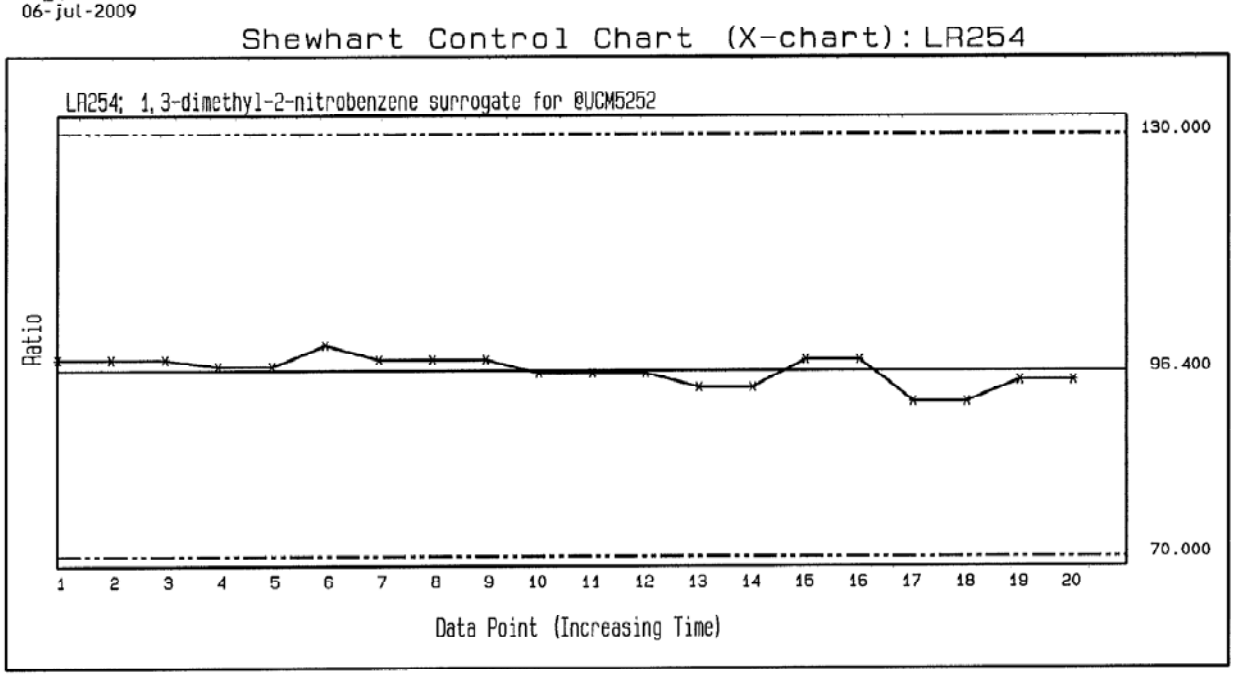


Figure 15-4 Example Surrogate Control Chart

mi_qcocc-A-3.1
06-jul-2009

Page: 1



Data Set Consisting of 20 Points
Inclusive Date Range: 12-JUN-2009 thru 30-JUN-2009
Last Updated: 31-JAN-2001 By: JDC

Historical		Calculated	
Average:	100.000	Average:	96.400
Plus Three Sigma:	130.000	Plus Three Sigma:	102.886
Minus Three Sigma:	70.000	Minus Three Sigma:	89.914

Data Point	Date	Actual	Found	Ratio	Component Lot ID#
1	12-jun-2009 15:59:00	100	98	98.000	
2	16-jun-2009 14:57:00	100	98	98.000	
3	16-jun-2009 14:57:00	100	98	98.000	
4	16-jun-2009 15:21:00	100	97	97.000	
5	16-jun-2009 15:21:00	100	97	97.000	
6	22-jun-2009 16:16:00	97.000	97.000	100.000	
7	22-jun-2009 16:40:00	100	98	98.000	
8	22-jun-2009 16:40:00	100	98	98.000	
9	22-jun-2009 16:40:00	100	98	98.000	
10	22-jun-2009 17:03:00	100	96	96.000	
11	22-jun-2009 17:03:00	100	96	96.000	
12	22-jun-2009 17:03:00	100	96	96.000	
13	24-jun-2009 13:11:00	100	94	94.000	
14	24-jun-2009 13:11:00	100	94	94.000	
15	24-jun-2009 13:34:00	100	98	98.000	
16	24-jun-2009 13:34:00	100	98	98.000	
17	30-jun-2009 11:30:00	100	92	92.000	
18	30-jun-2009 11:30:00	100	92	92.000	
19	30-jun-2009 11:53:00	100	95	95.000	
20	30-jun-2009 11:53:00	100	95	95.000	

End of Data

16.0 PERFORMANCE AND SYSTEM AUDITS/MANAGEMENT REVIEW

The QAO at MWH Laboratories is not directly involved in the production of analytical data. The QA department is responsible for an ongoing program of internal system audits and performance evaluation samples, and for coordinating all external audits and PT samples. In addition, the QA department is responsible for maintaining state and agency certifications.

16.1. INTERNAL AUDITS

The audits are carried out by the Quality Assurance Officer or designee(s) who will be independent of the activity to be audited. Also, to develop a proactive program for the detection of improper, unethical or illegal actions, the QA Officer or designee, during the internal audit procedure, includes the auditing of any improper, unethical or illegal action committed by the analyst or supervisor.

16.1.1. **Annual and Periodical Internal Audits**

16.1.1.1. The laboratory Quality Assurance Group conducts an annual lab internal audit to verify that its operations continue to comply with the requirements of the laboratory's quality system. [NELAC 5.4.13.1]

16.1.1.2. The laboratory periodically, in accordance with a predetermined schedule and procedure, conducts internal audits, at least annually, of the activities to verify that the operations continue to comply with the requirements of the quality systems of NELAC standards. The internal audit program addresses all elements of the quality system, including environmental testing and/or calibration activities. The QA Officer plans and organizes audits as required by the schedule and requested by management. Such audits are carried out by trained and qualified personnel who are independent of the activity to be audited. Personnel are trained not to audit their own activities except when it can be demonstrated that an effective audit will be carried out [NELAC 5.4.13.1].

16.1.1.3. When audit findings cast doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's environmental test or calibration results, the laboratory takes timely corrective action, and notifies the clients in writing when the investigations show that the laboratory results are affected. The laboratory notifies the client promptly, in writing of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of the results given in any test report or test certificate or amendment to a report or certificate. [NELAC 5.4.13.2].

16.1.1.4. The area of activity audited, the audit findings, and corrective actions that arise from them are recorded. The laboratory management ensures that these actions are discharge within the agreed time frame as indicated in the audit finding

documentation. Typically, corrective actions are required within 30-days after findings have been published [NELAC 5.4.13.3].

16.1.1.5. Follow up audit activities of the laboratory are conducted to verify and record the implementation and effectiveness of the corrective action taken [NELAC 5.4.13.4].

16.1.2. **Data Package Reviews**

16.1.2.1. Data package review is conducted annually by the Lab QA Officer or designee. At the start of the audit program, PT results obtained by using the drinking water, wastewater, hazardous waste methods are evaluated in order to have an objective assessment on the quality of the data generated by the lab. Annually several analytical methods i.e. at least one representative technology method from Wet Chem, Metals, Rad, GC, HPLC, GCMS, Asbestos and Microbiology are selected either from PT or client data reports for data package reviews. The laboratory ensures that at the end of the year, a representative method from each NELAC list of technology for drinking water, wastewater, and hazardous waste analysis have been reviewed. Compliance with all required QC is evaluated. A data package review checklist is used to serve as guidelines during the data package review. A report on the results of the data package review is submitted to the supervisors and the Lab Director after the data package review for corrective actions.

16.1.2.2. In addition, a response to the findings and appropriate corrective action is implemented by the supervisors to ensure continuous compliance to all method requirements. Also, to develop a proactive program for the detection of improper, unethical or illegal actions, the QA Officer or designee during the data package review includes the detection of any potential improper, unethical or illegal action by any of the lab personnel. The data integrity checklist from Arizona is used as guideline.

16.2. EXTERNAL AUDITS

16.2.1. External System audits are performed by outside agencies such as the California Department of Public Health (at least every 2 years for NELAC accreditation) and by other state agencies where MWH Laboratories is certified.

16.2.2. External audits are also conducted by the State of Arizona every 1-2 years, and Wisconsin every three (3) years. All other NELAC states recognize CA-DOH on-site assessment in accordance to NELAC secondary accreditation program. All corrective action reports audit findings and audit responses are retained by the laboratory for a minimum of 5 years (NELAC) and 10-years (Hawaii).

16.3. PERFORMANCE AUDITS

PT samples are used to provide a direct evaluation of the ability of the analytical systems to generate data that is consistent with the laboratories' stated objectives for accuracy and precision. MWH Laboratories analyzes internal PT samples as part of the ongoing QA program, while external PT samples are analyzed as part of the certification and approval process for various state and federal agencies, as well as for other organizations.

16.3.1. **Internal Performance Evaluation Samples/Internal Check Sample Program/Internal Proficiency Testing Program**

Internal PT Program is conducted as part of the corrective action process for any PT reported as unacceptable and evaluated by the PT provider as "check for error" or did not pass the PT provider's warning limits. Internal QC samples are also provided as needed as part of the analyst's initial demonstration of capability. The QA group maintains a logbook of all blind PT samples for traceability of the true and reported values. A LIMS report is generated for each QC sample logged in the LIMS system. Problem areas are reviewed as soon as they surface; the probable cause is determined as expeditiously as possible and corrective action implemented. If a severe problem with the analysis is evident, the analysis is halted until the cause is found and corrected.

16.3.2. **External Proficiency Testing (PT) Samples**

16.3.2.1. External Proficiency Testing samples are analyzed twice a year as part of the NELAP certification and approval process for various state and federal agencies.

16.3.2.2. Blind PE/PT samples are procured from NIST/NELAC Approved PE/PT Providers to include the following samples:

- Semi-annual Drinking Water PT Samples (WS series) Organic and Inorganic Samples, Coliform Microbe, HPC, and source water E.Coli
- Radiochemistry Gross Alpha, Beta , Radium 228 and Uranium PT samples
- Annual NPDES/DMR PT sample as required by EPA.
- Semi-annual Asbestos PT Samples
- Semi-annual Wastewater PT Samples (WP series)/NPDES Organic and Inorganic PT samples

16.3.3. **Proficiency Testing Protocol**

16.3.3.1. **Frequency**

16.3.3.1.1. The laboratory participates in the PT program of a NIST approved PT provider twice in each calendar year.

16.3.3.1.2. The laboratory enrolls and participates in a proficiency-testing program (PT) for each analyte or interdependent analyte group using all routine drinking water

methods. When new analytes are added to the certification, 2 successful PT studies must be performed at least "15 or 30 (for MA)" calendar days apart from closing date of one study to the shipment of another study for the same field of proficiency testing and will be completed within 18 months from the date the additional groups are added on the Laboratory Application. [NELAC STD 2.7.2].

16.3.3.2. **Laboratory Handling**

16.3.3.2.1. As per NELAC Standard Chapter 2.5, PT samples are managed, analyzed and reported in the same manner as real routine samples by utilizing the same staff, methods as used for routine analysis of that analyte, procedures, equipment, facilities, and frequency of analysis.

16.3.3.2.2. The laboratory follows the proficiency testing provider's instructions for preparing the proficiency-testing sample dilution (as needed) and analyzes the proficiency-testing sample as if it were a client sample.

16.3.3.2.3. The laboratory complies with the following prohibitions:

- Performing multiple analyses (replicates, duplicates) which are not normally performed in the course of analysis of routine samples;
- Performing increased frequency of quality control samples or initial and continuing calibrations which are not normally performed in the course of analysis of routine samples;
- Averaging the results of multiple analyses for reporting when not specifically required by the method; or
- Permitting anyone other than bona fide laboratory employees who perform the analyses on a day-to-day basis for the certified laboratory to participate in the generation of data or reporting of results.

16.3.3.2.4. The laboratory does not:

- Discuss the results of a proficiency testing audit with any other laboratory until after the deadline for receipt of results by the proficiency testing provider;
- Attempt to obtain the assigned value of any proficiency testing sample from the proficiency testing provider.
- Send proficiency testing samples or portions of samples to another laboratory to be tested; or
- Knowingly receive a proficiency-testing sample from another laboratory for analysis and fail to notify the department of the receipt of the other laboratory's sample within five business days of discovery.

16.3.3.2.5. The laboratory maintains a copy of all proficiency testing records, including analytical worksheets. The proficiency testing records include a copy of the

authorized proficiency testing provider report forms used by the laboratory to record proficiency testing results.

16.3.3.2.6. The laboratory participates in Client/State sponsored PT programs. The director of the laboratory or representatives of the laboratory provides, if needed, an attestation statement stating that the laboratory followed the proficiency testing provider's instructions for preparing the proficiency testing sample and analyzed the proficiency testing sample as if it were a client sample.

16.3.3.3. **Not Acceptable PT Results**

16.3.3.3.1. If the laboratory fails a PT sample, a corrective action plan is submitted to CA ELAP and other states requiring corrective action, such as Nevada, Maine and Massachusetts, within 30-days after receipt of PT report.

16.3.3.3.2. Corrective Action Reports are generated when non-acceptable results are reported. Data reported by the laboratory not within the warning limits and flagged as "check for error" are also investigated to determine the root cause of the problems. Internal PT samples are provided to the analyst to determine if corrective action implemented was effective to resolve the problem. Acceptable results of the internal PT samples help the analyst to determine if the analysis is in control after the implementation of the corrective action.

16.3.3.3.3. Make-up PT or supplemental PT samples are also analyzed when the laboratory fails to maintain a record of passing two out of the most recent three PT studies and wishes to re-establish its history of successful performance. Analysis dates of make up PT studies must be at least 15 calendar days from the closing date of one study to the shipment date of another study. [NELAC 2.7.3]. Since some states, such as Massachusetts requires at least 30-days apart, thus the Lab adopts the "30-days apart" requirement for Make-up samples.

16.3.3.4. **Reporting**

16.3.3.4.1. The laboratory analyzes and reports the results of the proficiency-testing test by the deadline set by the proficiency-testing provider.

16.3.3.4.2. When the PT falls below the range of the analytical method, the laboratory reports "<MRL" and does not perform special procedures to determine the low level result. [NELAC STD 2.5]

16.3.3.4.3. The laboratory reports the results of the proficiency testing test by the procedure specified by the proficiency-testing provider.

16.3.3.4.4. The laboratory notifies the approving states such as WI of the authorized proficiency testing program or programs in which it has enrolled for each analyte or interdependent analyte group.

16.3.3.4.5. The laboratory directs the proficiency-testing provider to send, either in hard copy or electronically, a copy of each evaluation of the laboratory's proficiency testing audit results to the state requiring the PT results. The laboratory allows the proficiency-testing provider to release all information necessary for the state to assess the laboratory's compliance to PT requirements.

16.3.3.5. **Remedial PT**

16.3.3.5.1. The certified laboratory participates in only one remedial proficiency-testing audit for an analyte or independent analyte group in any 12-month period to obtain or upgrade approval under this section, as per Massachusetts's PE requirements.

16.3.3.5.2. The laboratory directs the proficiency-testing provider to send, either in hard copy or electronically, a copy of each evaluation of the certified laboratory's remedial proficiency testing results to California, and all other NELAP and other non-NELAP states. The laboratory allows the proficiency-testing provider to release all information necessary for the state to assess the certified laboratory's compliance with this rule.

16.4. SYSTEM AUDITS AND MANAGEMENT REVIEW

In order to insure that the Quality Assurance program at the laboratory maintains a high profile, there are several mechanisms in place which insure that QA information is routinely conveyed to laboratory management. This includes a periodic QA report, reports on internal and external PE samples, and verbal transmittal of QA information to the Laboratory Director and group supervisors during a weekly staff meeting.

16.4.1. System Audits

System audits are performed both by external agencies, and by the laboratory Quality Assurance Group. The focus of these audits is the overall analytical "system", from login to delivery of the finished reports. The purpose of the audits is to document compliance with specified methodology contained in the SOPs.

All audit and review findings and any corrective actions that arise from them shall be documented. The laboratory shall ensure that these actions are discharged within the agreed time frame.

16.4.2. Management Review

16.4.2.1. The QAO prepares an annual QA/QC report for the Laboratory Director and Technical Directors. This report describes all the quality assurance activities conducted during the year, including performance evaluation sample results (both internal and external), holding time exceedances, de-briefing from external and internal systems audits, and a summary of all out of control events that required corrective action/preventive measures and the effectiveness of the initiated corrective action. Whenever any such quality assurance information impacts a specific analytical project, the events are immediately related to the Client Services Group, who is responsible for informing the client.

16.4.2.2. The QAO also submits the annual QC report to the Laboratory Director and Technical Directors regarding QA/QC issues. The annual QC report includes the outcome of recent internal audits, assessments by external bodies, the results of inter-laboratory comparisons of proficiency tests and corrective actions. The annual QC report also include a discussion of the lab certifications, the laboratory SOPs generated for the year including SOP updates, control charts, acceptance limits updates, QA Manual updates and data review results.

16.4.2.3. The Laboratory Director and Technical Directors perform an annual managerial review of the laboratory quality system and its testing and calibration activities to ensure its continuing suitability and effectiveness. Any necessary changes or improvements in the quality system and laboratory operations are introduced during the annual managerial review. Thus, the Laboratory Director and Technical Directors review the annual QC report, provide an overall assessment of all the QC activities stated in the annual QC report and introduce any necessary changes or improvements in the quality system and laboratory operations. The annual managerial review also takes into account changes in the volume and type of work undertaken for the previous year and feedback from clients, complaints and other relevant factors, such as resources and staff training [NELAC 5.4.14].

16.4.2.4. The QA Group conducts performance audits of the laboratory and also maintains a program of blind proficiency testing samples. Results of these blind performance samples are scored according to the methods criteria. In addition a debriefing to group leaders and the Laboratory Director is prepared by the QA group following each set of PT samples. Evaluations of any failures on external PT samples are prepared by Group Supervisors and summarized by the Quality Assurance Group for the certifying agencies, with copies conveyed to the Laboratory Director.

APPENDIX I

Arizona Certification and Approval

Arizona Department of Health Services

Division of Public Health Services
Public Health Preparedness Services
Bureau of State Laboratory Services

250 N. 17th Avenue
Phoenix, Arizona 85007-3231
(602) 364-0720
(602) 364-0759 FAX

JANET NAPOLITANO, GOVERNOR
JANUARY CONTRERAS, ACTING DIRECTOR

November 14, 2008

Andrew Eaton, Ph.D
MWH Laboratories
750 Royal Oaks Drive, Suite 100
Monrovia, CA 91016

Dear Dr. Eaton:

This is to confirm that your laboratory has fulfilled all requirements for Arizona Environmental Laboratory Licensure under the Arizona Revised Statute §§ 36.495 et.sec. and rules.

Your Arizona Environmental Laboratory License number is AZ0455, which is the number you will need to use when reporting compliance results to ADEQ or the USEPA.

If you have any questions, please do not hesitate to contact me at the above number.

Sincerely,

Barbara A Escobar

Barbara A. Escobar
Program Manager
Office of Laboratory Services
Bureau of State Laboratory Services

BAE:tdn

cc: File

Arizona Department of Health Services
Office of Laboratory Licensure, Certification & Training
250 North 17th Avenue, Phoenix, AZ 85007

Page: 1

Thursday, November 13 2008

AZ License: AZ0455 **Lab Name: MWH Laboratories, a division of MWH Amer**

Lab Director: Dr. Andrew Eaton **Phone: (626) 386-1100**

Fax: (626) 386-1139

Program HW

Parameter	EPA Method	Billing Code	Cert Date
Edb And Dbcp By Microextraction And Gc	EPA 8011	SOC5	11/12/96
Purge And Trap For Aqueous Samples	EPA 5030C	PREP2	12/05/06
Titanium	EPA 6010B	MTL3	11/10/05
Tox	EPA 9020B	MISC2	04/26/99
Vocs By Gc/Ms	EPA 8260B	VOC8	10/18/99

Total Licensed Parameters in this Program: 5

Program SDW

Parameter	EPA Method	Billing Code	Cert Date
Alkalinity	SM 2320B	NIA1	04/06/96
Aluminum	EPA 200.7	MTL3	09/30/96
Aluminum	EPA 200.8	MTL7	11/17/95
Antimony	EPA 200.8	MTL7	12/19/94
Arsenic	EPA 200.8	MTL7	12/19/94
Asbestos	EPA 100.2	MISC27	06/03/03
Barium	EPA 200.7	MTL3	11/24/93
Barium	EPA 200.8	MTL7	12/21/94
Beryllium	EPA 200.7	MTL3	01/10/94
Beryllium	EPA 200.8	MTL7	11/17/95
Bromate	EPA 300.1	NIIIA1	06/05/01
Bromate	EPA 317.0	NIA3	11/06/06
Bromide	EPA 300.0	NIIIA1	04/20/03
Bromide	EPA 300.1	NIIIA1	11/16/01
Cadmium	EPA 200.7	MTL3	11/24/93
Cadmium	EPA 200.8	MTL7	12/21/94
Calcium	EPA 200.7	MTL3	09/26/94
Carbamates By Hplc/Post Column Add	EPA 531.2	SOC34	08/14/03
Carbon, Dissolved Organic	SM 5310C	MISC1	10/23/08
Carbon, Total Organic	SM 5310C	MISC1	03/24/99
Chloramine	SM 4500 CL-G	NIA15	09/22/03
Chloride	EPA 300.0	NIIIA1	11/24/93
Chlorinated Acids	EPA 515.4	SOC3	08/14/03
Chlorinated Acids And Dalapon By Gc-Ecd Add	EPA 515.4	SOC34	10/23/08
Chlorinated Pesticides	EPA 505	SOC9	04/03/03
Chlorine	SM 4500-CL G	NIA3	04/06/96
Chlorine Dioxide	SM 4500-CL02 D	NIA17	11/16/01
Chlorite	EPA 300.0	NIIIA1	03/24/99
Chlorite	EPA 300.1	NIIIA1	03/05/01
Chlorite	EPA 317.0	NIIIA1	10/23/08

Arizona Department of Health Services
Office of Laboratory Licensure, Certification & Training
250 North 17th Avenue, Phoenix, AZ 85007

Thursday, November 13 2008

AZ License: AZ0455 **Lab Name: MWH Laboratories, a division of MWH Amer**

Program SDW

Parameter	EPA Method	Billing Code	Cert Date
Chromium Total	EPA 200.7	MTL3	11/24/93
Chromium Total	EPA 200.8	MTL7	11/17/95
Color	SM 2120B	NIA4	07/20/97
Copper	EPA 200.7	MTL3	11/24/93
Copper	EPA 200.8	MTL7	12/19/94
Corrosivity	SM 2330B	NIA5	08/16/93
Cyanide	EPA 335.4	MISC7	07/15/96
Cyanide	SM 4500 CN F	MISC7	04/06/96
Cyanide Amenable To Chlorination	SM 4500-CN G	MISC7	12/11/02
Dbps, Solvents And Pesticides	EPA 551.1	VOC9	10/25/04
Dbps,Solvents & Pesticides - Additional	EPA 551.1	VOC10	10/23/08
Diquat	EPA 549.2	SOC22	02/20/01
E. Coli By Colilert In Combo W/Total Coliform	SM 9223B	MIC15	10/23/08
Edb And Dbcp	EPA 504.1	SOC5	11/12/96
Endothall	EPA 548.1	SOC23	12/21/94
Escherichia Coli	TUBE PROCEDURE	MIC5	10/23/08
Fecal Coliform	SM 9221E	MIC5	12/11/02
Fluoride	SM 4500-F C	NIB9	07/15/96
Glyphosate	EPA 547	SOC24	11/24/93
Gross Alpha	EPA 900	RADIO	01/10/94
Gross Beta	EPA 900	RADIO	10/27/03
Haloacetic Acids	SM 6251B	SOC25	12/14/98
Hardness	EPA 200.7, CA&MG	MTL3	10/25/04
Hardness	SM 2340B	MTL3	11/24/93
Heterotrophic Plate Count	SM 9215B	MIC9	09/02/03
Hydrogen Ion (Ph)	EPA 150.1	NIA6	08/16/93
Hydrogen Ion (Ph)	SM 4500-H B	NIA6	11/30/97
Iron	EPA 200.7	MTL3	11/24/93
Lead	EPA 200.8	MTL7	12/19/94
Magnesium	EPA 200.7	MTL3	09/26/94
Manganese	EPA 200.7	MTL3	11/24/93
Manganese	EPA 200.8	MTL7	12/19/94
Mercury	EPA 245.1	MTL5	08/16/93
Nickel	EPA 200.7	MTL3	01/10/94
Nickel	EPA 200.8	MTL7	12/19/94
Nitrate	EPA 300.0	NIIIA1	11/24/93
Nitrate	EPA 353.2	NIB1	04/02/98
Nitric Acid	SM 3030E	PREP1	10/23/08
Nitric Acid/Hydrochloric Acid	SM 3030F	PREP1	10/23/08
Nitrite	EPA 300.0	NIIIA1	01/10/94
Nitrite	EPA 353.2	NIIB4	12/11/02

Arizona Department of Health Services
Office of Laboratory Licensure, Certification & Training
250 North 17th Avenue, Phoenix, AZ 85007

Page: 3

Thursday, November 13 2008

AZ License: AZ0455 **Lab Name: MWH Laboratories, a division of MWH Amer**

Program SDW

Parameter	EPA Method	Billing Code	Cert Date
Odor	SM 2150B	NIA13	10/29/03
Organics By Gc/Ms	EPA 525.2	SOC16	02/22/06
Organics By Gc/Ms - Additional	EPA 525.2	SOC34	12/05/06
Orthophosphate	EPA 365.1	NIIB5	11/17/95
Orthophosphate	SM 4500-P E	NIIB5	04/06/96
Orthophosphate	SM 4500-P F	NIIB5	03/20/08
Perchlorate	EPA 314.0	NIB5	03/30/01
Perchlorate	EPA 331.0	NIIIA1	10/23/08
Pesticides And Pcbs By Gc	EPA 505	SOC9	04/03/03
Pesticides And Pcbs By Gc - Additional	EPA 505	SOC34	10/23/08
Preliminary Filtration	SM 3030B	PREP1	10/23/08
Radium 228	EPA 904	RADIO	01/06/04
Residue, Filterable (Tds)	SM 2540C	NIIA8	04/06/96
Selenium	EPA 200.8	MTL7	12/19/94
Silica	EPA 200.7	MTL3	11/17/95
Silica	SM 4500-Si D	MISC13	11/08/02
Silica	SM 4500-SIO2C	MISC13	03/24/08
Silver	EPA 200.7	MTL3	11/24/93
Silver	EPA 200.8	MTL7	11/17/95
Sodium	EPA 200.7	MTL3	09/26/94
Specific Conductance	SM 2510B	NIA7	04/06/96
Strontium	EPA 200.7	MTL3	11/24/93
Sulfate	EPA 300.0	NIIIA1	11/24/93
Surfactant (Mbas)	SM 5540C	NIIA3	07/15/96
Thallium	EPA 200.8	MTL7	12/19/94
Total Coliforms And E. Coli By Colilert	SM 9223B	MIC3	04/02/98
Total Coliforms By Mtf	SM 9221B & C	MIC1	12/23/97
Turbidity, Ntu: Nephelometric	EPA 180.1	NIA9	02/10/98
Uranium	EPA 200.8	MTL7	09/08/04
Uv Absorbing Organic Constituents	SM 5910B	NIB6	07/10/99
Vocs By Gc-Ms	EPA 524.2	VOC1	01/15/03
Vocs By Gc-Ms-Additional	EPA 524.2	VOC10	10/23/08
Zinc	EPA 200.7	MTL3	11/24/93
Zinc	EPA 200.8	MTL7	12/19/94

Total Licensed Parameters in this Program: 105

Program WW

Parameter	EPA Method	Billing Code	Cert Date
Alkalinity, Total	SM 2320B	NIA1	04/02/98
Aluminum	EPA 200.7	MTL3	04/02/98
Aluminum	EPA 200.8	MTL7	04/02/98

Arizona Department of Health Services
Office of Laboratory Licensure, Certification & Training
250 North 17th Avenue, Phoenix, AZ 85007

Page: 3

Thursday, November 13 2008

AZ License: AZ0455 **Lab Name: MWH Laboratories, a division of MWH Amer**

Program SDW

Parameter	EPA Method	Billing Code	Cert Date
Odor	SM 2150B	NIA13	10/29/03
Organics By Gc/Ms	EPA 525.2	SOC16	02/22/06
Organics By Gc/Ms - Additional	EPA 525.2	SOC34	12/05/06
Orthophosphate	EPA 365.1	NIIB5	11/17/95
Orthophosphate	SM 4500-P E	NIIB5	04/06/96
Orthophosphate	SM 4500-P F	NIIB5	03/20/08
Perchlorate	EPA 314.0	NIB5	03/30/01
Perchlorate	EPA 331.0	NIIIA1	10/23/08
Pesticides And Pcbs By Gc	EPA 505	SOC9	04/03/03
Pesticides And Pcbs By Gc - Additional	EPA 505	SOC34	10/23/08
Preliminary Filtration	SM 3030B	PREP1	10/23/08
Radium 228	EPA 904	RADIO	01/06/04
Residue, Filterable (Tds)	SM 2540C	NIIA8	04/06/96
Selenium	EPA 200.8	MTL7	12/19/94
Silica	EPA 200.7	MTL3	11/17/95
Silica	SM 4500-Si D	MISC13	11/08/02
Silica	SM 4500-SIO2C	MISC13	03/24/08
Silver	EPA 200.7	MTL3	11/24/93
Silver	EPA 200.8	MTL7	11/17/95
Sodium	EPA 200.7	MTL3	09/26/94
Specific Conductance	SM 2510B	NIA7	04/06/96
Strontium	EPA 200.7	MTL3	11/24/93
Sulfate	EPA 300.0	NIIIA1	11/24/93
Surfactant (Mbas)	SM 5540C	NIIA3	07/15/96
Thallium	EPA 200.8	MTL7	12/19/94
Total Coliforms And E. Coli By Colilert	SM 9223B	MIC3	04/02/98
Total Coliforms By Mtf	SM 9221B & C	MIC1	12/23/97
Turbidity, Ntu: Nephelometric	EPA 180.1	NIA9	02/10/98
Uranium	EPA 200.8	MTL7	09/08/04
Uv Absorbing Organic Constituents	SM 5910B	NIB6	07/10/99
Vocs By Gc-Ms	EPA 524.2	VOC1	01/15/03
Vocs By Gc-Ms-Additional	EPA 524.2	VOC10	10/23/08
Zinc	EPA 200.7	MTL3	11/24/93
Zinc	EPA 200.8	MTL7	12/19/94

Total Licensed Parameters in this Program: 105

Program WW

Parameter	EPA Method	Billing Code	Cert Date
Alkalinity, Total	SM 2320B	NIA1	04/02/98
Aluminum	EPA 200.7	MTL3	04/02/98
Aluminum	EPA 200.8	MTL7	04/02/98

Arizona Department of Health Services
Office of Laboratory Licensure, Certification & Training
250 North 17th Avenue, Phoenix, AZ 85007

Page: 4

Thursday, November 13 2008

AZ License: **AZ0455** **Lab Name: MWH Laboratories, a division of MWH Amer**

Program **WW**

Parameter	EPA Method	Billing Code	Cert Date
Ammonia	EPA 350.1	NIIB1	12/23/97
Antimony	EPA 200.7	MTL3	04/02/98
Antimony	EPA 200.8	MTL7	04/02/98
Arsenic	EPA 200.8	MTL7	04/02/98
Barium	EPA 200.7	MTL3	04/02/98
Barium	EPA 200.8	MTL7	04/02/98
Base/Neutrals And Acids Excluding Pesticides	EPA 625	SOC16	05/09/94
Beryllium	EPA 200.7	MTL3	04/02/98
Beryllium	EPA 200.8	MTL7	04/02/98
Biochemical Oxygen Demand	SM 5210B	DEM1	11/30/97
Boron	EPA 200.7	MTL3	04/02/98
Bromide	EPA 300.0	NIIIA1	04/02/98
Cadmium	EPA 200.7	MTL3	04/02/98
Cadmium	EPA 200.8	MTL7	04/02/98
Calcium	EPA 200.7	MTL3	04/02/98
Chemical Oxygen Demand	EPA 410.4	DEM3	12/23/97
Chemical Oxygen Demand	SM 5220D	DEM2	10/27/03
Chloride	EPA 300.0	NIIIA1	04/02/98
Chlorine	HACH 8021	NIA3	10/23/08
Chlorine Residual Total	HACH 8167	NIA3	10/23/08
Chlorine Residual Total	SM 4500-CL G	NIA3	04/02/98
Chromium Total	EPA 200.7	MTL3	04/02/98
Chromium Total	EPA 200.8	MTL7	04/02/98
Chromium, Hexavalent	EPA 218.6, R 3.3 1	MTL4	11/20/07
Chromium, Hexavalent	SM 3500-CR D	MTL8	02/07/98
Cobalt	EPA 200.7	MTL3	04/02/98
Cobalt	EPA 200.8	MTL7	04/02/98
Color	SM 2120B	NIA4	07/20/97
Copper	EPA 200.7	MTL3	04/02/98
Copper	EPA 200.8	MTL7	04/02/98
Cyanide Amenable To Chlorination	SM 4500-CN G	MISC7	10/16/07
Cyanide, Total	EPA 335.4	MISC7	10/16/07
Fluoride	SM 4500-F C	NIB3	12/23/97
Gross Alpha	EPA 900	RADIO	10/18/99
Gross Beta	EPA 900.0	RADIO	10/18/99
Hardness	EPA 200.7	MTL3	10/23/08
Hardness	SM 2340B	NIA5	04/02/98
Hydrogen Ion (Ph)	SM 4500-H B	NIA6	03/10/98
Iron	EPA 200.7	MTL3	04/02/98
Kjeldahl Nitrogen	EPA 351.2	NIIB3	11/30/97
Lead	EPA 200.8	MTL7	04/02/98

Arizona Department of Health Services
Office of Laboratory Licensure, Certification & Training
250 North 17th Avenue, Phoenix, AZ 85007

Thursday, November 13 2008

AZ License: AZ0455 **Lab Name: MWH Laboratories, a division of MWH Amer**

Program WW

Parameter	EPA Method	Billing Code	Cert Date
Magnesium	EPA 200.7	MTL3	04/02/98
Manganese	EPA 200.7	MTL3	04/02/98
Manganese	EPA 200.8	MTL7	04/02/98
Mercury	EPA 245.1	MTL5	04/02/98
Molybdenum	EPA 200.7	MTL3	04/02/98
Molybdenum	EPA 200.8	MTL7	04/02/98
Nickel	EPA 200.7	MTL3	04/02/98
Nickel	EPA 200.8	MTL7	04/02/98
Nitrate	EPA 300.0	NIIIA1	04/02/98
Nitrate-Nitrite (As N)	EPA 353.2	NIB1	12/23/97
Nitric Acid	SM 3030E	PREP1	10/23/08
Nitric Acid/Hydrochloric Acid	SM 3030F	PREP1	10/23/08
Nitrite	EPA 353.2	NIIB4	10/16/07
Nitrite (As N)	EPA 300.0	NIIIA1	04/02/98
Orthophosphate	EPA 365.1	NIIB5	03/20/08
Orthophosphate	HACH 8048	NIIB8	12/05/06
Orthophosphate	SM 4500-P E	NIIB5	11/20/07
Orthophosphate	SM 4500-P F	NIIB5	03/20/08
Oxygen, Dissolved	SM 4500-O G	NIA12	10/25/04
Phenols	EPA 420.1	MISC8	12/11/02
Phosphorus Total	EPA 365.1	NIIB6	04/26/99
Phosphorus Total	SM 4500-P E	NIIB6	10/25/04
Phosphorus Total	SM 4500-P F	NIIB6	01/16/99
Potassium	EPA 200.7	MTL3	04/02/98
Preliminary Filtration	SM 3030B	PREP1	10/23/08
Purgeables	EPA 624	VOC8	05/09/94
Residue Nonfilterable	SM 2540D	NIIA5	11/30/97
Residue Total	SM 2540B	NIIA4	12/05/06
Residue Volatile	EPA 160.4	NIIA7	10/27/03
Residue, Filterable	SM 2540C	NIA8	12/23/97
Residue, Settleable Solids	SM 2540F	NIIA6	12/11/02
Selenium	EPA 200.8	MTL7	04/02/98
Semivolatile Organic By Gc/Ms	EPA 1625B	VOC8	11/06/01
Silica, Dissolved	EPA 200.7	MTL3	09/02/03
Silica, Dissolved	SM 4500-SI D	MISC13	11/08/02
Silica, Dissolved	SM 4500S-SIO2C	MISC13	10/23/08
Silver	EPA 200.7	MTL3	04/02/98
Silver	EPA 200.8	MTL7	04/02/98
Sodium	EPA 200.7	MTL3	04/02/98
Specific Conductance	EPA 120.1	NIA7	12/11/02
Specific Conductance	SM 2510B	NIA7	12/23/97

Arizona Department of Health Services
Office of Laboratory Licensure, Certification & Training
250 North 17th Avenue, Phoenix, AZ 85007

Page: 6

Thursday, November 13 2008

AZ License: AZ0455 **Lab Name: MWH Laboratories, a division of MWH Amer**

Program WW

Parameter	EPA Method	Billing Code	Cert Date
Strontium	EPA 200.7	MTL3	11/17/95
Sulfate	EPA 300.0	NIIIA1	04/02/98
Sulfide	SM 4500-S D	MISC11	12/05/06
Surfactants (Mbas)	SM 5540C	NIIA3	07/10/99
Thallium	EPA 200.7	MTL3	04/02/98
Thallium	EPA 200.8	MTL7	04/02/98
Tin	EPA 200.7	MTL3	10/18/99
Tin	EPA 200.8	MTL7	10/23/08
Titanium	EPA 200.7	MTL3	10/23/08
Titanium	EPA 200.8	MTL7	10/23/08
Total Coliforms By Mtf	SM 9221B	MIC1	04/02/98
Total Organic Carbon	SM 5310C	MISC1	04/02/98
Turbidity	EPA 180.1	NIA9	02/08/98
Turbidity	SM 2130B	NIA9	02/08/98
Vanadium	EPA 200.7	MTL3	04/02/98
Vanadium	EPA 200.8	MTL7	04/02/98
Zinc	EPA 200.7	MTL3	04/02/98
Zinc	EPA 200.8	MTL7	04/02/98

Total Licensed Parameters in this Program: 103

Instruments	Quantity	Date
GAS CHROMATOGRAPH	17	10/16/08
GAS CHROMATOGRAPH/MASS SPECTROMETER	10	10/16/08
ION CHROMATOGRAPH	9	10/16/07
HIGH PERFORMANCE LIQUID CHROMATOGRAPH	3	10/16/08
INDUCTIVELY COUPLED PLASMA/MASS SPECTROMETER	3	10/16/07
RADIATION COUNTING INSTRUMENT	2	11/25/02
AUTOMATED AUTOANALYZER	2	10/16/08
TOTAL ORGANIC HALIDE	2	10/16/07
INDUCTIVELY COUPLED PLASMA SPECTROMETER	1	11/25/02
TRANSMISSION ELECTRON MICROSCOPE	1	10/16/02
MERCURY ANALYZER	1	10/18/99

Softwares
TURBOCHROM - GC
PERKIN ELMER - ICP
PERKIN ELMER - AA
CHROMELEON (DIONEX) - IC
CHEMSTATION - GC/MS

Arizona Department of Health Services
Office of Laboratory Licensure, Certification & Training
250 North 17th Avenue, Phoenix, AZ 85007

Thursday, November 13 2008

AZ License: AZ0455 **Lab Name: MWH Laboratories, a division of MWH Amer**

TOX-10E MITSUBISHI CHEMICAL CORPORATION
PIC MDS
CHROMELEON GC
CHROMELEON HPLC
PERKIN ELMER FLOW INJECTION SYSTEM
FIMS 400

Arizona Department of Health Services

ENVIRONMENTAL LABORATORY LICENSE

Issued to:

Laboratory Director: **Andrew Eaton, Ph.D**
Owner/Representative: **Mona E. Altieri**

MWH Laboratories,
a division of MWH America
AZ0455

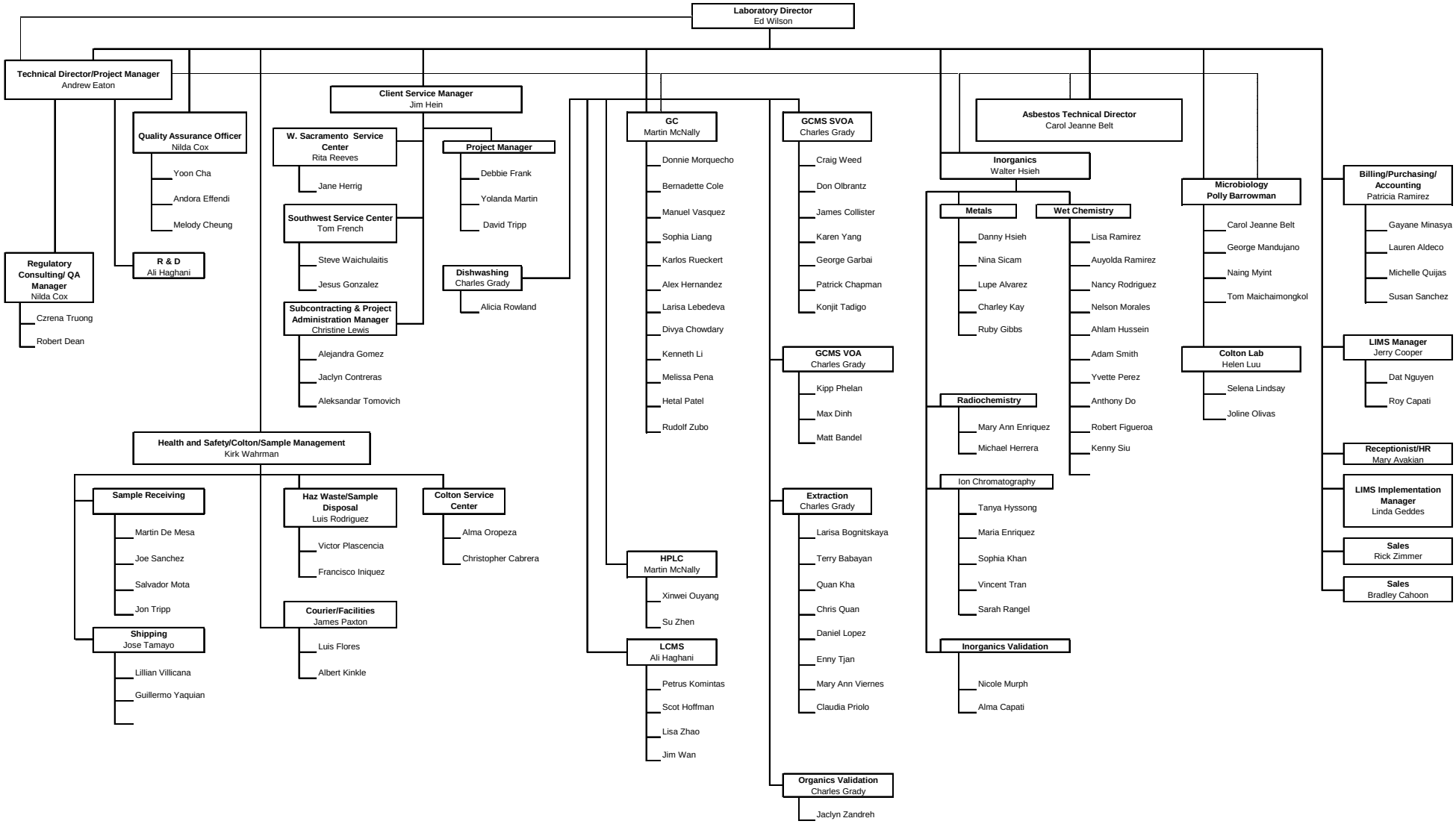
is in compliance with Environmental Laboratory's applicable standards for the State of Arizona and maintains on file a List of Parameters for which the laboratory is certified to perform analysis.

PERIOD OF LICENSURE FROM: 12/15/2008 TO: 12/14/2009

Steven D. Baker, Chief
Office of Laboratory Services
Bureau of State Laboratory Services

APPENDIX II

Laboratory Organizational Chart


Laboratory Director
Ed Wilson
Technical Director/Project Manager
Andrew Eaton
Quality Assurance Officer
Nilda Cox
Yoon Cha
Andora Effendi
Melody Cheung
Regulatory Consulting/ QA Manager
Nilda Cox
Czrena Truong
Robert Dean
R & D
Ali Haghani
Client Service Manager
Jim Hein
W. Sacramento Service Center
Rita Reeves
Jane Herrig
Southwest Service Center
Tom French
Steve Waichulaitis
Jesus Gonzalez
Subcontracting & Project Administration Manager
Christine Lewis
Alejandra Gomez
Jaclyn Contreras
Aleksandar Tomovich
Project Manager
Debbie Frank
Yolanda Martin
David Tripp
Dishwashing
Charles Grady
Alicia Rowland
Health and Safety/Colton/Sample Management
Kirk Wahrman
Sample Receiving
Martin De Mesa
Joe Sanchez
Salvador Mota
Jon Tripp
Shipping
Jose Tamayo
Lillian Villicana
Guillermo Yaquian
Haz Waste/Sample Disposal
Luis Rodriguez
Victor Plascencia
Francisco Iniquez
Courier/Facilities
James Paxton
Luis Flores
Albert Kinkle
Colton Service Center
Alma Oropeza
Christopher Cabrera
GC
Martin McNally
Donnie Morquecho
Bernadette Cole
Manuel Vasquez
Sophia Liang
Karlos Rueckert
Alex Hernandez
Larisa Lebedeva
Divya Chowdary
Kenneth Li
Melissa Pena
Hetal Patel
Rudolf Zubo
HPLC
Martin McNally
Xinwei Ouyang
Su Zhen
LCMS
Ali Haghani
Petrus Komintas
Scot Hoffman
Lisa Zhao
Jim Wan
GCMS SVOA
Charles Grady
Craig Weed
Don Olbrantz
James Collister
Karen Yang
George Garbai
Patrick Chapman
Konjit Tadigo
GCMS VOA
Charles Grady
Kipp Phelan
Max Dinh
Matt Bandel
Extraction
Charles Grady
Larisa Bognitskaya
Terry Babayan
Quan Kha
Chris Quan
Daniel Lopez
Enny Tjan
Mary Ann Viernes
Claudia Priolo
Organics Validation
Charles Grady
Jaclyn Zandreh
Asbestos Technical Director
Carol Jeanne Belt
Inorganics
Walter Hsieh
Metals
Danny Hsieh
Nina Sicam
Lupe Alvarez
Charley Kay
Ruby Gibbs
Wet Chemistry
Lisa Ramirez
Auyolda Ramirez
Nancy Rodriguez
Nelson Morales
Ahlam Hussein
Adam Smith
Yvette Perez
Anthony Do
Robert Figueroa
Kenny Siu
Radiochemistry
Mary Ann Enriquez
Michael Herrera
Ion Chromatography
Tanya Hyssong
Maria Enriquez
Sophia Khan
Vincent Tran
Sarah Rangel
Inorganics Validation
Nicole Murph
Alma Capati
Microbiology
Polly Barrowman
Carol Jeanne Belt
George Mandujano
Naing Myint
Tom Maichaimongkol
Colton Lab
Helen Luu
Selena Lindsay
Joline Olivas
Billing/Purchasing/ Accounting
Patricia Ramirez
Gayane Minasya
Lauren Aldeco
Michelle Quijas
Susan Sanchez
LIMS Manager
Jerry Cooper
Dat Nguyen
Roy Capati
Receptionist/HR
Mary Avakian
LIMS Implementation Manager
Linda Geddes
Sales
Rick Zimmer
Sales
Bradley Cahoon

APPENDIX III

Glossary
MWH Vendor List

Glossary

Calibration Blank (CB) –
A volume of reagent water fortified with the same matrix as the calibration standards, but without the analytes, internal standards, or surrogates analytes.

Calibration Standard (CAL) –
A solution prepared from the primary dilution standard solution and stock standard solutions of the internal standards and surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

Dissolved Analyte –
The concentration of analyte in an aqueous sample that will pass through a 0.45 µm membrane filter assembly prior to sample acidification (Section 11.1).

Dissolved Phosphorus (P-D) –
All of the phosphorus present in the filtrate of a sample filtered through a phosphorus-free filter of 0.45 micron pore size and measured by the persulfate digestion procedure.

Dissolved Orthophosphate (P-D ortho) –
As measured by the direct colorimetric analysis procedure.

Dissolved Hydrolyzable Phosphorus (P-D, hydro) –
As measured by the sulfuric acid hydrolysis procedure and minus predetermined dissolved orthophosphates.

Dissolved Organic Phosphorus (P-D, org) –
As measured by the persulfate digestion procedure, and minus dissolved hydrolysable phosphorus and orthophosphate

Estimated Detection Limit (EDL) –
Defined as either the MDL or a level of compound in a sample yielding a peak in the final extract with a signal to noise (S/N) ratio of approximately five, whichever is greater.

External Standard (ES) –
A pure analyte(s) that is measured in an experiment separate from the experiment used to measure the analyte(s) in the sample. The signal observed for a known quantity of the pure external standard(s) is used to calibrate the instrument response for the corresponding analyte(s). The instrument response is used to calculate the concentrations of the analyte(s) in the sample.

Field Duplicates (FD1 and FD2) –
Two separate samples collected at the same time and place under identical circumstances and treated exactly the same throughout field and laboratory procedures. Analyses of FD1 and FD2 give a measure of the precision associated with sample collection, preservation and storage, as

well as with laboratory procedures. Since laboratory duplicates cannot be analyzed, the collection and analysis of field duplicates for this method is critical.

Field Reagent Blank (FRB) –
An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FRB is to determine if method analytes or other interferences are present in the field environment.

Instrument Performance Check Solution (IPC) –
A solution of one or more method analytes surrogates, internal standards, or other test substances used to evaluate the performance of the instrument system with respect to a defined set of criteria.

Instrument Detection Limit (IDL) –
The concentration equivalent to the analyte signal which is equal to three times the standard deviation of a series of 10 replicate measurements of the calibration blank signal at the same wavelength (Table 1.)

Internal Standard –
Pure analyte(s) added to a sample, extract, or standard solution in known amount(s) and used to measure the relative responses of other method analytes that are components of the same sample or solution. The internal standard must be an analyte that is not a sample component

Laboratory Reagent Blank (LRB) –
An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. The LRB is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

Linear Calibration Range (LCR) –
The concentration range over which the instrument response is linear.

Laboratory Duplicates (LD1 and LD2) –
Two aliquots of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of LD1 and LD2 indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Laboratory Fortified Blank (LFB) –
An aliquot of LRB to which known quantities of the method analytes are added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

Laboratory Fortified Sample Matrix (LFM) –
An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations.

Linear Dynamic Range (LDR) –
The concentration range over which the instrument response to an analyte is linear.

Laboratory Performance Check Solution (LPC) –
A solution of selected method analytes, surrogate(s), internal standard(s), or other test substances used to evaluate the performance of the instrument system with respect to a defined set of method criteria.

Limit of Detection (LOD) –
The lowest amount of analyte in a sample that can be detected, but not necessarily quantitated as an exact value. The LOD may be expressed as:

LOD = 3.3 * SD / S

where:
SD = the standard deviation of the response
S = the slope of the calibration curve

Limit of Quantitation (LOQ) –
Also known as Minimum Reporting Level (MRL). The lowest amount of analyte in a sample that can be quantitatively determined with suitable precision and accuracy.

Linear Calibration Range (LCR) –
The concentration range over which the instrument response is linear.

Material Safety Data Sheet (MSDS) –
Written information provided by vendors concerning a chemical's toxicity, health hazards, physical properties, fire, and reactivity data including storage, spill, and handling precautions.

Method Detection Limit (MDL) –
The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero (Section 9.2.4 and Table 4.). Procedural Standard Calibration - A calibration method where aqueous calibration standards are prepared and processed (e.g., purged, extracted, and/or derivatized) in exactly the same manner as a sample. All steps in the process from addition of sampling preservatives through instrumental analyses are included in the calibration. Using procedural standard calibration compensates for any inefficiencies in the processing procedure.

Minimum Reporting Level (MRL) –
Also known as Limit of Quantitation (LOQ). The lowest amount of analyte in a sample that can be quantitatively determined with suitable precision and accuracy.

Plasma Solution –
A solution that is used to determine the optimum height above the work coil for viewing the plasma (Sections 7.15 and 10.2.3).

Primary Calibration Standard (PCAL) –
A suspension prepared from the primary dilution stock standard suspension. The PCAL suspensions are used to calibrate the instrument response with respect to analyte concentration.

Primary Dilution Standard Solution (PDS) –
A solution of several analytes prepared in the laboratory from stock standard solutions and diluted as needed to prepare calibration solutions and other needed analyte solutions. The following forms, when sufficient amounts of phosphorus are present in
the sample to warrant such consideration, may be calculated:

Insoluble Phosphorus (P-I) = (P) - (P-D).

Insoluble Orthophosphate (P-I, ortho) = (P, ortho) - (P-D, ortho).

Insoluble Hydrolyzable Phosphorus (P-I, hydro) = (P, hydro) - (P-D, hydro).

Insoluble Organic Phosphorus (P-I, org) = (P, org) - (P-D, org).

All phosphorus forms shall be reported as P, mg/L, to the third place.

Procedural Standard Calibration –
A calibration method where aqueous calibration standards are prepared and processed (e.g., purged, extracted, and/or derivatized) in exactly the same manner as a sample. All steps in the process from addition of sampling preservatives through instrumental analyses are included in the calibration. Using procedural standard calibration compensates for any inefficiency in the processing procedure.

Quality Control Sample (QCS) –
A solution of method analytes of known concentrations which is used to fortify an aliquot of LRB or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check either laboratory or instrument performance.

Secondary Calibration Standards (SCAL) –
Commercially prepared, stabilized sealed liquid or gel turbidity standards calibrated against properly prepared and diluted formazin or styrene divinylbenzene polymers.

Stock Standard Suspension (SSS) –
A concentrated suspension containing the analyte prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source. Stock standard suspension is used to prepare calibration suspensions and other needed suspensions.

Solid Sample –
For the purpose of this method, a sample taken from material classified as either soil, sediment or sludge.

Spectral Interference Check (SIC) Solution –
A solution of selected method analytes of higher concentrations, which is used to evaluate the procedural routine for correcting known interelement spectral interferences with respect to a defined set of method criteria.

Standard Addition –
The addition of a known amount of analyte to the sample in order to determine the relative response of the detector to an analyte within the sample matrix. The relative response is then used to assess either an operative matrix effect or the sample analyte concentration.

Stock Standard Solution (SSS) –
A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source

Surrogate Analyte (SA) –
A pure analyte(s), which is extremely unlikely to be found in any sample, and which is added to a sample aliquot in known amount(s) before extraction or other processing and is measured with the same procedures used to measure other sample components. The purpose of the SA is to monitor method performance with each sample.

Total Recoverable Analyte –
The concentration of analyte determined either by "direct analysis" of an unfiltered acid preserved drinking water sample with turbidity of <1 NTU , or by analysis of the solution extract of a solid sample or an unfiltered aqueous sample following digestion by refluxing with hot dilute mineral acid(s) as specified in the method.

Total Phosphorus (P) –
All of the phosphorus present in the sample regardless of forms, as measured by the persulfate digestion procedure.

Total Orthophosphate (P-ortho) –
Inorganic phosphorus [(PO)] in the 4 -3 sample as measured by the direct colorimetric analysis procedure.

Total Hydrolyzable Phosphorus (P-hydro) –

Phosphorus in the sample as measured by the sulfuric acid hydrolysis procedure and minus predetermined orthophosphates. This hydrolyzable phosphorus includes polyphosphates [(P O) , (P O) , etc.] plus some organic 2 7 3 10-4 –5 phosphorus.

Total Organic Phosphorus (P-org) –
Phosphorus (inorganic plus oxidizable organic) in the sample as measured by the persulfate digestion procedure, and minus hydrolyzable phosphorus and orthophosphate.

Tuning Solution –
A solution which is used to determine acceptable instrument performance prior to calibration and sample analyses.

Water Sample –
For the purpose of this method, a sample taken from one of the following sources: drinking, surface, ground, storm runoff, industrial or domestic wastewater.

MWH Vendor List

Supplier	Address	Used by	Intended Use
Absolute Standards, Inc.	P. O. Box 5585 Hamden, Ct. 06518-0585	GCMS Lab, Inorganic Lab, HPLC/LCMS Lab	Standards
AccuStandard	125 Market Street New Haven, Ct. 06513	GCMS Lab, GC. HPLC/LCMS Lab	Standards
AF Murphy Die & Machine Co.	430 Hancock St Quincy, MA 02171	Inorganic Lab	Radiochemistry Planchetts
Agilent Technologies	Chemical Analysis Group 2850 Centerville Rd. Wilmington, De. 19808	GCMS Lab, GC Lab	Supplies, instrument maintenance, repair, technical support
Altech Associates, Inc.	P.O. Box 23 Deerfield, IL 60015	Inorganic Lab	Chemicals
American Type Culture Collection	12301 Parklawn Lane Rockville, Me. 20852	Microbiology Lab	Bacterial Controls
Beckman Instruments, Inc.	2500 Harbor Blvd., E-20-D Fullerton, Ca. 92634	Inorganic Lab	Instrument maintenance, repair, technical support
Biomerieux Industry	595 Anglum Rd Hazelwood, MO 63042	Microbiology Lab	BactID Supplies
Chem Service, Inc.	660 Tower Lane P. O. Box 310 West Chester, Pa. 19380	GC Lab	Reagents, supplies
Cole Parmer Instrument Co.	Dept CH 10464 Palatine, IL 60055	Inorganic Lab	Supplies
Cosa Instruments Corporation	84G Horseblock Road Yaphank, NY 11980	Inorganic Lab	Supplies
CPI International	P. O. Box 1290 Suisun City, Ca. 94585-1290	Inorganic Lab	Standards, Reagents
Crescent Chemical Co., Inc.	1324 Motor Parkway Hauppauge, NY 11788	Inorganic Lab	Standards, Reagents
Dionex Corporation	1228 Titan Way Sunnyvale, Ca. 94088-3603	Inorganic Lab, HPLC Lab, GC	Instrument maintenance, repair, technical support
Environmental Express LTD	490 Wando Park Blvd. P. O. Box 669 Mt. Pleasant, SC. 29464	Inorganic Lab	Standards, reagents, supplies
Environmental Resource Associates	6000 West 54th Avenue Arvada, CO 80002	Inorganic Lab	Standards
Fisher Scientific	Dept. LA21160 Pasadena, CA 91185	Inorganic Lab	Chemicals, Supplies

MWH Vendor List

Supplier	Address	Used by	Intended Use
Full Spectrum Analytics, Inc.	5635 West Las Positas Blvd. #403 Pleasanton, Ca. 94588	GCMS Lab, GC Lab, Inorganic Lab	Instrument maintenance, repair, technical support
Glass Expansion Inc.	4 Barlows Landing, Unit #2 Pocasset, MA 02559	Inorganic Lab	Supplies
Hach Company	P. O. Box 389 Denver, Co. 80539	GC Lab, Inorganic Lab	Reagents, supplies
High Purity Standards	P.O. Box 41727 Charleston, SC 29423	Inorganic Lab	Standards
IDEXX Distribution Corporation	6100 E. Shellby Dr. Memphis, Tn. 38141-7602	Microbiology Lab	Microbiological media
Inorganic Ventures	195 Lehigh Ave. Ste 4 Lakewood, NJ 08701	Inorganic Lab	Supplies, Standards
Isotope Products Laboratories	1800 North Keystone Street Burbank, Ca. 91504	Inorganic Lab	Standards
Lab Safety Supply - WI	P.I. Box 5004 Janesville, WI 53547	Inorganic Lab, Health and Safety Department	Safety equipment
Lachat Instruments	5566 Collections Center Dr Chicago, IL 60693	Inorganic Lab	Supplies
Man-Tech Associates Inc.	600 Main St. Tonawanda, NY 14150	Inorganic Lab	Supplies
McBain Instruments	9601 Variel Ave. Chatsworth, Ca. 91311-4914	Microbiology Lab	Instrument maintenance, repair
Miele Professional	9 Independence Way Princeton, NJ 08540	Dishwashing	Supplies
OI Analytical	P. O. Box 9010 151 Graham Road College Station, Tx. 77842-0440	GCMS Lab	Instrument maintenance, repair, technical support, supplies, chemicals
Perkin Elmer	761 Main Ave. Norwalk, Ct. 06859-0001	Inorganic Lab	Instrument maintenance, repair, technical support
Phenomenex	411 Madrid Avenue Torrance, CA 90501	HPLC/LCMS Lab	Supplies
Pickering Laboratories, Inc	1280 Space Park Way Mountain View, CA 94043	HPLC/LCMS Lab	Instrument supplies
Precision Glassblowing	14775 E. Hinsdale Ave. Centennial, CO 80112	Inorganic Lab	Supplies

MWH Vendor List

Supplier	Address	Used by	Intended Use
Protean Instrument Corporation	P. O. Box 1008 260 Grand Street Lenoir City, Tn. 37771-1008	Inorganic Lab	Instrument maintenance, repair, technical support
Protocol Analytical Supplies, Inc.	472 Lincoln Blvd. Middlesex, NJ 08846	GCMS Lab	Standards
Restek Corporation	Penn Eagle Industrial Park 110 Benner Circle Bellefonte, Pa. 16823-8812	GC Lab, HPLC Lab, GCMS Lab	Reagents, supplies
Scientific Instrument, SIS	1027 Old York Road Ringoes, NJ 08551-1039	GCMS Lab	Supplies
SCP Science	348 Route 11 Champlain, NY 12919	Inorganic Lab	Standards, Supplies
SEAL Analytical, Inc	1492 Mequon Road Mequon, WI 53092	Inorganic Lab	Supplies
Sigma_Aldrich, Inc.	P. O. Box 952968 St. Louis, Mo. 63195-2968	Inorganic Lab, GCMS Lab, GC	Standards, Reagents, supplies
Spectrum Laboratories, Inc. dba	755 Jersey Ave. New Brunswick, NJ 08901	Inorganic Lab	Supplies
Tekmar Company	7143 East Kemper Road Cincinnnati, Oh. 45249	GCMS Lab	Instrument maintenance, repair, technical support, supplies, chemicals
Davis Inotek	5730 Ayala Ave. Irwindale, Ca. 91703	Quality Assurance Department	Calibration of reference thermometers
Thermo Optek Corporation	Service Operations Drawer CS 100623 Atlanta, Ga. 30384-0623	Inorganic Lab, GCMS Lab	Instrument maintenance, repair, technical support
Ultra Scientific	250 Smith Street North Kingstown, RI 02852-7723	Inorganic Lab, GCMS Lab, GC Lab, HPLC Lab, QA Department	Standards, supplies, reagents
Varian	Chromatography Systems 2700 Mitchell Drive Walnut Creek, Ca. 94598	GC Lab, GCMS Lab	Instrument maintenance, repair, technical support, supplies, chemicals

MWH Vendor List

Supplier	Address	Used by	Intended Use

VWR Scientific Products Corporation*	P. O. Box 640169 Pittsburgh, Pa. 15264-0169	Inorganic Lab, GCMS Lab, GC Lab, QA Department, Microbiology, HPLC/LCMS Lab	Standards, reagents, supplies, standard thermometers
Waters Corporation	34 Maple Street Milford, MA 01757	HPLC/LCMS Lab	Instrument Supplies
Watson Brothers, Inc.	1235 South Victory Blvd. Burbank, Ca. 91502	Quality Assurance Department	Maintenance and calibration of the laboratory's balances and S class weights
WestAir Gases and Equipment		All Labs	Reagents, Supplies

*VWR supplies MWH Laboratories with reagents, standards and supplies from many companies, including but not limited to the following:
JT Baker, Mallinckrodt, Difco, Becton Dickinson, Ricca, Gelman, J & W Scientific, Ultra Scientific, EM Science

Supplier	**Address**	**Used by**	**Intended Use**
Post Security		Facilities Management	Fire alarm panel maintenance
Iron Mountain	P.O. Box 65017 Charlotte, NC 28265-0017	All Departments	Archiving and off-site data storage
MOE Plumbing		Facilities Management	Building maintenance
Post Alarm		Facilities Management	Building security, escorts
Viking Refrigeration	1770 East Cypress Covina, CA 91724	Facilities Management	Refrigerator maintenance
DuraCold	1551 S. Primrose Lane Monrovia, CA 91016	Facilities Management, Sample Control Department	Walk-in coolers, storage refrigerator maintenance
Westway Electrical Systems		Facilities Management	Building maintenance